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WIMAX-OFDMA USING HIGH EFFICIENCY VIDEO CODING IN VLSI ACCOMPLISHMENT

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Abstract - *The demand for video transmission is increasing day to day life so an effective video communication for wireless transmission is High Efficiency Video Coding in WIMAX - OFDMA.HEVC (High Efficiency Video Coding) is recently prepared new video coding standard by ITU- T Video Coding Expert Group along with ISO /IEP Moving Picture Expert Group. The HEVC standard is design to achieve higher compression compared to existing standard and approx. 50% low bit rate for same quality video. Wi-Max is design to serve over MAN, targeting approx 50KM range with the approx speed more than 1 Gbps with large no of users. It must support the H D quality video and all other data traffic at the same time to all users. Hence , the video must be compressed in such a way that HD quality video should be passed at lower data rate. This paper is focused on transmitting high quality video over the 4G Network with low data rate.*

***Key Words*: : HEVC, HEVC Encoder, HEVC Decoder, 4G Wireless Network, WIMAX-OFDMA,HD quality**

1.INTRODUCTION

WiMAX stands for Worldwide Interoperability for Microwave Access. WiMAX is based on wireless Metropolitan Area Network (MAN) standards developed by IEEE 802.16 group. It operates in the licensed exempt and licensed spectrum between 2-11 GHz and 10-66 GHz frequency ranges respectively [1]. It was developed to connect the Internet and to provide a last mile wireless extension to cable and DSL broadband access. IEEE 802.16 provides up to 50 km of linear service area range and allows users connectivity without a direct Line of Sight (LOS) to a Base Station (BS). The technology also provides shared data rates up to 70 Mbps, which is enough bandwidth to simultaneously support many users.

In Space Time Block Codes (STBC), data stream is encoded in blocks and distributed among time and spaced antennas. At the transmitter side this encoded data is transmitted along multiple antennas whereas, at the receiver side multiple antennas receive multiple copies of the same signal and then extract the best possible out of it. It provides significant increase in throughput and range without any increase in the overall bandwidth and transmits power expenditure. It also increases the spectral efficiency (number of information bits per hertz of bandwidth) of wireless system by using multiple antennas that are separated in space and time [2].

Turbo codes are the best approximation of the Shannon limit. In Turbo codes at the transmitter side a single bit is encoded into a combination of bits depending on the architecture of the encoder. When this encoded data is transmitted over the channel the probability of error is reduced to a great extent. When the data reaches the receiver side the data is decoded back into the original bits that are understandable by the receiver.

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2.WIMAX

A number of industry standards govern the design and performance of wireless broadband equipment. The standards that chiefly concern wireless broadband are 802.16 and its derivative 802.16a, both of which were developed by the Institute of Electrical and Electronic Engineers (IEEE), a major industry standards body headquartered in the United States.

A. Physical Layers of WiMAX

The IEEE 802.16 standard supports multiple physical specifications due to its modular nature. The first version of the standard only supported single carrier modulation and after the passage of time and as technology grew; OFDM and scalable OFDMA were also used but only for operating in the Non Line of Sight (NLOS) environment and were meant to provide mobility. The standards were then further enhanced to work in the lower frequency range of 2-11GHz along with the previous 10-66GHz band.

1) Orthogonal Division Multiplexing (OFDM): The idea of OFDM comes from Multi Carrier Modulation (M CM) transmission technique. MCM is based on the division of input bit stream into several parallel bit streams and then using them to modulate several sub carriers as shown in Fig 1. Guard band is introduced in between each subcarrier so that they do not overlap with each other. This guard band also supports the band pass filter on the receiver side in identifying individual subcarriers. OFDM is a special form of spectrally efficient MCM technique. It differs from its predecessors in the way that it uses orthogonal subcarriers which also eliminate the use of a band pass filter from the receiver side. The orthogonal nature of the subcarriers also removes the Inter Carrier Interference (ICI) which was a

great problem previously. The guard band previously used is also removed in OFDM hence concluding in the reduction of bandwidth us age as shown in the Fig. 2.

