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Performance Evaluation of 5G transmission system and Simulation Modeling

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Abstract: Orthogonal multiple access (OFDMA) is a very important technology for the fifth generation (5G) wireless communication networks to provide the need of the flexible demands of users on lower latency rate, high level of reliability, good amount of connectivity, large fairness, and high data throughput. The key idea behind MIMO based 5G networks are to provide multiple users in common resource block. The MIMO OFDM principle is the main framework and several 5G multiple access space time schemes can be found fo different cases. This paper provides a simulation performance of the latest MIMO OFDM based 5G systems and to explore their applications.

Keywords: 5G, dense networks, MIMO, LTE

1. Introduction:

5G LTE is an rising international broadband wireless system based totally on IEEE 802.16 popular. It is a brand new wi-fi OFDM-based generation that gives excessive excellent broadband services lengthy distances based totally on IEEE.802.16 wi-fi (Metropolitan Area Network) MAN air interface general to fixed, transportable and cellular customers[1,2]. 5G LTE promises to mix high facts price services with extensive vicinity coverage (in frequency variety of 10 – 66 GHz (Line of sight) and 2 -eleven GHz (Non-Line of Sight)) and huge person densities with a selection of Quality of Service (QoS) requirements. 5G LTE can provide broadband wi-fi access (BWA) up to 30 miles (50 km) for constant station and 3 to ten miles (5-15 km) for mobile stations with theoretical information prices among 1.5 and seventy five Mbps according to channel. The new standards for 5G LTE are being advanced for expanding the mobility similarly with more advantageous coverage, overall performance and higher statistics fees (of the order of a hundred Mb/s) in a 5G LTE Network. The 5G LTE popular air interface consists of the that means of both the medium get entry to manipulate (MAC) and the bodily (PHY) layers for the endorser station and base station whilst the doorway gadget operability is characterised through the 5G LTE Forum, an association comprising of administrators and component and gear manufacturers. As the vital capacity of 5G LTE PHY layer is the genuine physical transportation of facts. The number one execution seems to be all the extra difficult whilst transportable conditions are experienced in remote channel. Keeping in thoughts the stop intention to perform most severe execution at low BER, high facts price transmission (both in settled and versatile conditions) and high ghastly productiveness with collection of QoS wishes IEEE 802.16d/e widespread backings collection of PHY layer gadgets with an collection of additives. The adaptability of the PHY empowers the framework planners to tailor their framework as in line with their prerequisites.

5G LTE is slicing area broadband remote innovation it gives fast, comfortable, sophisticate broadband administrations .The advancement of 5G LTE began with the need of having a faraway Internet get right of entry to and other broadband administrations that can characteristic admirably in rustic tiers or in areas wherein it's miles difficult to installation stressed base and financially no longer possible. IEEE 802.16, otherwise known as IEEE Wireless-MAN is preferred of altered remote broadband and included transportable broadband application. 5G LTE discussion, installation in 2001 to set up the segments and upload to the equipment those may be perfect and bury operable. In 2007, Mobile 5G LTE hardware created with the same old IEEE 802 16e [5] got the affirmation and discharged theitem in 2008, giving versatility and traveling get admission to. The IEEE 802.16e relied on Orthogonal Frequency Division Multiple Access (OFDMA) can deliver better execution in non-observable pathway conditions. IEEE 802.16e acquainted versatile channel transfer accelerate with 20 MHz, Multiple Input Multiple Output (MIMO) and AMC empowered 802.16e innovation to bolster crest Downlink (DL) records fees as much as 63 Mbps in a 20 MHz channel through Scalable OFDMA (S-OFDMA) framework [2]. It has strong protection engineering because it makes use of Extensible Authentication Protocol (EAP) for not unusual verification, a progression of stable encryption calculations, CMAC or HMAC primarily based message coverage and lessened key lifetime [4].

