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Performance Evaluation of WiMAX in Orthogonal Space Time Block Coding

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ABSTRACT: WiMAX (Worldwide Interoperability for Microwave Access) is a wireless communications standard designed to provide 30 to 40 megabit-per-second data rates, with the 2011 update providing up to 1 Gbit/s for fixed stations. The name "WiMAX" was created by the WiMAX Forum, which was formed in June 2001 to promote conformity and interoperability of the standard. At present, telecommunication industries are highly concerned with the wireless transmission of data which can use various transmission modes, from point- to-multipoint links. It contains full mobile internet access.

Keywords: WiMAX, Multicast/Broadcast Service, Broadband Wireless Application, minimizing energy consumption.

I. INTRODUCTION

The Multicast/Broadcast Service (MBS) feature of mobile WiMAX network is a promising technology for providing wireless [1] multimedia, because it allows the delivery of multimedia content to large-scale user communities in a cost-efficient manner. In this paper, we focus on two research problems in such networks: maximizing the video quality and [6] minimizing energy consumption for mobile receivers. We prove that these problems are NP-Complete, and propose constant factor approximation algorithms to solve them.Our algorithms intelligently select video layers from a scalable video stream to maximize video quality and construct burst transmission schedules that reduce receiver device energy consumption without sacrificing the video quality. Using extensive simulation and mathematical analysis we show that the proposed solution: is efficient in terms of execution time, achieves high radio resource utilization, maximizes the received video quality, and minimizes the energy consumption for mobile receivers. multicast video streaming; mobile multimedia; wireless transmission scheduling; scalable video coding; WiMAX; energy efficiency The demand for mobile multimedia streams has been increasing in the past few years as indicated by multiple market analysis studies. Multimedia streams can be delivered to mobile devices over a variety of wireless networks, including 3G (Third Generation mobile communication standards), WiFi (Wireless Local Area Network technologies based on IEEE802.11 set of standards) and WiMAX (Worldwide Interoperability for Microwave Access) networks. In this paper, we focus on multimedia streaming over WiMAX networks, which are specified by the IEEE 802.16 standard [9].Although some of the currently de- played WiMAX networks are mostly used to provide wireless Internet access to subscribers, the WiMAX standard supports various network services. One of these services is the Multicast and Broadcast Service (MBS), which can be used to deliver multimedia traffic to large-scale user communities. For example, Yota Telecom [4] has recently started a mobile TV service with 25 channels over its 10Mbps mobile WiMAX network, and UD Cast [7] has announced plans for developing broadcast TV service supporting around 50 channels over mobile WiMAX. It is expected that more WiMAX deployments will offer mobile multimedia services in the near future. Although a considerable amount of work has been done to make these deployments a reality, several research problems remain to be addressed in order to optimize the quality of the offered multimedia services. The Multicast/Broadcast Service feature of mobile WiMAX networks is a promising technology for providing wireless multimedia, because it allows the delivery of multimedia content to large-scale user communities in a cost-efficient manner. In this paper, we consider WiMAX networks that transmit multiple video streams encoded in scalable manner to mobile receivers using the MBS feature.

In addition, since many subscribers of the WiMAX multimedia services are expected to be mobile users with energy constrained devices, such as smart phones, 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 evolution of WiMAX commence 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.

