NUMERICAL MODELING OF EFFICIENT WIMAX STANDARD WITH VBLAST TECHNIQUE

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ABSTRACT - *This paper presents the numerical modeling of IEEE 802.16 standard WiMAX in an efficient way by implementing one of the most promising MIMO technique i.e. VBLAST scheme. Currently the huge growth can be observed in the area of wireless networking and as a part of that WiMAX standard has been treated as the most innovative 4G standard that fills the gape between existing wireless networking standards and cellular telephony standards. Today's demand is to achieve the highest speed of communication along with excellent reliability. Currently WiMAX offers end to end last mile connectivity along with sufficient mobility as well as proper reliability in terms of error disturbances but still under certain unfavorable channel conditions, the output performance will degrade due to channel noise and atmospheric conditions. Hence to cope up with the current demands, the existing WiMAX standard can be made more efficient with the implementation of MIMO-VBLAST scheme. VBLAST is the innovation in the direction of advance antenna systems. It is the category of Multiple Input Multiple Output Antenna system wherein the multipath structure of wireless channel is exploited as an advantage for reducing bit error rate and for increasing data rate. With the implementation of VBLAST scheme which is also known as Matrix-B MIMO in WiMAX, the 4th generation wireless communication technique can be made more efficient in terms of BER and data rate*

Key Words: ***Wimax, MIMO System, V-BLAST Structure, STBC, Data Rate, BER & SNR.***

I: INTRODUCTION

WiMAX, the Worldwide Interoperability for Microwave Access is the most promising technology developed by IEEE as an IEEE 802.16 standard that aims to provide business and consumer wireless broadband services in form of Metropolitan Area Network (MAN). The technology has a target range of up to 31 miles and a target transmission rate exceeding 100 Mbps and is expected to challenge DSL and T1 lines (both expensive technologies to deploy and maintain) especially in emerging markets. WiMAX's attributes open the technology to a wide variety of applications. As WiMAX is offering comparatively longer range and high enough transmission rate, it can be considered as a backbone for existing Wi-Fi hotspots for the Internet connections. Moreover, WiMAX base stations are also compatible for establishing connectivity with devices such as laptops and handsets without the use of 802.11 standards.

Basically the WiMAX system fills the gap between the WiFi standard and Cellular GSM standard in terms of mobility and speed.

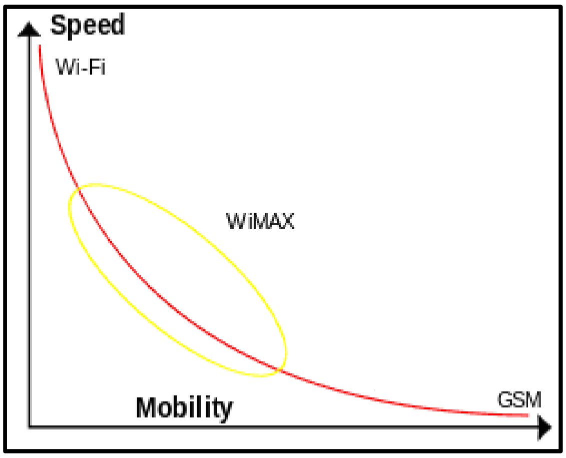

Fig-1: Relationship of WiMAX with WiFi and GSM

Following are the Salient features of WiMAX system:
i. OFDM-based physical layer: The OFDM transceiver is utilized as a base of WiMAX physical layer through which the multi path fading effects can be nullified with 50% saving in transmission bandwidth. ii. Very high peak data rates: This is the unique feature of WiMAX system where the current cellular standards are having difficulties. This

standard is able to provide data rates up to 70Mbps theoretically with 20MHz spectrum range.

iii. Orthogonal frequency division multiple access (OFDMA): Along with multiplexing, the multiple access technique utilize by this standard to access different services is OFDMA where in again frequency diversity can be employed.

iv. Adaptive modulation and coding (AMC): For the improvement in channel capacity, WiMAX physical layer supports many advanced signal processing algorithms such as adaptive modulation and coding, spatial multiplexing, and multi-user diversity.