2. Literature review:

In 2012 Nitin Sharma et al, "On the use of particle swarm optimization for adaptive resource allocation in orthogonal frequency division multiple access systems with proportional rate constraints" Presented his work on the use of particle swarm optimization for adaptive aid allocation in orthogonal frequency department a couple of get entry to systems with proportional charge constraints. In this paintings they proposed that orthogonal frequency division multiple access (OFDMA) turned into a promising approach, that could offer high downlink capacity for future wireless structures. The total ability of OFDMA may be maximized by using adaptively assigning subchannels to the consumer with the satisfactory advantage for that subchannel, with energy eventually distributed through water-filling set of rules. In this work they had proposed the use of a customized particle swarm optimization (PSO) aided algorithm to allocate the subchannels. The PSO set of rules is population-primarily based: a hard and fast of ability answers evolves to technique a near-superior answer for the hassle beneath take a look at. The custom designed set of rules labored for discrete particle positions not like the classical PSO set of rules which become legitimate for only continuous particle positions. It changed into showed that the proposed technique obtains better sum capacities compared to that acquired by means of preceding works, with similar computational complexity. In his work, they'd proposed using PSO, a stochastic optimization technique, for sub-channel allocation in downlink of OFDMA systems accompanied by means of energy allocation the use of water-filling set of rules. The effects produced with the aid of the simulations indicate that the algorithm performs higher in terms of sum capacities in comparison. The sum ability increases with the increase variety of customers. The sum potential additionally increases to start with with the boom in wide variety of iterations and populace length but swiftly saturates to a near most efficient fee. This result indicates that PSO aided subchannel allocation ought to offer great benefit in ability even with very small populace length and variety of iterations. Moreover in PSO aided subchannel allocation the search and subchannel allocation became achieved concurrently compared to conventional methods where the subchannels had been first sorted according of their gains and then allocation turned into performed. This extensively reduces the complexity of PSO aided allocation. The complexity of our set of rules was assessed to be O(N) compared to O(KNlog2N) for that of method in . Hence it might be concluded that the proposed set of rules turned into order of magnitude faster as compared to the approach in This fact makes PSO aided subchannel allocation a appropriate preference for practical wi-fi systems like WiMAX (802.16e) wherein the convergence charge plays a totally important role as the wireless channel changes unexpectedly. The fact that the channel is thought to be regular at some stage in allocation makes convergence price a totally essential parameter for wireless systems. The future scope of this paper could be to use more than one antennas on each transmitter and receiver site, which could offer similarly gain in potential due to spatial multiplexing.

In 2012 Nelly M. Shafik"Wavelet Transform Effect on MIMO-OFDMSystem Performance" Offered his work and proposed that many motives purpose multi- service CDMA to be the satisfactory generation inside the today's mobile generations acknowledged by fourth generation for cell. As widely known, the finest enemy for any wi-fi conversation is multi- course fading which commonly result in distortion in time- area, or in frequency domain or maybe in both. Therefore any new approach carried out into cellular conversation machine become regarding with mitigating multi-course fading distortion which appears in shape of lowering BER degree. In this work three techniques have been blended with the intention to enhance cellular machine performance within the presence of multipath fading channel. These techniques have been, orthogonal frequency department multiplexing (OFDM), code division more than one get right of entry to (CDMA), and changed area shift keying (SSK). The ultimate method was taken into consideration unique case for MIMO generation. By the useful resource of MATLAB code, proposes machine become simulated with a view to show BER performance versus variation in the SNR at many numerous device conditions.

Fourth generation of cell has introduced many exclusive families one of these households uses each OFDM and CDMA techniques together if you want to be part of blessings of frequency and time variety. But despite the efficient overall performance of all households of the 4G, it faces first rate undertaking due to required services. Modern packages for digital conversation systems consisting of video calls, internet services, mobile stay entertainments . . .Etc all those programs need better transmission statistics charges and high pleasant of offerings. They had encouraged on this paper, novel technique for MIMO generation denoted through changed SSK were inserted into OFDM- CDMA machine. This modified algorithm supplied efficient choice for transmitting antennas rather than the usage of all transmitting antennas as in case of conventional MIMO technology. Simulation outcomes for proposed system showed appropriate BER degree at small price of SNR and also at horrific fading channel condition. For instance at best SNR = 4dB, BER is order of 10^-6 the use of 7 transmitting antennas and a couple of receiving antennas in presence of multi- direction Rayleigh fading channel.

