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# Implementation of Interleave Division Multiple Access (IDMA) and comparison using different Modulation Techniques in Wireless Communication System

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***Abstract:*** **This paper provides a review on the IDMA (Interleave Division Multiple Access) technology in wireless communication system based on Inter leaver. In this paper, IDMA technique is proposed in AWGN channel. IDMA is a multi- user scheme in which chip Inter leavers are the only means of user separation. The IDMA performance in terms of bit error rate ,error rate is discussed. Here comparison with different modulation techniques is done on the basis of error rates, maximum no. of symbols, Total no. of errors. The simulation is done in matab environment**

***Keywords:*****--Additive White Gaussian Noise (AWGN), Interleave Division Multiple Access (IDMA), BPSK, DBPSK and M-FSK**

## I. INTRODUCTION

From last several years, the broadband communication service in wireless grows rapidly. It gains extensive popularity in all over the world. Due to various parameters in wireless communication systems, it also performs many personal or organizational requirements. It include mobility and cost effectiveness that need the transmission of high rate data are highly reliable in order to fulfill the increasing services applications such as high quality audio recording , messaging services, and video chatting in next generation mobile system that is 4G generation. Existing wireless technologies reliably cannot support high rates of data, because of these technology fading become very sensitive.

For broadband wireless networks, the various multiple access technique (MA) has been proposed to support multi-service transmissions over the shared wireless link. In wireless communication system, the multiple access technique is one of the most efficient methods, particularly used in cellular network by mobile phone communication system. In recent that is many years back, the availability in wireless networks can be exceeded by the use of bandwidth. It has been studied that, various techniques are used to make the efficiency of bandwidth utilization; is better more users can be allotted in the cell. So that it can provide sufficient space within each cell. Previously existed multi- access techniques like FDMA, TDMA and CDMA are used in 1G/2G/3G systems are suitable for voice communication only but it is not suitable for burst data traffic and high data rate transmission which would be the dominant part in 4G system for traffic load. For high mobility, the data rate is up to 100 Mega bits per second (Mbps) and for low mobility the data rate is up to 1 Giga bits per sec (Gbps). But the 3rd generation systems allows the data rate of nearly 3.6 to 7.2 Mbps. usually if the systems fulfill all these requirements then it can be considered as fourth generation (4G) systems.

There are different types of multiple approaching techniques which are proposed for 4G systems follows CDMA, MC- CDMA, OFDMA and IDMA. In code division multiple access, every user assigned a single coded sequence and it is used to encode the significance of information signal. The receiver knows the sequence of the user code. After reception, it converts or decodes the received signal and retrieves the sequence of data. Hence the spectrum of the coded sequence is selected to be larger than the information signal.

In Multi-carrier CDMA, it is also a multiple access technique which is used in orthogonal frequency division multiplexing based telecommunication system. It permits the system to hold multiple-users at identical time. Multicarrier CDMA system is highly complex in receiver and exceedingly necessary for changing the spreaded code at high data rates in transmitter which build the system inefficient.

One of the most multi-carrier techniques that are used in modulation system that transmits the signal through multiple carriers is nothing but orthogonal frequency division multiplexing (OFDM). These sub carriers are orthogonal to each other and they have different frequencies. On the other side, the orthogonal frequency division multiplexing is quickly detect or response the slight changes in carrier or offset frequency and phase noise than compared to single carrier systems. OFDM subcarriers result in the appearance of inter-carrier interference (ICI) and common phase error (CPE) due to loss of orthogonality in OFDM. To maintain the condition of orthogonality and to eliminate the loss of collision between the Inter leavers in the channel . In OFDM, the cyclic prefix needs to be greater than the time delay increases in the channel.

A basic fundamental of Interleave division multiple access i.e. IDMA is differentiated by two users in Inter leaver. A multi- user technique in which chip Interleaved are only means of separating the users that is nothing but IDMA. The iterative multi-user detection is done by receiver in chip-by-chip form. In this work, by combining the OFDM and IDMA, we propose a new method referred as a multi-user system in the mobile radio environment.

All users can transmit their information in same time at same frequency band in OFDM and IDMA method. By using Interleaving technique, the orthogonality can be obtained between the users. The choice of good Inter leaver must demonstrate that the inter leavers are weekly correlated, do not require large memory or large bandwidth to communicate between transmitter and receiver and easy to generate.