v. Link-layer retransmissions: For anticipating extra robustness against channel errors, this standard supports Automatic Retransmission Request (ARQ) protocol in the data link layer. The logic behind this service protocol is establish reliable connection through which the transmitted packet should be acknowledged positively or negatively. In case of negative acknowledgement, the packets are assumed to be lost and retransmitted again.

vi. Support for advanced antenna techniques: This feature depicts the compatibility of WiMAX standard with a innovative approach of antenna diversity. In physical layer of WiMAX system, multiple antennas can be implemented and utilized for increasing spectral efficiency and data rate.

vii. Quality-of-service support: The parameter of QoS defines structure and specification of the WiMAX layer. It's a connection oriented architecture through which different form of data i.e. voice, video, etc. can be transmitted.

viii. Robust security: WiMAX standard provides robust security by means of strong encryption and authenticaltion.

ix. IP-based architecture: WiMAX describes a flexible all-IP-based network architecture which permits for the exploitation of all the benefits of IP.

In this paper, the modeling of WiMAX system with V–BLAST technique has been carried out so as make the system more efficient. The following two consecutive sections deal with the basic architecture of V-BLAST system and the numerical modeling and simulation of WiMAX with V-BLAST structure along with the simulation results in image form.

II. V-BLAST TECHNIQUE

BLAST stands for Bell Laboratories Layered Space Time. As already discussed that the traditional approach of wireless communication system analyzes fading as a culprit because the images arrive at the receiver at slightly different times and can thus interfere destructively but with the use of antenna diversity techniques this multipath structure has become the boon for the betterment of system capacity.

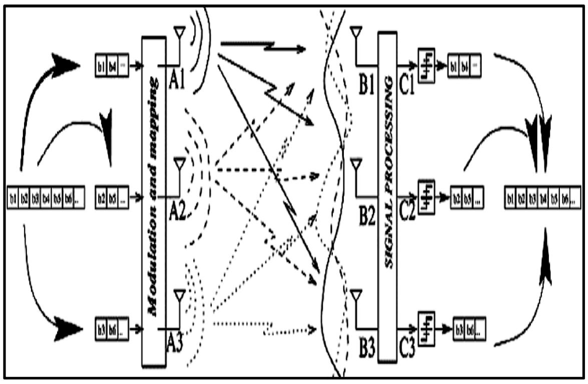

Fig-2: V-BLAST Architecture

As contrary to the alamouti technique in which multiple antennas are transmitting the same signal at a time and at the receiver side, multiple antennas are receiving those many copies of data stream out of which best path will get selected, in this case the data stream is bifurcated into substreams proportional to the no. of transmitting antennas and then individual antenna will transmit each independent substream which all are going to received and detected by multiple receivers. The idea behind the technique is to increase the data rate of the system dramatically by taking the advantage of multiplexing gain property of antenna diversity.

In V-BLAST a single data stream is split into multiple sub-streams and multiple transmitter antennas are used to simultaneously launch the parallel sub streams as shown in figure 2. All the sub-streams are transmitted by using the same frequency band, so spectrum efficiency will improve drastically. Moreover the user's data is being sent in parallel over multiple antennas, the effective data rate is increased in roughly in proportion to the number of transmit antennas used. One thing that has to be made sure is number of receivers for this system must be equal to or greater than that of the transmitter. The transmitted sub-streams are independent of one another. Individual transmitter power is scaled by 1/M. So, total power remains constant independent of number of the transmitters (M).

At the receiver, again the multiple antennas i.e. array of antennas is used to receive the multiple transmitted data sub streams and their multipath replicas. Each receiver antenna receives all the data sub streams that are transmitted by no. of antennas. These all streams approaching to the individual receiver are not separate but are superimposed over one another. However, because of sufficient multipath scattering observed by different data substreams is different, by the use of quality signal processing algorithms the individual substreams will be detected from the multiple copies of it at each receiver side. In effect, the unavoidable multipath is exploited to provide a very useful spatial parallelism that is used to greatly improve data transmission rates. Thus, when using the V-BLAST technique, the more multipath, the better, just the opposite of conventional systems.