2008YueHongGao et al presented his work on "**Performance Evaluation of Mobile 5G LTE withDynamic Overhead"**. In this paintings they proposed that Mobile WiMAX had come to be one of the third Generation conversation structures and its overall performance has been extensively evaluated. The physical overhead is a crucial component that could have an effect on the overall performance extensively. But almost no attention has been paid to the effect of overhead on device performance but. In this paper, we first analyze important signaling assets needed in physical layer, which encompass the physical overhead. Then the dynamic overhead version for downlink and uplink are proposed respectively and simplified, while retaining the simulation accuracy. Average overhead amount was obtained thru machine degree simulation the usage of dynamic overhead calculation. Finally, it became proved that the model became affordable and the average overhead size can be used instead of dynamic calculation for the sake of lowering simulation complexity as well as keeping evaluation consequences unique. In his paintings, they analyze each signaling thing wanted in cellular 5G LTE bodily layer at the downlink and the uplink, respectively. Then the dynamic overhead calculation version is presented and simplified by using the common fee. It was proved that the model become reasonable and the common overhead size may be used in place of dynamic calculation for the sake of decreasing simulation complexity as well as retaining assessment precision.

3. Methodology:

5G LTE uses a special type of modulation technique which is a mixture of ASK and PSK with a new name called Quadrature Amplitude Modulation (QAM). In QAM, amplitude and phase changes at the same time. Different types of QAM are available for 5G LTE networks depending on throughput and range. 64 QAM has higher throughput but lower range whereas 16 QAM has lower throughput but higher range to cover from the BS.

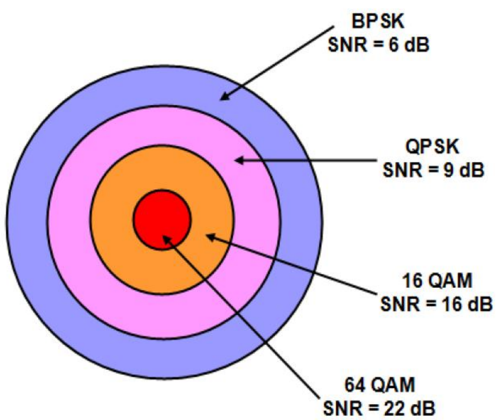

Fig. 1. Adaptive Modulation Scheme [7]

5G LTE has the freedom to select Quadrature Phase Shift Keying (QPSK) and QAM as its modulation techniques depending on the situation. As for downlink, in both fixed and mobile 5G LTE , QPSK, 16 QAM and 64 QAM is mandatory but it can use 64 QAM as an optional for uplink channel. Depending on the radio link, 5G LTE adjusts its modulation and coding scheme based on Signal to Noise Ratio (SNR). So when it uses 64 QAM, special care is needed for SNR to minimize the interference. To maintain SNR, 5G LTE uses different modulation schemes such as for SNR = 22 dB, the modulation is 64 QAM, for SNR= 16 dB, modulation is 16 QAM and for SNR= 9 dB, modulation is QPSK etc.

Based on the weather, interference in signal and the client distance, the BS dynamically select the modulation scheme. When the link quality is high, 5G LTE uses highest modulation with low coding scheme that increases the system capacity. While the signal has to travel a long distance and experiencing fading, 5G LTE can easily shift to the lower order modulation with higher coding scheme. This kind of Adaptive modulation gives 5G LTE more stable links and good connection quality [1].

4. Result and Discussion:

Physical layer model without fading:

In figure 2 the input is provided by binary data generated from MAC layer in packet data unit format. In MAC PDU block the generated data could be predefined integers or random integers. These inputs are arrays of 35x1 sizes generating repetitively. The generated inputs are attached with 6 byte MAC header and passed to randomizer in binary packets. These MAC PDUs (packet data units) are transmitted at the end from physical layer and we have connected AWGN channel to introduce white noise in transmitted signal.