## II. IDMA MECHANISM

In wireless communication system, Interleaving can be referred as a technique which is commonly used to overcome noise in the channel such as error burst or fading. In interleaving process, the input data bits reorder itself such that consecutive bits of data are exchanged and splitted among various blocks in a known pattern among them. At receiver, the interleaved data is arranged back to original sequence of bits with the help of de-Inter leaver. As a result , introducing the correlated noise in transmission channel seems to be statistically independent at the receiver in interleaving and thus allocate better error correction.

In IDMA system, there exist several areas which are still open for the researchers. Many of them includes the optimum design of integral parts of IDMA communication system and hence future applications of IDMA mechanism in other areas including satellite communication, LAN networking, optical communications, power line communications, MIMO system and UWB technologies. In addition to this its horizon are still open for investigation about optimum modulation, channel coding, spreading, interleaving, and detection techniques.

The IDMA can be performed in terms of bit error rate and compare its complexity with an Inter-symbol interference cancellation technique for AWGN multipath channel. Thus, it promises a better performance that is compared with OFDM and IDMA when the existing information is completely evaluated. However we noticed that during iterative process the OFDM and IDMA out performs the IDMA with ISI Cancellation when numbers of users are increased. Indeed, increasing the number of users in MAI and ISI is carried out in IDMA requires independent processing.

### *Inter leavers in IDMA Scheme*

In [2], the Inter leavers based on multi-access method has discussed earlier for large bandwidth efficiency, performance is improved and receiver complexity is low. This method depends on interleaving as the only mean to differentiate the signal from particular users. Then it is named as interleave division multiple access (IDMA). The user-specific Inter leavers play a vital function in IDMA system. In case of turbo codes and decoding, the de-correlation between adjacent bit sequence is not possible. The correlation between the Inter leavers should compute, the signals that get affected strongly from other user and the decoding process of specific user also get effected [1]. The transmitter and receiver doesn't store or communicate maximum bits in order to agree with interleaving sequence. It might be demonstrated that defining the correlation between the Inter leavers .It can be used to produce the collision criteria, where zero cross- correlation implies that, it is not collided. In IDMA systems, transmission is required for transfer the convolution Inter leaver. Whereas in receiver , it consist of spreader data along with the interleaving pattern and is related to the users . So that larger the size of the Inter

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leavers, more bandwidth are consumed during transmission, more the orthogonality is achieved among Inter leaver [1].