III. MODELING & SIMULATION OF WiMAX-V-BLAST TECHNIQUE

This section of the peper deals with the realization of MIMO-VBLAST in WiMAX system by anticipating 4x4 structure of antenna at the transmitter as well as at the receiver side. The following literature elaborates the block by block analysis of WiMAX-VBLAST model.

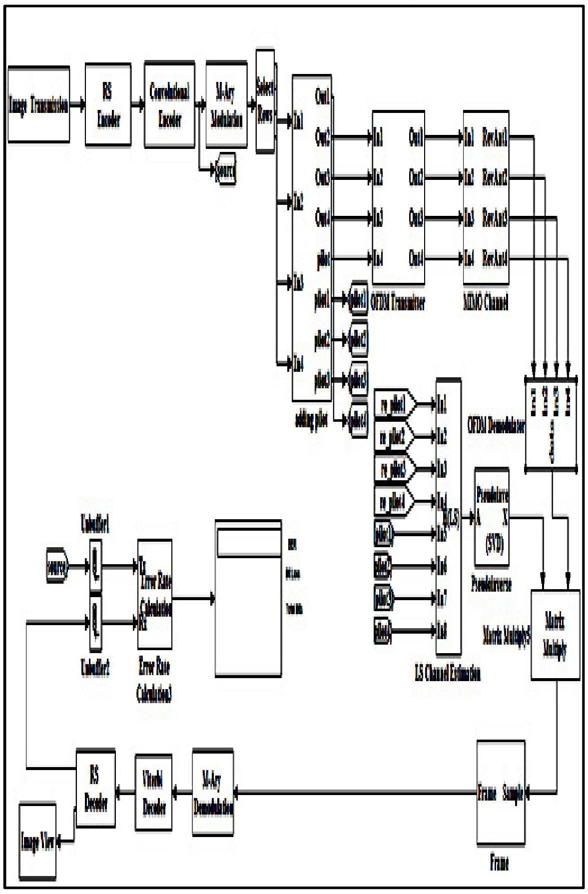

Fig-3: MIMO-VBLAST Model

1. The system is initiated with input image block. Input image of dimension (256x256) would be captured and converted into the bits by means of “image transmission” block.
2. Then after the data bits are encoded through the series combination of RS encoder and Convolution encoder.
3. This data stream is modulated by means of M-ary Modulator which will be having order of modulation 8.
4. Now as it has been already discussed in the previous section that VBLAST follows the logic of transmission of different data sub streams through different antennas, here in this system prior to exact transmission, the complete modulated data stream of M-ary Modulator block will be divided into four sub streams as this system is having 4x4 designing of antennas. With help of multi port selector (Select Rows) utility block of MATLAB, this bifurcation of data stream into no. of sub streams proportional to no. of antennas is carried out.
5. Further, as a next transmission step, the four data sub streams are combined with 64 pilot carriers by means of “adding pilot” MATLAB utility block.
6. The data sub streams with added pilots are made to modulate with OFDM transmitter sub system which is the base of WiMAX physical layer.
7. The four OFDM processed data sub streams will be made to transmit through four AWGN channels whose performance will be judged based on the value of signal to noise ratio.
8. The very first block of receiver system is OFDM receiver wherein FFT will be performed at the initial stage and then simultaneously cyclic prefix and training sequences will be eliminated.
9. Further, these four sub streams are given to four demultiplexers’ assembly where the four BLAST pilots of size (64x1) will be separated from the data that are utilized to estimate the behavior of the channel. Subsequently the recovered BLAST pilots from the process of demultiplexing as explained in the step no. 9 are compared with original transmitted pilots so as to estimate the behavior of the channel. This task is carried out by LS channel estimation block which is doing ML detection. The process is getting completed by doing pseudo inverse of the output of LS estimation. Finally (4x4) matrix would be generated that gives the estimation of channel errors.
10. Now, as a next process this modulated data stream will be demodulated by means of M-ary demodulator.
11. At last over binary data RS decoding, viterbi decoding and output image retrieval kind of processes would be performed and by doing MATLAB simulation, the output and input image comparison and BER calculation would be performed.

