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Performance and assessment of STBC OFDM Downlink Baseband Receiver

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Abstract- **The development of 802.16 standards for Broadband Wireless Access technologies(BWA) wasmotivated by the rapidly growing need for high-speed, ubiquitous and cost-effective access.The proposed baseband receiver applied inthe system with two transmit antennas and one receiveantenna purposes to offer high performance in outdoormobile environments. It delivers a simple and robustsynchronizer and an precise but hardware inexpensivechannel estimator to overcome the challenge ofmultipath fading channels.**

Index Terms- **base band receiver,WMAN, adaptivemodulation**

I. INTRODUCTION

Most first generations structures have been added inthe mid-1980’s and can be characterized by the use ofanalog transmission techniques and the use of simplemore than one get admission to strategies which includes Frequency DivisionMultiple Access (FDMA). First generationtelecommunications structures along with Advanced MobilePhone Service (AMPS) handiest supplied voicecommunications. They also suffered from a low user capacity, and security problems due to the simple radiointerface used. Second era systems have beenintroduced in the early 1990’s, and all use virtualtechnology. This supplied a boom within the usercapacity of around 3 times. This becomes carried out by means ofcompressing the voice waveforms earlier than transmission.Third generation systems are an extension on thecomplexity of 2nd-generation structures and areanticipated to be brought after the year 2000. Thedevice potential is anticipated to be extended to over teninstances authentic first-generation structures. This goes tobe performed by way of the usage of complex multiple get access tostrategies consisting of Code Division Multiple Access(CDMA), or an extension of TDMA, and by way of enhancingthe flexibility of offerings available.The telecommunications industry faces the hassleof offering smartphone services to rural regions, in which thecustomer base is small, but the value of installing a stressedmobile network could be very high. One approach to reducing thehigh infrastructure price of a stressed out gadget is to use afixed wi-fi radio network. The problem with this isthat for rural and urban regions, large cellular sizes arerequired to get sufficient coverage.Fig.1 shows the evolution of cutting-edge services andnetworks to the goal of combining them into a unifiedthird generation network. Many currently separatestructures and services consisting of radio paging, cordlesstelephony, satellite phones and personal radio structures forgroups and so on could be blended so that each one these servicescan be provided with the aid of third generation telecommunicationssystems.Initial proposals for OFDM had been made inside the 60sand the 70s. It has taken more than a quarter of a centuryfor this era to move from the studies area tothe industry. The concept of OFDM is quite easy butthe practicality of enforcing it has manycomplexities. So, it's a complete software program undertaking. OFDM depends on Orthogonality principle. Orthogonalityway, it permits the subcarriers, which can be orthogonalto every other, meaning that go-communicate among channels is removed and inter-service protect bands arenow not required.

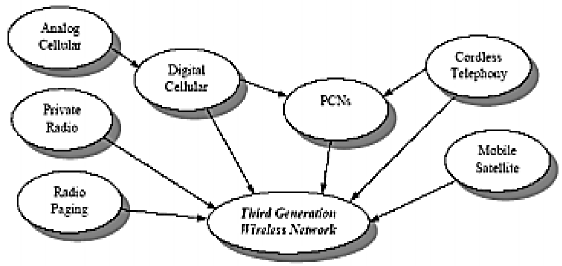

Fig: 1 Evolution of current networks to the nextgeneration of wireless networks

II. RELATED WORKS

In [1] authors have presented design and implementation of OFDM with 512 subcarriers and 2x2 STBC MIMOtransceiver for WiMAX 802.16e standard. The design consists of (Space Time Block Code) STBC, Fast FourierTransform (FFT / IFFT) for subcarrier division, mapping and de-mapping symbols, and system integration using highlevel design tool based on VHSIC Hardware Description Language (VHDL) on FPGA.In [2] authors have describedperformance study of adaptive modulation and various coding schemes in WiMAX OFDM-based system.In [11] authorshave presented design of MIMO-OFDM system for Wireless Broadband Communications and have analysed its BERperformance.In [12] authors have presented a comprehensive analysis about BER and SNR for various scenarios whichinclude different channels, different modulation techniques and carrier frequency offsets.In [13] authors have presentedMIMO-OFDM techniques which are used to increase the performance efficiency by having multiple transmit and receiveantenna for the Rayleigh channel. The reference model SISO, MISO, MIMO(2X2) are esigned and simulated in MATLAB.The evaluation of Bit Error Rate (BER) and Signal to Noise Ratio (SNR) performance of the MIMO-OFDM techniquecombined with Alamouti Space Time Block Codes (STBC) based on 16 QAM over Rayleigh Channels are carried out.In [14]authors have presented a new Non-Linear precoding method to the acclimatization for the Worldwide Interoperabilityfor fixedMicrowave Access (WiMAX) baseband, in the physical layer performance of multi-antenna techniques.Theproposed Non-Linear Precoding Tomlinson-Harashima Precoding (THP) in WiMAX baseband consider a new way tofurther reduce the level of interference and signals achieved much lower bit error rates and increase spectral efficiency.