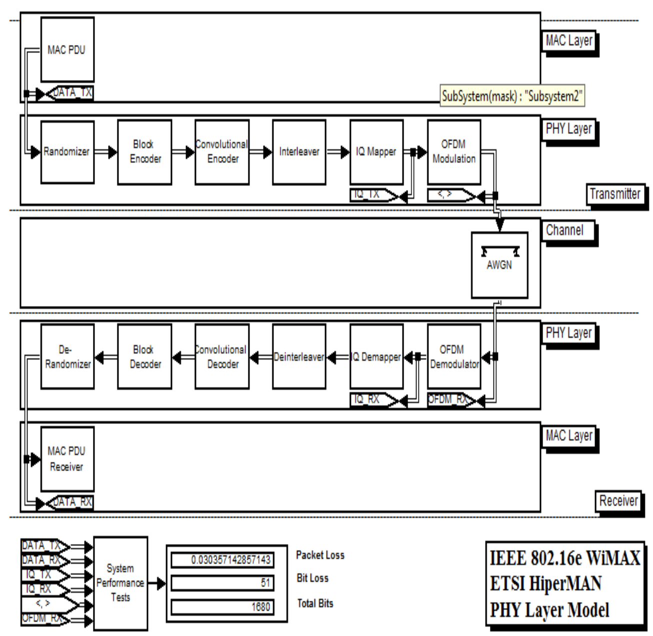

Fig. 2. Simulink model for 5G LTE Physical layer without fading

4.1. MAC PDU (MAC address):

Medium access control protocol data units are a package of data (group of data bits) that contain header, connection address and data protocol information that is used to control and transfer information across a type of medium (such as a radio channel). The 5G LTE system MAC PDUs contains a header, which holds the connection identifier along with control information. MAC PDUs may also have payload of data and error checking bits (CRC) bits after the header (e.g. user data). A MAC PDU header contains a header type, encryption control field, payload type and error checking (CRC) code.

Fig 3. MAC PDU

4.2 Randomizer:

Randomization is the first process carried out in the physical layer after the data packet is received from the higher layers.Each burst in Downlink and Uplink is randomized. Randomizer operates on a bit bybit basis.

The purpose of the scrambled data is to convert long sequences of 0's or 1's in a random sequence to improve the coding performance. The main component of the data randomization is a Pseudo Random Binary Sequence generator which is implemented using Linear Feedback Shift Register.

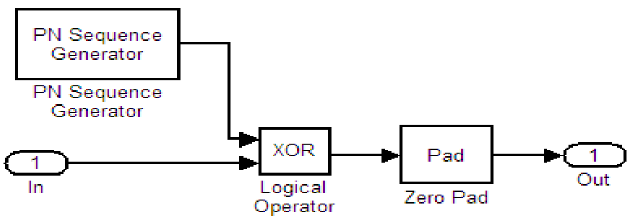

Fig: 4. Randomiser

4.2.1 PN Generator:

Generate a pseudorandom noise (PN) sequence using a linear feedback shift register (LFSR). The LFSR is implemented using a simple shift register generator (SSRG, or Fibonacci) configuration.

4.2.2 PAD (MASK) (LINK):

Append or prepend a constant value to the input along the specified dimensions. Truncation occurs when the specified output dimensions are shorter than the corresponding input dimensions.

4.3 Block Encoder:

Using this block we get the data in coding form.

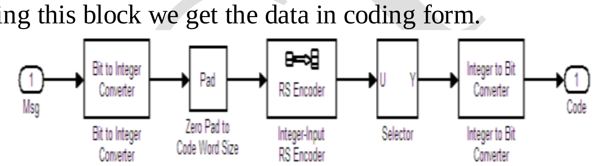

Fig: 5. Block Encoder

4.3.1 Reed- Solomon:

The purpose of using Reed-Solomon code to the data is to add redundancy to the data sequence. This redundancy addition helps in correcting block errors that occur during transmission of the signal.

4.4 Convolutional encoder:

Convolutional codes are used to correct the random errors in the data transmission.A Convolutional code is a type of FECcode that is specified by CC (m, n, k), in which each in-bit information symbol to be encoded is transformed into an n-bit symbol, where m/n is the code rate (n>m) and the transformation is a function of the last k information symbols, where k is the constraint length of the code. To encode data, start with memory registers, each holding input bit. All memory registers start with a value of 0.The encoder has n modulo-2 adders and n generator polynomials one for each adder.

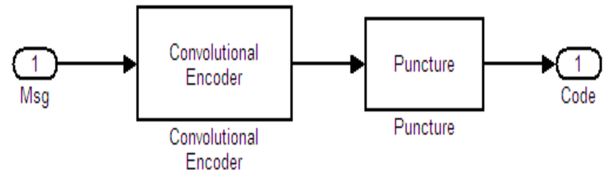

Fig. 6. Convolutional encoder

4.4.1 Puncture:

The Puncture block creates an output vector by removing selected elements of the input vector and preserving others. This block accepts an input signal that is a real or complex vector of length K.