***Schematic diagram of IDMA***

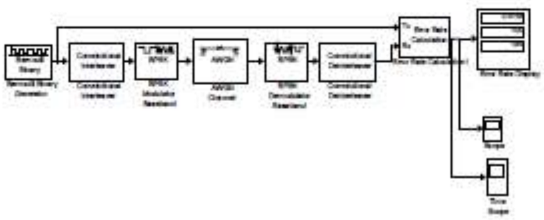

***Fig 1 Schematic diagram BPSK Modulation using Bernoulli binary generator of IDMA***

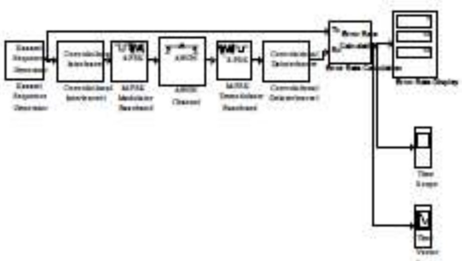

***Fig 2 Schematic diagram M-FSK Modulation using Kasami sequence generator of IDMA***

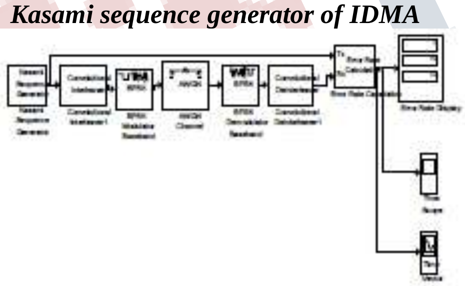

***Fig 3 Schematic diagram BPSK Modulation using Kasami sequence generator of IDMA***

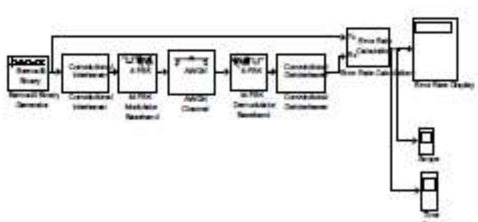

***Fig 4 Schematic diagram 8-FSK Modulation using Bernoulli bnary generator of IDMA***

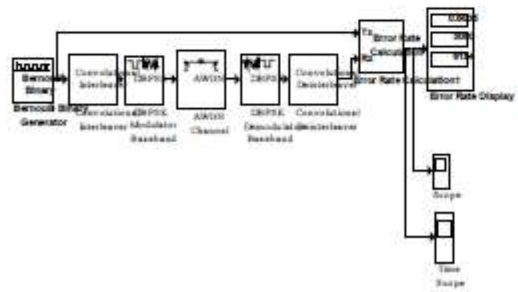

***Fig 5 Schematic diagram DBPSK Modulation using Bernoulli bnary generator of IDMA***

***Schematic diagram of IDMA Scheme using different sources***

***In fig1***.The sequence is- bernoulli binary generator to convolutional interleaver to BPSK modulator to AWGN channel to BPSK demodulator to convolutional deinterleaver to error rate calculator to error rate display.

***In fig2.***The sequence is- kasami sequence generator to convolutional interleaver to M-PSK modulator to AWGN channel to M-PSK demodulator to convolutional deinterleaver to error rate calculator to error rate display.

***In fig3.***The sequence is- kasami sequence generator to convolutional interleaver to BPSK modulator to AWGN channel to BPSK demodulator to convolutional deinterleaver to error rate calculator to error rate display.

***In fig4.***The sequence is- bernoulli binary generator to convolutional interleaver to M-FSK modulator to AWGN channel to M-FSK demodulator to convolutional deinterleaver to error rate calculator to error rate display.

***In fig5***.The sequence is- bernoulli binary generator to convolutional interleaver to DBPSK modulator to AWGN channel to DBPSK demodulator to convolutional deinterleaver to error rate calculator to error rate display.

The error rate is calculated between transmitter and receiver and is compared in simulation result in matlab environment.

***a. Kasami Sequence Generator***

Generate Kasami sequence from set of Kasami sequences.The Kasami Sequence Generator block generates a sequence from the set of Kasami sequences. The Kasami sequences are a set of sequences that have good cross-correlation properties.

***b. Bernoulli Binary Generator***

Generate Bernoulli-distributed random binary numbers. The Bernoulli Binary Generator block generates random binary numbers using a Bernoulli distribution. The Bernoulli distribution with parameter p produces zero with probability p and one with probability 1-p. The Bernoulli distribution has mean value 1-p and variance p(1-p). The **Probability of a zero** parameter specifies p, and can be any real number between zero and one.

***c. Convolution Inter leaver***

Permute input symbols using set of shift registers. The Convolutional Inter leaver block permutes the symbols in the input signal. Internally, it uses a set of shift registers. The delay value of the kth shift register is (k-1) times the **Register length step** parameter. The number of shift registers is the value of the **Rows of shift registers** parameter.

***d. PSK Modulator***

Modulate using Phase frequency shift keying method. The PSK Modulator Baseband block modulates using the Phase frequency shift keying method. The output is a baseband representation of the modulated signal.

***e. AWGN Channel***

Add white Gaussian noise to input signal. The AWGN Channel block adds white Gaussian noise to a real or complex input signal. When the input 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.

***f. PSK Demodulator***

Demodulate PSK-modulated data. The PSK Demodulator Baseband block demodulates a signal that was modulated using the Phase frequency shift keying method. The input is a baseband representation of the modulated signal. The input and output for this block are discrete-time signals. The input can be either a scalar or a frame-based column vector of type single or double.

***g. M-FSK Demodulator Baseband***

Demodulate FSK-modulated data. The M-FSK Demodulator Baseband block demodulates a signal that was modulated using the M-ary frequency shift keying method. The input is a baseband representation of the modulated signal. The input and output for this block are discrete-time signals. The input can be either a scalar or a frame-based column vector of type single or double.

***h. M-FSK Modulator Baseband***

Modulate using M-ary frequency shift keying method**.** The M-FSK Modulator Baseband block modulates using the M-ary frequency shift keying method. The output is a baseband representation of the modulated signal.