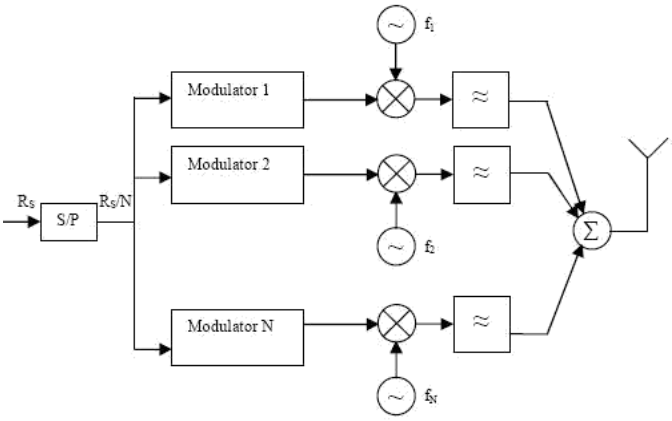

Fig. 1. OFDM Transmitter

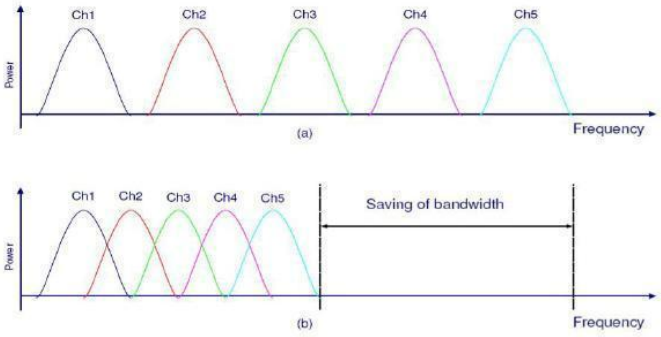

Fig. 2. OFDM Symbols

2) Adaptive Modulation and Coding: AMC allows WiMAX systems to select the most appropriate Modulation and Coding Scheme (M CS) depending on the propagation conditions of the communication channel, e.g., if the propagation conditions are good, a higher order modulation scheme with a lo were coding redundancy is used which also increase the data rate of the transmission, while on the other hand during a signal fade, the system selects a modulation scheme of a lower order to maintain both the connection quality and the link stability without an increase in the signal power [3]. For this purpose WiMAX uses four modulation schemes that are:

Binary Phase Shift Keying (BPSK)
Quadrature Phase Shift Keying (QPSK)
16- Quadrature Amplitude Modulation (16- QAM)
64-Quadrature Amplitude Modulation (64- QAM)

III. SYSTEM MODEL

The networking giant cisco estimates that video consumed about 70% of all online traffic in 2014, and it will be rise up to 80 to 90 % by 2018. And all these traffic is raised due to a perfect storm of rapidly increasing demand and quality. There is no any reversing trend. As time of 21st sanctuary video is going to become more popular and it will consume more bandwidth. Therefore there is a huge need to compress the video with the high quality and less bandwidth requirements. As per increasing the diversity of services, the growing need of HD (High Definition) video and the beyond HD formats like 4k x 2k are, there is a huge need of high coding efficiency and less bandwidth requirements.

A. Introduction of HEVC in WiMAX System

H.265/HEVC is a new video coding standard that defines how decodes the video. HEVC generally focuses on two key issue: increased video resolution and increased key of parallel processing architectures. These standard is designed to fulfill many requirements including coding efficiency, data loss resilience, lower memory requirements.