III. SUGGESTEDSYSTEM

Space-time block code (STBC)-orthogonalfrequency division multiplexing (OFDM) techniques(STBC-OFDM) have been shown to be very promising .With multiple transmit antennas, STBC can providetransmit diversity gain to improve system performancein wireless communications, especially when receivediversity is too expensive to deploy. STBC-OFDMsystems have been adopted in IEEE 802.16e which is anextension of IEEE 802.16-2004 for supporting themobility of wireless metropolitan area network(WMAN). However, for STBC decoding, STBC-OFDMsystems require accurate channel state information(CSI), which is particularly difficult to obtain in mobilewireless channels. Therefore, high quality channelestimation with acceptable hardware complexity is acrucial challenge for realizing a successful STBCOFDM system.Various channel estimation methods havebeen proposed for OFDM systems. Among thesemethods, discrete Fourier transform (DFT)-basedchannel estimation methods using either minimummean square error (MMSE) criterion or maximumlikelihood (ML) criterion have been studied forOFDM systems with preamble symbols. Since noinformation on channel statistics or operatingsignal-to-noise ratio (SNR) is required in the MLscheme, the ML scheme is simpler to implementthan the MMSE scheme . Additionally, when thenumber of pilots is sufficient, the two schemeshave comparable performances. For this reason, thedecision-feedback (DF) DFT-based channelestimation method is adopted to use the decideddata as pilots to track channel variations forproviding sufficient tracking information.Recently, Ku and Huang presented a DF DFTbased method derived from ML criterion andNewton’s method. Moreover, they concluded that arefined two-stage channel estimation method ismore robust than the classical DF DFT-basedmethod to apply in fast time-varying channels.Thus, the two-stage channel estimation methodwith an initialization stage and a tracking stage isadopted in this paper.

The MPIC-based decorrelation estimatesCIR path-by-path and cancels out the knownmultipath interference. The channel estimation foreach transceiver antenna pair can be independentlyperformed because the preambles transmitted fromdifferent antennas do not interfere with each other.First, two parameters and are defined as apresumptive path number of a channel and anobservation window set, respectively. Second, thecyclic cross-correlation between the received andtransmitted preambles as well as the normalizedcyclic auto-correlation of the transmitted preambleare calculated. The indexes and which stand for apathcounting variable and the number of the legalpaths found by the MPIC-based decorrelation areinitialized to zero. Third, the process is started bypicking only one path whose time delay yields thelargest value in, for it.If the path delay is larger than the lengthof CP, this path is treated as an illegal path anddiscarded by setting . Otherwise, this path isrecorded as the legal path with a time delay and acomplex path gain . Then, the interferenceassociated with this legal path is canceled from toobtain a refined cross-correlation function.