The **M-ary number** parameter, M, is the number of frequencies in the modulated signal. The **Frequency separation** parameter is the distance, in Hz, between successive frequencies of the modulated signal.

***i. DBPSK Modulator Baseband***

Modulate using differential binary phase shift keying method. The DBPSK Modulator Baseband block modulates using the differential binary phase shift keying method. The output is a baseband representation of the modulated signal.

***j. DBPSK Demodulator Baseband***

Demodulate DBPSK-modulated data. The DBPSK Demodulator Baseband block demodulates a signal that was modulated using the differential binary phase shift keying method. The input is a baseband representation of the modulated signal.

***k. Convolution De Inter leaver***

Restore ordering of symbols that were permuted using shift registers. The Convolutional De Inter leaver block recovers a signal that was interleaved using the Convolutional Inter leaver block. The parameters in the two blocks should have the same values.

***l. Error Rate Calculator***

Compute bit error rate or symbol error rate of input data. The Error Rate Calculation block compares input data from a transmitter with input data from a receiver. It calculates the

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error rate as a running statistic, by dividing the total number of unequal pairs of data elements by the total number of input data elements from one source.[12]

## III. SIMULATION RESULTS

| Parameter | Fig1 | Fig2 | Fig3 |
|---|---|---|---|
| Target no. of errors | 100 | 100 | 100 |
| Max. no. of symbols | 1e5 | 1e5 | 1e5 |
| Error rate | 0.7143 | 0.5155 | 0.5236 |
| Total no. of errors | 100 | 100 | 100 |
| The total no. of comparisons | 140 | 194 | 191 |
| Modulation Technique | M-FSK | BPSK | DBPSK |
| Interleaver | convolutional | convolutional | convolutional |
| Source | Bernoulli binary generator | Bernoulli binary generator | Bernoulli binary generator |

### *Scope and Floating Scope*

Display signals generated during simulation. The Scope block displays its input with respect to simulation time. The Scope block can have multiple axes (one per port) and all axes have a common time range with independent *y*-axes. The Scope block allows you to adjust the amount of time and the range of input values displayed. We can move and resize the Scope window and you can modify the Scope's parameter values during the simulation. The Scope Block described here is not the same as the Scope Viewer. When we start a simulation the Scope windows are not opened, but data is written to connected Scopes. As a result, if you open a Scope after a simulation, the Scope's input signal or signals will be displayed. If the signal is continuous, the Scope produces a point-to-point plot. If the signal is discrete, the Scope produces a stair-step plot.

Time Scope Display signals generated during simulation. The Scope block displays its input with respect to simulation time. Axes