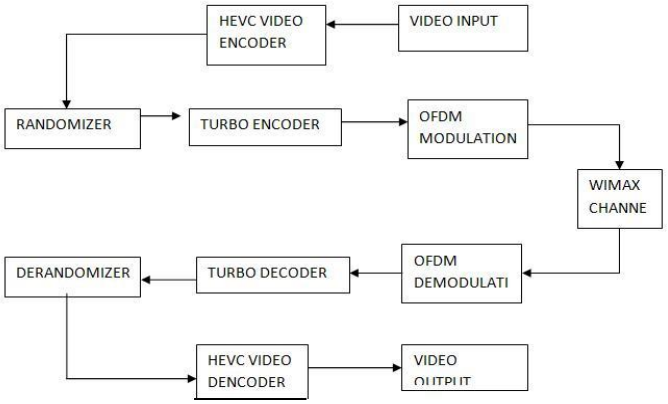

Fig. 3. WiMAX Module with HEVC

*B.*HEVC - *ADVANCE VIDEO CODING STANDARD.*

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HEVC Video Encoder

As in H.264/AVC, HEVC consist of Inter frame prediction, Intra frame prediction, 2D transformation, entropy coding and in loop filters. One main difference between H.264/AVC and HEVC is that HEVC uses a quad tree coding structure. In HEVC, a frame is partitioned into multiple coding tree units (CTUs) which is similar to the concept of macroblock in previous standard. A CTU supporting a larger sub block of a picture with a variable size up to 64 x 64 luma samples, while in macroblock structure allows maximum size of 16 x 16 luma samples. A coding tree units (CTU) is subdivided into coding tree

blocks (CTBs) and CTBs can be further split into smaller coding blocks (CBs). One luma CB and two Chroma CBs compose a coding unit (CU).

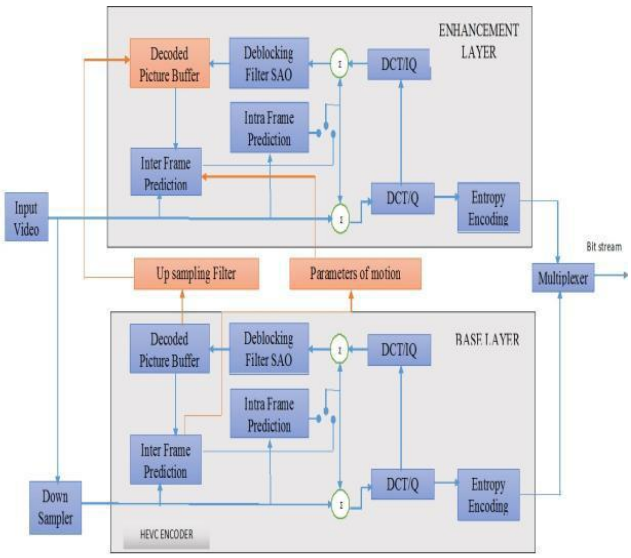

Fig. 4. HEVC Video Coder

A CU also defines the prediction units (PU), for intra or inter picture prediction decision, and transform units (TUs), describing the block transform coding of the prediction residual. The CBs can then have identical or smaller in size prediction blocks (PBs) and luma transform blocks (TBs). The luma CB residual may be identical to the luma transform block (TB) or may be further split into smaller luma TBs. The same applies to the Chroma TBs. Integer basis functions similar to those of a discrete cosine transform (DCT) are defined for the square TB sizes 4×4, 8×8, 16×16, and 32×32. For the 4×4 transform of luma intrapicture prediction residuals, an integer transform derived from a form of discrete sine transform (DST) is alternatively specified. A detailed overview and performance evaluation of the emerging HEVC standard can be found in [1].

HEVC Video Decoder :

The video codec can be design based on either single loop architecture or multi loop decoding architecture. There are inter-layer prediction schemes such as residual prediction requires to achieve comparable coding efficiency to that of the multi-loop decoding architecture .

In the multi-loop decoding architecture, the motion com-pensation is done in every Reference layer, which is needed to reconstruct the target layer. Both inter-coded blocks and intra-coded blocks are reconstructed in all reference layers, and the reconstructed samples of the reference layers can be used as additional predicted samples for the enhancement layer .Although the multi-loop decoding architecture increases the decoded picture buffer size and memory bandwidth for motion compensation on the decoder side depending on the number of layers, it is known that the coding efficiency is better than that of the single-loop decoding architecture. It also has the advantage that the multi-view scalability can easily be supported at the same time since the scalable codec based on multi-loop decoding architecture can display any view of the multi-view configuration as view scalability. Therefore in HEVC based on multi-loop decoding architecture is used which employs inter-layer sample prediction and motion parameter prediction.[1]