The block determines which elements to remove and preserve by using the binary Puncture vector parameter.

4.5 Interleaver:

The interleaver reorders the data and sends the data frame to the IQmapper. The function of the IQmapper is to map the incoming bits of data from interleaver onto a constellation. Reorder the elements of the input vector. y = u (Elements). The length of Elements must match the input signal width (or) the General Block Interleaver block rearranges the elements of its input vector without repeating or omitting any elements. If the input contains N elements, then the Elements parameter is a column vector of length-N. The column vector indicates the indices in order of the input elements that form the length-N output vector;

That is: Output (k) = Input (Elements(k))

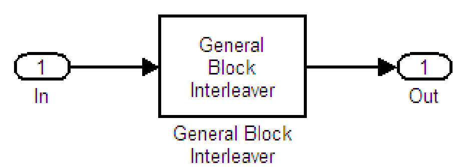

Fig. 7. Interleaver

4.6 IQ Mapper:

The Data Mapper block accepts integer inputs and produces integer outputs. You can select one of four mapping modes: Binary to Gray, Gray to Binary, User Defined or Straight Through.

This block accepts a scalar, column vector or full matrix input signal. It can accept multichannel inputs and allows for input and output data types

of double, single, int32, int16, int8, int32,int16 and int8. The input signal must be a non-negative value. The block truncates non-integer input signals as integer values.
Gray coding is an ordering of binary numbers such that all adjacent numbers differ by only one bit. However the inputs and outputs of this block are integer not binary vectors. As a result, the first two mapping modes perform code conversions as follows:

- In the Binary to Gray mode, the output from this block is the integer equivalent of the Gray code bit representation for the input integer.
- In the Gray to Binary mode, the output from this block is the integer position of the binary equivalent of the input integer in a Gray code ordering.

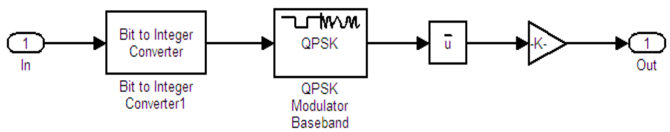

Fig: 4.7
Fig. 8. IQ Mapper

4.6.1 QPSK:
Quadrature Phase-shift Keying (QPSK) is a widely used method of transferring digital data by changing or modulating the phase of a carrier signal. In QPSK digital data is represented by 4 points around a circle which correspond to 4 phases of the carrier signal. These points are called symbols.

4.7 OFDM modulator:
In the modulation phase the coded bits are mapped to the IQ constellation, starting with carrier number -100 on up to carrier number +100. To simplify transmitter and receiver designs, all symbols in the FCH and DL data bursts are transmitted with equal power by using a normalization factor.

4.7.1 IQ Mapper:
The Multiport Selector block extracts multiple subsets of rows or columns from M-by-N input matrix u, and propagates each new sub matrix to a distinct output port. The block treats asunoriented length-M input as an M-by-1 matrix.

4.7.2 Compute IFFT:
Compute the inverse fast Fourier transform (IFFT) across the first dimension of the input.
When you set the 'FFT implementation' parameter to 'Radix-2', the FFT length must be a power of two.

4.7.3 Cyclic Prefix:
Cyclic prefix acts as a buffer region where delayed information from the previous symbols can get stored. The receiver has to exclude samples from the cyclic prefix which got corrupted by the previous symbol when choosing the samples for an OFDM symbol.

4.8 AWGN:
The AWGN Channel block adds white Gaussian noise to a real or complex input signal. When theinput signal is real, this block adds real Gaussian noise and produces a real output signal. When the input signal is complex, this block adds complex Gaussian noise and produces a complex output signal. This block inherits its sample time from the input signal.
Input processing: Inherited
Initial seed: 1
Mode: Signal to Noise Ration
SNR: 10(variable)
Input signal power, referenced to 1 ohm (watts): 0.01