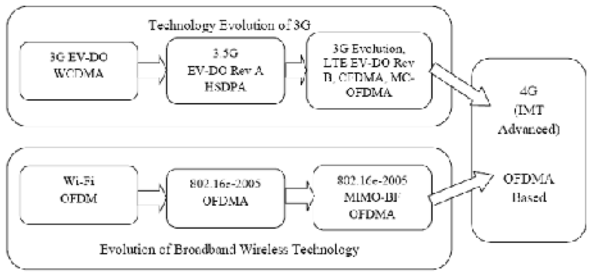

Fig. 1. Evolution Path of Mobile Technologies towards 4G WiMAX

A. Fixed Vs Mobile WiMAX

There are certain differences between Fixed WiMAX and Mobile WiMAX. 802.16d (Rev 2004) is known as Fixed WiMAX and 802.16e standard is fondly referred as Mobile-WiMAX. The 802.16d standard supports fixed and nomadic applications whereas 802.16e standard supports fixed, nomadic, mobile and portable applications. The 802.16e carries all the features of 802.16d standard along with new specifications that enables full mobility at vehicular speed, better QoS performance and power control but 802.16e devices are not compatible with 802.16d base stations as 802.16e based on TDD whereas 802.16d is on FDD. Due to other compatibility issues with existing networks, 802.16e adopted S-OFDMA and 2048-FFT size. The main aim of mobile WiMAX is to support roaming capability and handover between Mobile Station (MS) and Base Station (BS) [3]. Several countries have already planned Mobile WiMAX for commercial services. The development included some new features on the link layer. Such features are, different types of handover techniques, robust power saving system and multiple broadcast supports etc.

B. WiMAX's Path to Overcome

There are several challenges for WiMAX. These important issues must be solved to fulfill its dream of last mile solution. Some of those are mentioned below.

C. Multi Path Fading

When an object comes on the way between a wireless transmitter and a receiver, it blocks the signal and creates several signal paths known as multi path. Even though the signal makes till the receiver but with variant time and it is hard to detect the actual signal. Multi path degrade the quality of the signal. Several multipath barriers which as shown in Table 1.

Table. 1: Sample Traffic Parameters for Broadband Wireless Application.

Parameter	**Interactive Gaming**	**Voice**	**Streaming Media**	**Data**	**Video**
Data rate	50Kbps to 85Kbps	4Kbps-64Kbps	5Kbps-384Kbps	0.01Mbps-100Mbps	> 1Mbps
Applications	Interactive gaming	VoIP	Music, Speech, Video Clips	Web browsing, e-mail, instant messaging, telnet, file download	IPTV, movie download, p2p video sharing
Packet loss	Zero	<1%	<1% Audio <2% Video	Zero	<10-8
Delay Variation	Not Applicable	<20ms	<2sec	Not Applicable	<2sec
Delay	<50ms-150ms	<100ms	<250ms	Flexible	<100ms

To get high speed network connectivity, only necessary thing is to become a subscriber of WiMAX service providers. Then they will provide hardware that is very easy to install. Most of time hardware connects through USB ports or Ethernet and the connection may be made by clicking button.

Frequency selective fading can be overcome by applying adaptive equalization.

Adaptive Modulation and Coding (AMC), AAS and MIMO techniques helps WiMAX to works efficiently in NLOS condition.

Sub-channelization permits to transmit appropriate power on sub-channels.

Based on the required data rate and channel condition, AMC provides the accurate modulation and code dynamically.

AAS directs WiMAX BS to a subscriber station.

MIMO helps to improve the signal strength and throughput in both stations.

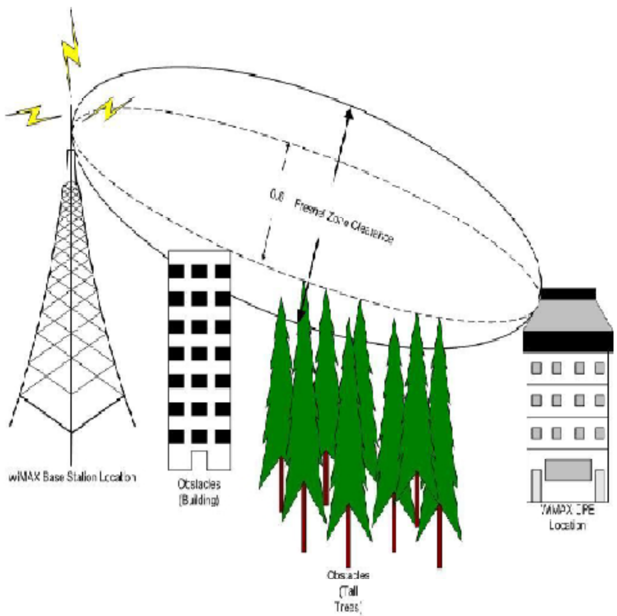

Fig. 2. WiMAX in LOS Condition.