IV. SIMULATION RESULTS & DISCUSSION

As per the snap shot of VBLAST model shown in figure-3, by setting the value of SNR=24dB is simulated in MATLAB environment.

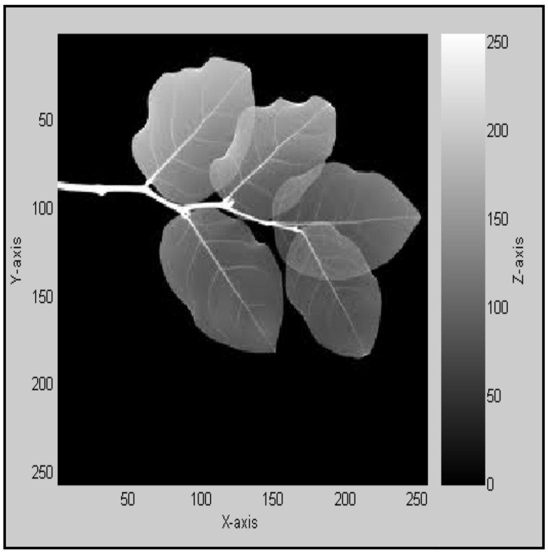

Fig-4: Input Image

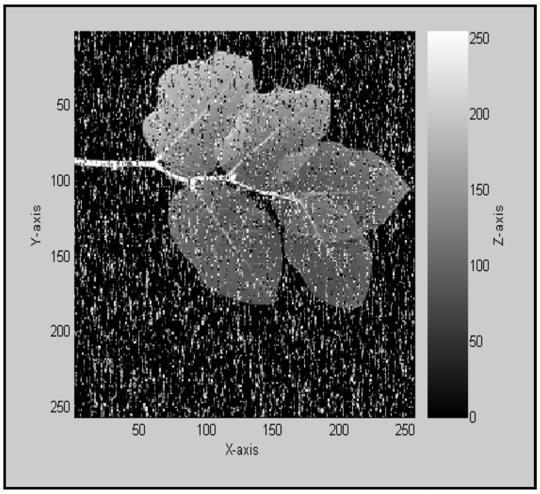

Fig-5: Output Image without VBLAST

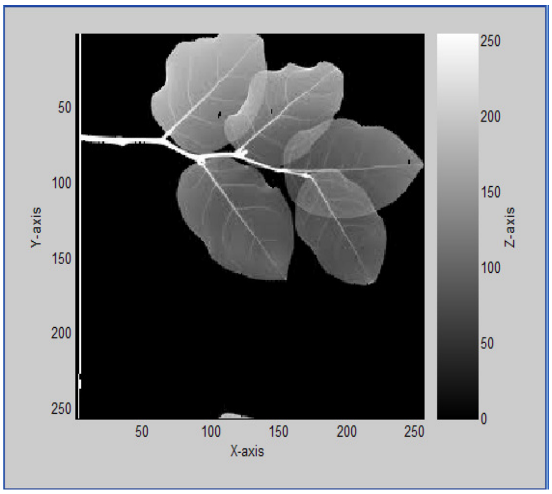

Fig-6: Output Image withVBLAST

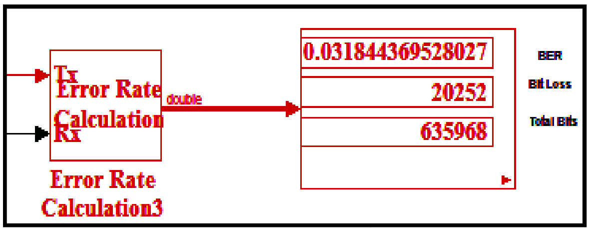

Fig-7: BER calculator without VBLAST

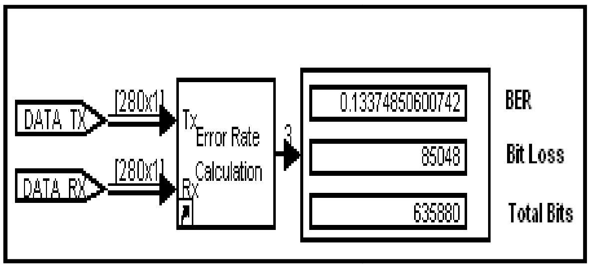

Fig-8: BER calculator withVBLAST

The model is simulated by passing the input image as shown in figure 4. Figure 5 shows the output image of traditional WiMAX model without VBLAST structure which is significantly distorted and the the same fact can also be justified by the reading of BER calculator. Without VBLAST, by simulating WiMAX model, out of 635900 bits, 85048 bits are getting lost leading to BER of 0.13. While under the same condition, once the WiMAX model with VBLAST is simulated the error performance will increase dramatically which can be seen from the quality of output image as shown in figure 6. Also the measurement of BER calculator is having improved BER of around 0.03 as compare to the traditional model.

V. CONCLUSION

With the implementation of MIMO-VBLAST in WiMAX structure, the whole capacity of the system will improve considerably in terms of Bit Error rate and data rate. With traditional WiMAX system that utilizes single antenna transmitter and receiver system, due to multi path structure of wireless channel, the error rate is high, while with the implementation of 4x4 VBLAST structure in WiMAX, the BER will improve considerably from 0.1 to 0.03 and subsequently data rate would be much higher as 4 antennas will transmit different signals simultaneously.

VI. FUTURE WORK

Implementation of VBLAST in WiMAX leads to increase in multiplexing gain thereby improvement in data rate. But still more work is required towards the improvement in BER. Though BER is better in WiMAX-VBLAST as compare to WiMAX-SISO, yet it can be improved with the hybrid implementation of STBC-VBLAST in WiMAX.