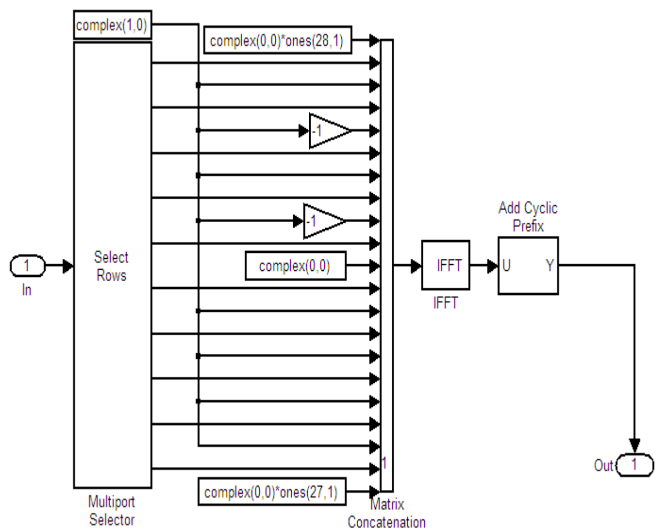

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Fig: 9. IQ Mapper

4.9 OFDM Demodulator:
An OFDM waveform can be demodulated using the inverse transform to that used at the transmitter, yielding the original symbol values. The inverse to the inverse DFT used at the transmitter is a "regular" (forward) DFT. Then OFDM receivers diagrammed with an "FFT" block at the front end. The output of the transform contains the symbol values mapped onto each of the carriers, including all of the unused ones that make up the guard band. The demodulator plucks out the (complex-valued) amplitudes of each of the carriers of interest and passes those on to any further decoding logic (equalization, channel decoding, mapping to bits etc.).
This block helps in removing cyclic prefix, zero paddling and pilots.

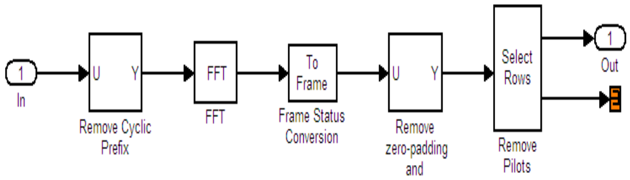

Fig: 10 OFDM Demodulator

4.9.1 Compute FFT:

The fast Fourier transform (FFT) across the first dimension of the input.

When we set the 'FFT implementation' parameter to 'Radix-2', the FFT length must be a power of two.

4.10: De – interleaver:

Reorder the elements of the input vector y (elements) = u. The length of Elements must match the input signal width.

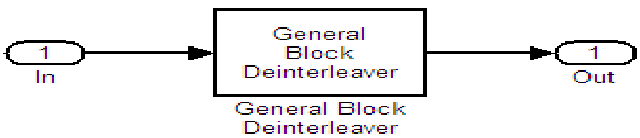

Fig: 11. De-interleaver

4.11: Convolutional Decoder:

The coded data comes in unipolar to bipolar converter and converted into bipolar then we insert zero because it match the number of data to the next block.

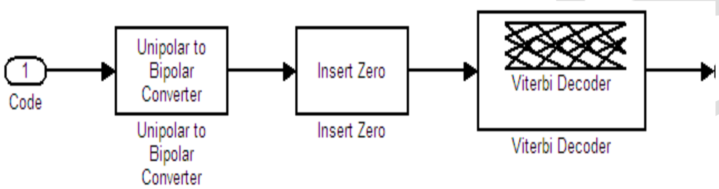

Fig: 12. Convolutional Decoder

4.11.1 Viterbi Decoder:

A **Viterbi decoder** uses the Viterbi algorithm for decoding a bit stream that has been encoded using a convolutional code.Use the poly2trellis function to create a trellis using the constraint length, code generator (octal) and feedback connection (octal).

4.12 Block Decoder:

The block decoder decodes the data from coded form and by using selector it selects row or column and converts the data into bit form.