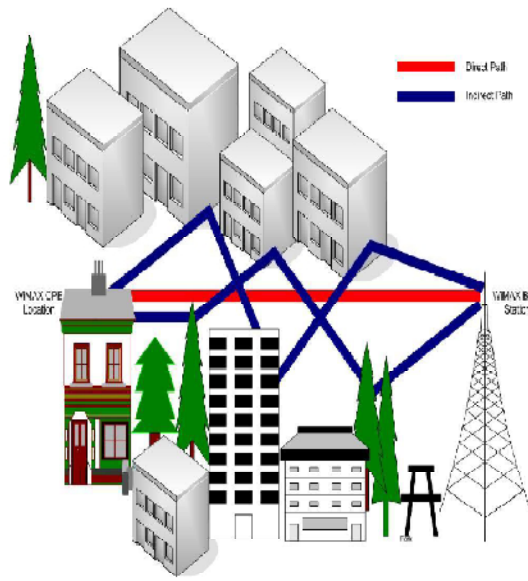

Fig. 3. WiMAX in NLOS Condition.

.In condition, the speed is high but the coverage area would be lower than that of LOS condition.

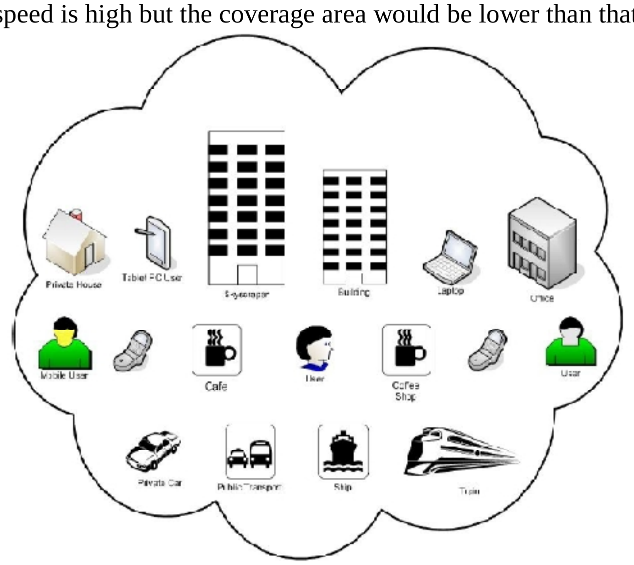

Fig. 4. Mobile WiMAX Scenario.

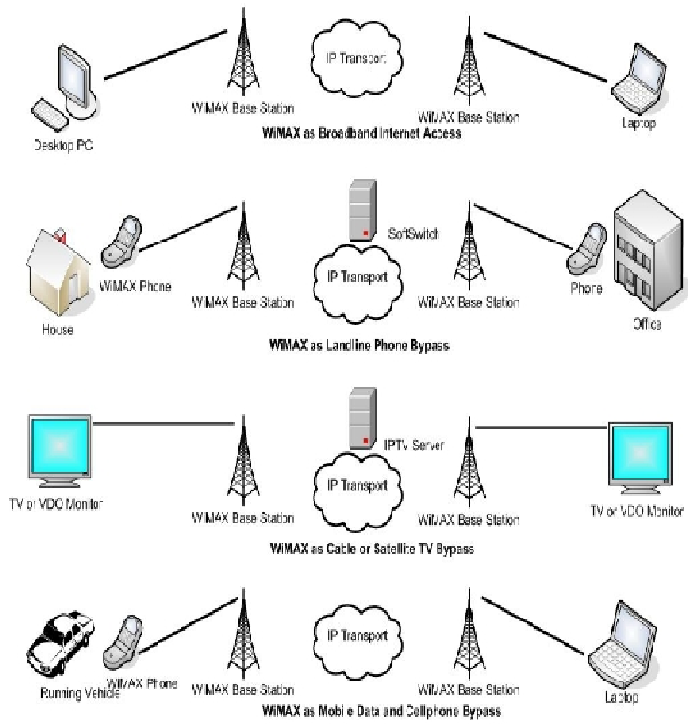

Fig. 5. Fixed and Mobile WiMAX in different applications.

WiMAX comprises of two main parts
1. WiMAX base station and
2. WiMAX receiver

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. [17] The WiMAX base station may be connected with other base stations by high speed microwave link which is called backhaul. 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.