VII. REFERENCES

[1] A.L. F. de Almeida, W. C. Freitas Jr., J. C. M. Mota, F. R. P. Cavalcanti and R. L. de Lacerda Neto (2003), "Performance of MIMO Systems with a Hybrid of Transmit Diversity and Spatial Multiplexing", XX Symposiums, Brasileiro De Telecommunication, Rio De Janeiro.

[2] Ahmed S. Ibrahim, Mohamed M. Khairy, and A. F. Hussein (2004), "Multi Layered Space Time Block Codes For OFDM Systems", Proc. The International Conference on Electrical, Electronic and Computer Engineering, Ain Shams University, Egypt.

[3] Angela Doufexi, Andrew Nix, Mark Beach (2005), "Combined Spatial Multiplexing and STBC to Provide Throughput Enhancements to Next Generation WLANs", IEEE transaction.

[4] Fenghua Li, "Performance Analysis of V-BLAST Detectors for the MIMO channel."

[5] Nirmalendu Bikas Sinha, R. Bera, M. Mitra (2005), "Capacity and V-BLAST Techniques for MIMO Wireless Channel", Journal of Theoretical and Applied Information Technology.

[6] Rui Zhang and John M. Cioffi (2008), "Approaching MIMO-OFDM Capacity With Zero-Forcing V-BLAST Decoding and Optimized Power, Rate, and Antenna-Mapping Feedback", IEEE Transactions on signal processing, vol.56, No. 10.

[7] W. C. Freitas Jr., A. L. F. de Almeida and F. R. P. Cavalcanti, "Interference Cancellation Receiver for Space Time Block Coded Systems Over Frequency Selective Channels", IEEE transaction.

[8] Yu-Jin Song, Seong-Weon Ko, Hyun-Jin Park, Hun-Hee Lee, and Hyoung-Kyu Song (2010), "A Novel Efficient Detection Scheme for Hybrid STBC in MIMO-OFDM Systems", IEEE International Conference on Communication Technology, pp. 701-704, 978-1-4244-6868-3.

[9] Chee Wei Tan and A. Robert Calderbank (2009), "Multiuser Detection of Alamouti Signals", IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 57, NO. 7.

[10] Amitabh Kumar, "Mobile Broadcasting with WiMAX: Principles, Technology, and Applications", Focal Press Media Technology Professional Elsevier.

[11] Rajesh Bansode, Prajakta Sarode and B.K.Mishra (2013), "Performance Evaluation of 4x4 MIMO transceiver using 16 QAM", International Conference and workshop on emerging trends in technology.