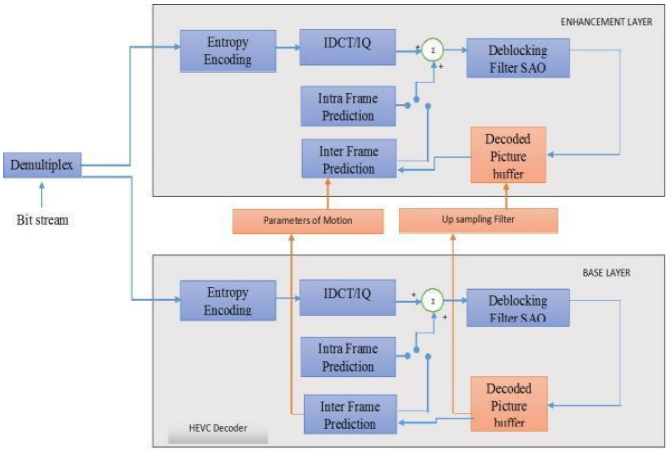

Fig. 5. HEVC Video Decoder

C.4G WIRELESS NETWORK

WiMAX, the Worldwide Interoperability for Microwave Access is the highly anticipated technology 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. The IEEE 802.16 standard was firstly designed to address communications with direct visibility in the frequency band from 10 to 66 GHz. Due to the fact that non-line-of-sight transmissions are difficult when communicating at high frequencies, the amendment 802.16a was specified for working in a lower frequency band, between 2 and 11 GHz.WiMAX is a technology standardized by IEEE for wireless MANs conforming to parameters which enable interoperability. WiMAX developments have been moving forward at a rapid pace since the initial standardization efforts in IEEE 802.16.WiMAX is one of the closest technologies to meet the standards of true 4G and as it develop should surpass the 100MB/second which is the 4G standard [5],[6],[7].

Quality Factor (QF)

A modest metric to assess a video file's compression density is the Quality factor (QF). The QF indicate the three

parameters of video compression: bitrate, the number of pixels in the frame, and the overall frame-rate of the video. QF is essentially a measure of, "the amount of data allocated to each pixel in the video". This metric doesn't take into account the type of compression profile used, the number of passes originally utilized in the encoding process, or any tweaks implemented by the encoding engineer to optimize the video quality. So QF or compression density, is just a baseline guide for an administrator that is responsible for trans coding or managing large video libraries.

$$Quality\ factor = \frac{bit\ rate}{pixels\ per\ frame * frame\ rate}$$

$$= \frac{\frac{bits}{second}}{\frac{pixels}{frame} * \frac{frames}{second}}$$

$$= \frac{bits}{pixel}$$

Introduction of Turbo Codes in WiMAX System

Turbo Encoder uses the bits passed on to it by the MAC layer of WiMAX and with help of Recursive Systematic Convolution Encoder encoded the bits and passes them on to the modulation scheme block. At the receiver the Log MAP decoder takes bits from the demodulation block and passes this data on to the MAC layer after decoding it [5]. This is shown in Fig 6.

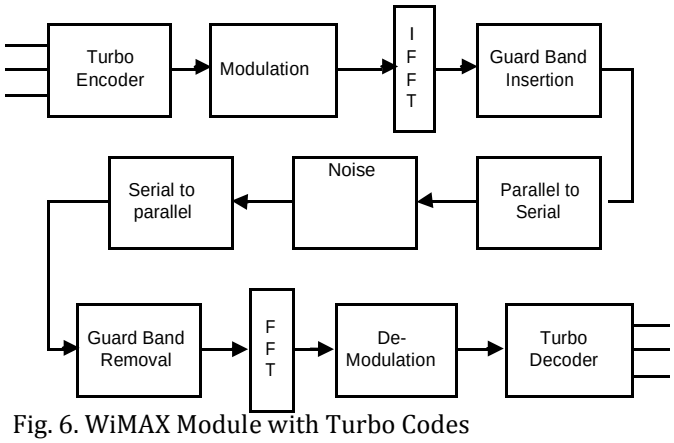

Fig. 6. WiMAX Module with Turbo Codes

1) Recursive Systematic Convolutional Encoder (RSC): This type of encoder works on a bit by bit basis. For every input bit it generates a *parity bit* depending on the structure of the encoder and outputs the same input bit at the output known as the *systematic bit.* The encoder is implemented using Linear Feedback Shift Register (LFSR). These registers are the main reason why we call it Recursive process. The output is feed back to the input and every new output is dependent on the previous input to the encoder.