II. RESULTS

Performance comparisons of the WiMAX based MIMO-OSTBC systems developed in MATLAB. In the simulation process, the goal was to reach a symbol error rate (SER) of at least 10^{-4} to evaluate the performances of the systems. Therefore for each SNR at least 2,50,000 information bits were simulated for each system. One run of sending about 2,50,000 bits for all SNR values is called a Monte Carlo run. The systems were simulated for a specified number of Monte Carlo runs and the results were averaged such that the SER curves were smooth enough for evaluation. The results of this dissertation are based on M-ary PSK modulation technique over fast Rayleigh fading channel. We have simulated the proposed approach for 2-PSK (M = 2), 4-PSK (M = 4), and the number of OSTBC subcarriers are assumed to be 124. Moreover in our result we have considered that there is perfect channel state information (CSI) at both transmitter and receiver so that maximum diversity is confirmed. illustrates the noise reduction in balanced MIMO for OSTBC based on Alamouties technique with 2-PSK modulation scheme in terms of symbol error rate (SER) and signal to noise ratio (SNR) gain while Fig. and represent the evaluation of same codes but with 2-PSK and 4-PSK modulation schemes.

We simulate the result with 2 transmit and 2 receiver antennas and the decoding of the signal OSTBC codes are simulated by using three different decoding techniques, these are MMSE (minimum mean square error), ZF (zero forcing) and ML (maximum likelihood) using soft decision decoding with viterbi algorithm. Our result shows that out of these techniques the Alamouti with BPSK,OSTBC with QPSK, No Diversity with BPSK,Maximal-Ratio Combining with BPSK,and Theoretical 4th Order Diversity, QPSK gives much better result than MMSE and ZF decoding. Moreover our result shows that the 16-PSK modulation scheme can reduce more noise than 2-PSK and 4-PSK for same codes having similar antennas and similar bit rate.

The results of BER performance and SNR of Phase Shift Keying for M = 2,4,8 and 16 obtained using communication toolbox in MATLAB are shown in Fig. and The comparative performance analysis of simulated and theoretical curves for BER vs SNR (signal to noise ratio). A brief view for various simulation parameters are listed in the following Table 2.

Table 2: Various simulation parameters.

Modulation scheme	**2-PSK, 4-PSK, 16-PSK**
Number of subcarrier for OSTBC	**124**
Symbol length	**64**
Channel estimation	**Perfect/8 pilot symbol per frame**
Signal estimation	**Correlated**
Channel techniques	**Alamouti, Fast Rayleigh fading channel**
Decoding techniques	**MMSE, ZF, Soft decision ML**

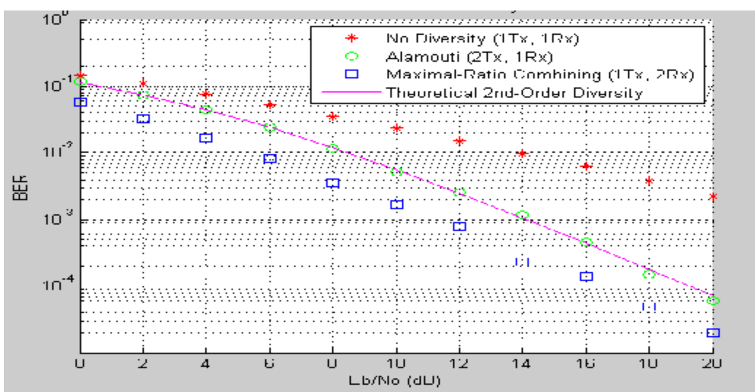

Fig. 6. The relation of symbol error rate (SER) and SNR gain with No Diversity, Alamouti, Maximal-Ratio Combining and Theoretical 2nd-Order Diversity.

The above graph shows the Comparison of symbol error (SER) rate and SNR gain for Alamouti with BPSK,OSTBC with QPSK, No Diversity with BPSK, Maximal-Ratio Combining with BPSK, and Theoretical 4th Order Diversity, QPSK average total bit rate, as a function of the total CRU transmit power, , for = 0.7, 0.9, and 1 with , = 0.02 W, and a PU transmit power of 5W. As expected, the average total bit rate increases with the maximum transmit power budget.