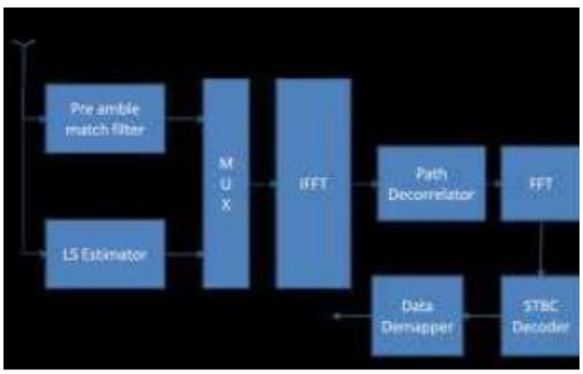

Figure1.Architecture of Downlink baseband receiver

A.Tracking Stage: After the initialization stage, we canobtain the information of the path numbers, themultipath delays, the multipath complex gains, andthe corresponding channel frequency responses,where is corresponding to the transmit antenna.Under the assumption that the multipath delays donot change over the duration of a frame, the DFDFT-based channel estimation method can beequivalently expressed in Newton's method asAccording to, the vector calculates the differencebetween the previous estimated channel frequencyresponse vector and the least-square (LS)estimation vector in, where is the iteration index. The matrix is the re-encoded STBC matrix withdecided symbols, and, as its entries. The decidedsymbols are obtained by applying the previousestimated channel frequency responses to decodethe received signal vector, where is the symbolindex within a time slot. The value is the energynormalization factor.The inverse DFT (IDFT) matrixmultiplying by the vector in is to form the gradientvector in Newton's method, where is a subset of. Inaddition, the weighting matrix is infact the inverseof the Hessian matrix in Newton's method. Theentry of is given by in the previous It isdemonstrated that the two-stage channel estimationmethod has better performance than the classicalDF DFT-based method, the STBC-based MMSEmethod, and the Kalman filtering method forestimating channels in high mobility, and itscomputational complexity is quite the same withthese methods. However, the high complexityproblem still needs to be solved for hardwareimplementation. Hence, we propose a modifiedtwo-stage channel estimation method and itsarchitecture for hardware design.

B. FFT/IFFT: The FFT and IFFT are required by theproposed two-stage channel estimator and can beshared by the initialization stage and the trackingstage. A parallel memory-based FFT/IFFTarchitecture with multiple inputs and outputs innormal order is used to have a lower cost andreduce the latency which is targeted to be less than1/4 of an OFDM symbol time. The 1024-point.

FFT/IFFT module that is composed of eightindependent memory modules, four radix-8processing elements (PEs), two radix-2 butterflyelements, and two commutators. The memorymodules are implemented with single-port SRAMmodules which consume less area and power thandual-port SRAM modules. The PE adopts thepipelined single-path delay feedback (SDF) FFTarchitecture with a reorder buffer, a complexmultiplier and the associated twiddle factor table.

By the symmetry property of sine/cosinefunctions, the lookup table just requires to store thesine/cosine values from 0 to 1. For radix-8 FFToperation, the read-out data index of the memoryaccess is the 3-bit reversal of the write-in dataindex. In order to achieve the parallel inputs andoutputs in normal order, the memory accessaddressing for eight memory modules must avoidthe memory conflict occurring. Assume that thebinary index of the write-in data is, and the binaryindex of the read-out data. 3-bit reversalwrite-inindex. The parallel write-in data assigned to theeight independent memory modules are based onthe addressing scheme. The data located in thedifferent memory modules can be paralleloutputted in normal order.

C.STBC Decoder And Demapper: This technique used in wirelesscommunications to transmit multiple copies of datastream a cross a number of antenna and to exploitthe various received versions of the data toimprove the reliability of data transfer. The factthat the transmitted signal must traverse apotentially difficult environment withscattering,reflection,refraction and so on and maythen be future correpted by thermal noise in thereceiver means that some of the receiver copies ofthe data will be better choose In the tracking stage,from , the LS estimator is used to calculate the LSestimations followed by calculating the vector thatcan be expressed. Before the LS estimationcalculation, the decided symbols and must bedetermined first. Based on the latest estimatedchannel frequency responses, the STBC decoderthe symbol demapper are used to decode these tworeceived symbols and can be formulated as whereis the demapper process. The hardware design of adivider is very costly; therefore, a demappingdichotomy method with two stages is adopted toavoid the divider implementation.

V. CONCLUSION

In this paper, we propose a downlinkbaseband receiver for mobile WMAN that isapplied in the STBC-OFDM machine with twotransmit antennas and one gets hold of the antenna. Asimple image boundary detector, a servicefrequency recovery loop modified by way of the ping-pong algorithm, and a correct two-degree channelthe estimator is efficiently carried out. Althoughthe 2-stage channel estimator requires higherhardware cost compared with the interpolation based totally channel estimators, it has good sizedperformance development for efficientlyfiguring out the STBC-OFDM system in outdoor cellular environments.From the simulation outcomes,we have shown that the proposed receiverimproves about 8.5dB of the normalized MSE for16QAM modulation in comparison with thatadopting the 2-D interpolation strategies inmultipath fading channels.

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