In Fig 6 the D denotes the registers which are initially at a known state of 00. After a packet is encoded the registers can be in any one of the four possible states 00,01,10,11 depending on the previous input. These states cause problem for the next packet. To remove this problem and to bring the registers back into a known state of 00, *Memory Flushing or Trellis Termination* is done. For memory flushing we pad *Trail Bits* at the end of each packet depending on the state of the registers.

2) Interleaver: Interleaver is an essential part of the a frame. In the encoding stage the data is interleaved before the data is feed to the second encoder.

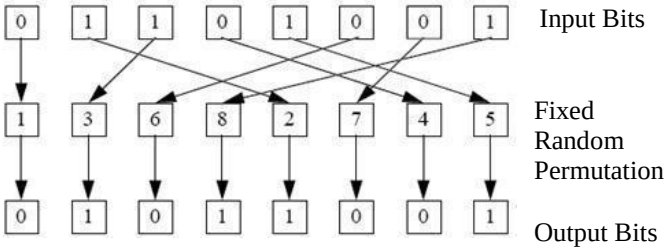

Fig. 7. Random Interleaver

The interleaver of Fig 8 uses a fixed random permutation and maps the input according to that permutation order. Here the length of the input is denoted by L the greater the size of L the better will be the performance Fig 8 shows that if we take L=8 then the interleaver inputs a sequence [0 1 1 0 1 0 0 1] and outputs [0 1 0 1 1 0 0 1].

3) Log Map Decoder: To achieve a soft decision through turbo decoding, two Log Map Decoders are used together which work iteratively on a symbol by symbol decoding method.

III.SIMULATION RESULT:

The Simulation result model was implemented in Matlab 12. The simulation was run for a packet size of 10^6, and for better approximation this packet was transmitted 10^2 times. Fig. 10. shows the result obtained for the performance of WiMAX, using modulation technique.

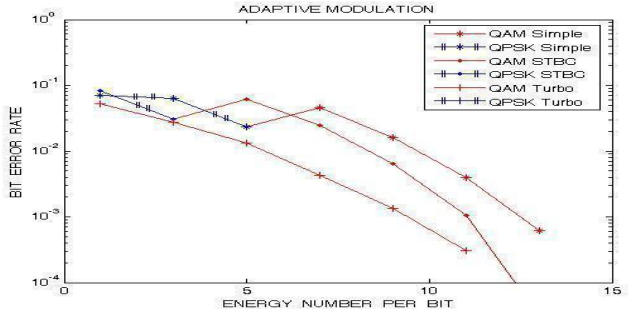

Fig. 8. Performance Graph of WiMAX

Initially the packet was sent over simple WiMAX architecture and the graph marked with achieved. It shows that it gives better performance compared with other decoder. The Quality factor is improved with high video compression and all other data traffic at the same time to all users is achieved by turbo decoder.

IV. CONCLUSION

This paper proposed the WiMAX OFDMA using the HEVC with turbo decoder that the video transmission is achieved by low data rate. HEVC coding layer design is based on conventional block-based motion compensated hybrid video coding concepts, but with some important differences relative to prior standards. On the other hand, Turbo codes can eliminate the residual inter symbol interference (ISI) and inter channel interference (ICI) and therefore reduce the length of the required Cyclic prefix in an OFDMA system. This decreases the overhead associated with the Cyclic Prefix. The use of Turbo codes in OFDMA system for transmitting video with low data rate transmission in wireless LANs due to HEVC, results in a considerable improvement in terms of bit error rate performance and bandwidth efficiency. In future it is used in 4G networks.

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