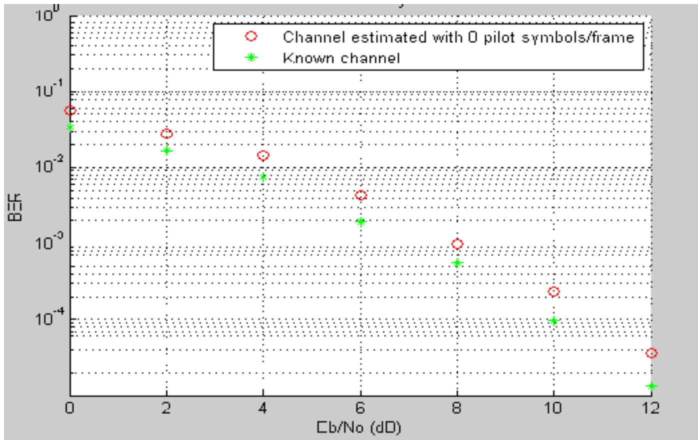

Fig. 7. The relation of symbol error rate (SER) and SNR gain with channel estimated with 8 pilot symbols/frame and known channel.

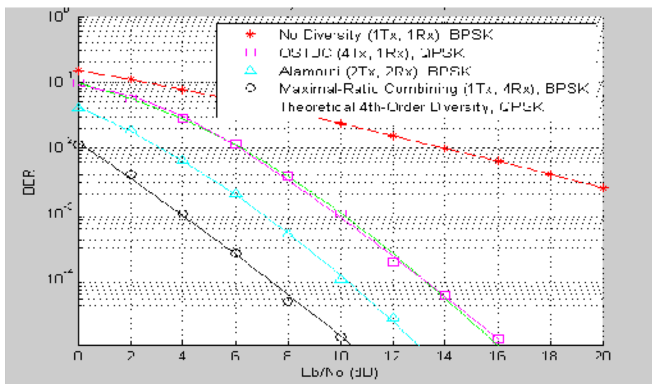

Fig. 8. The relation of symbol error (SER) rate and SNR gain for Alamouti with BPSK, OSTBC with QPSK, No Diversity with BPSK, Maximal-Ratio Combining with BPSK, and Theoretical 4th Order Diversity, QPSK.

III. CONCLUSION

After all conditions we applied and the results we got we can conclude our work as follows, We studied WiMAX OFDM physical layer, mobile systems, modulation techniques and features of WiMAX networks properly, with the help of necessary figures and tables. We studied SUI-3 channel model and also implemented it through Matlab simulation to evaluate the performance of Mobile WiMAX. We also used and understood the adaptive modulation techniques like, BPSK, QPSK, 16-QAM and 64 QAM according to IEEE 802.16e standard. We know that fading is one of the main parts of wireless communication. At the beginning of our simulation, we used multipath fading and then got some results using Rayleigh fading and AWGN. In all aspects of adaptive modulation technique, we can conclude the performance of WiMAX as, Binary Phase Shift Keying (BPSK) is more power efficient and needs less bandwidth. On the other hand 64-Qadrature Amplitude Modulation (64-QAM) has higher bandwidth with very good output. In another case, Quadrature Phase Shift Keying (QPSK) and 16-QAM modulation techniques are in middle of those two (BPSK and 64-QAM) and they requires higher bandwidth. QPSK and 16-QAM are less power efficient than BPSK. During all simulations we got, BPSK has the lowest BER and 64-QAM has the highest BER than other modulation techniques. We also add some more things in here. We included Cyclic Prefix (CP) and random signals which reduced noise resulting lower Bit error Rate (BER) for OFDM system but increased the complexity in the system. Cyclic Prefix requires higher power but non Cyclic Prefix requires lower power.

FUTURE WORK

A lot of works can be done for future optimization of Wireless communication especially in WiMAX system. Adaptive modulation techniques and WiMAX physical layer can be adopted with High Amplitude Platform (HAP) and Long Term Evaluation (LTE). As we used SUI-3 channel model along with AWGN, Rayleigh and Rician Fading channels, performance of WiMAX can be evaluated in other types of channel model.

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