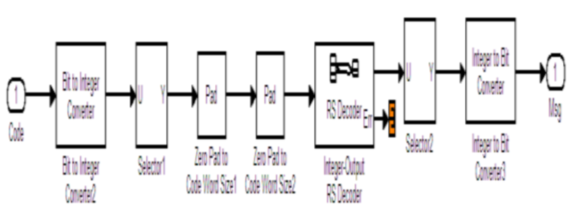

Fig 13 Block Decoder

4.13 De-randomizer:

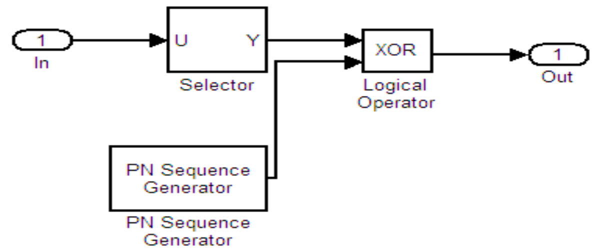

Fig 14. De-randomizer

Algorithmic de-randomization techniques look at a particular randomized algorithm and using the inherent properties of the problem, analyze the randomized algorithm better to come up with ways to remove randomness from that algorithm. Here we start with the original randomized algorithm for a particular problem and improve it to de-randomize it. Complexity theoretic de-randomization techniques refer to a general strategy that can be used to remove randomness from a broad class of algorithms. Typically this is done by pseudo-random generators which produce random-looking bits

4.14 MAC PDU Receiver:

The MAC PDU receiver the data and by sending it in converter we get the data in integer form.

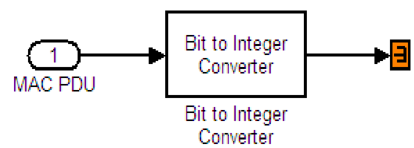

Fig: 15. MAC PDU Receiver

4.14.1 Bit to Integer Converter:

Map a vector of bits to a corresponding vector of integer values. M defines how many bits are mapped for each output integer. The input length must be an integer multiple of M.

Results and discussion:

The transmit diversity system has a computation complexity very similar to that of the receive diversity system.The resulting simulation results show that using two transmit antennas and one receive antenna provides the same diversity order as the maximal-ratio combined (MRC) system of one transmit antenna and two receive antennas.

Also observe that transmit diversity has a 3 dB disadvantage when compared to MRC receive diversity. This is because we modelled the total transmitted power to be the same in both cases. If we calibrate the transmitted power such that the received power for these two cases is the same, then the performance would be identical. The theoretical performance of second-order diversity link matches the transmit diversity system as it normalizes the total power across all the diversity branches.

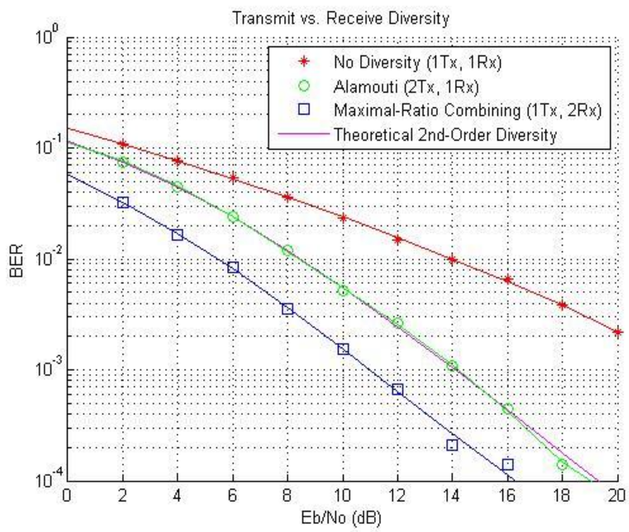

Fig. 3. BER performance at different MIMO coding schemes for 1x2 or 2x1 sytems.

After discussion and analysis of MIMO systems of data coding and transmission and OFDM performance at different modulation scheme we are going to describe the results that are obtained for MIMO OFDM system by using the adaptive modulation strategy that estimates the channel SNR from the pilot symbols and cyclic prefix values and then from the estimated SBR the algorithm decides the modulation scheme that can be most suitable for minimum BER values.

5. Conclusion:

This paper provides a 5G network simulation that can performs data transfer by sharing multiple spectrum by MIMO OFDM based network services. The proposed network mode is composed multiple antenna with a reliable space coding that conducts error-prone sensing of the traffic. In this work it has been demonstrated the performance between the multiple diversity scheme at different availability of SNR in data information and error proof transfer operations by inter-dependent channel estimation analysis and observe that there is a multi-user gain in the sum utilization due to the broadcast nature of the energy transmission. It has been demonstrated that the proposed model of 5G network is a feasible candidate for MIMO systems for a green and spectrally efficient network of 5G operation with high number of nodes.

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