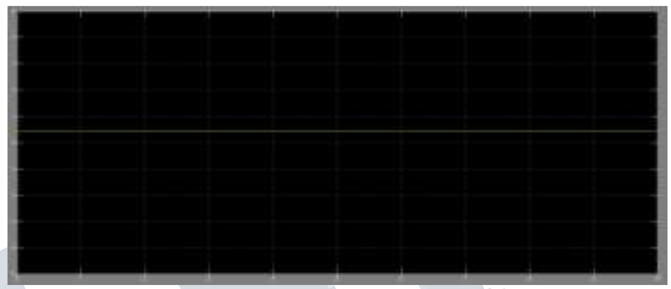

*Fig 6 Scope diagram M-FSK Modulation using Kasami sequence generator of IDMA*

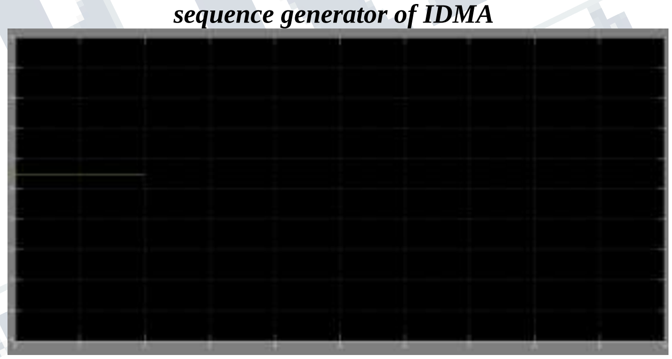

*Fig 7 Scope diagram BPSK Modulation using Kasami sequence generator of IDMA*

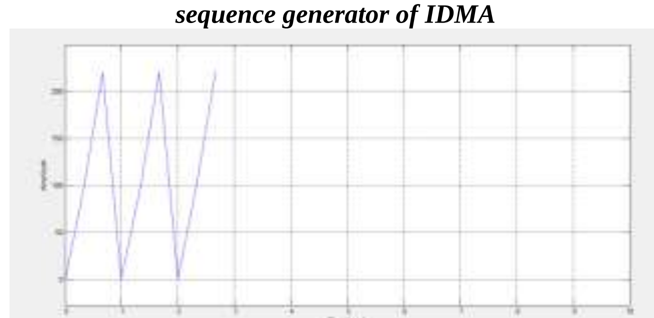

*Fig 8 Time Scope diagram BPSK Modulation using Kasami sequence generator of IDMA*

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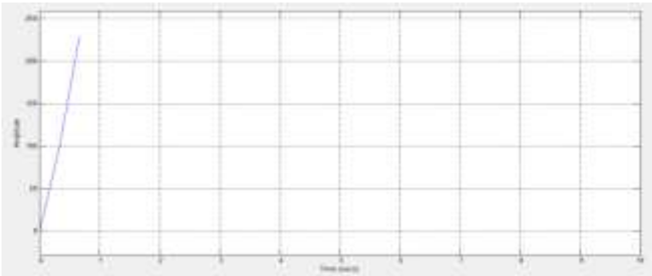

*Fig 9 Scope diagram M-FSK Modulation using Kasami sequence generator of IDMA*

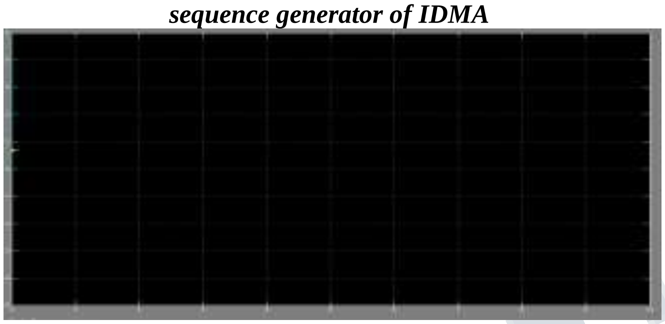

*Fig 10 Scope diagram BPSK Modulation using Bernoulli Binary generator of IDMA*

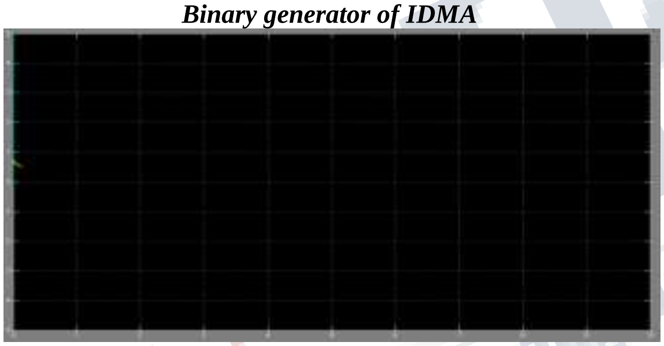

*Fig 11 Scope diagram M-FSK Modulation using Bernoulli Binary generator of IDMA*

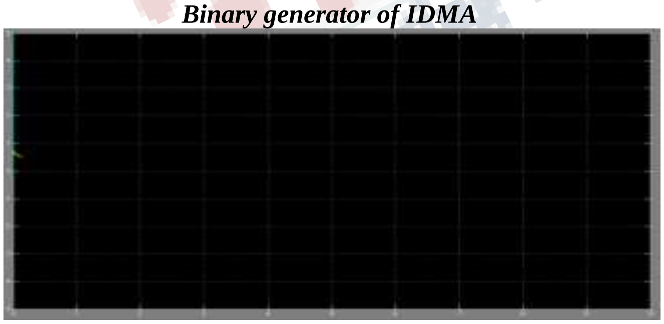

*Fig 12 Scope diagram DBPSK Modulation using Bernoulli Binary generator of IDMA*

**Parameters**

| | |
|---|---|
| **Kasami sequence generator** | |
| **Probability of zero** | **0.5** |
| **Initial seed** | **89** |
| **Data type** | **double** |
| **Sample time** | **1/1200** |
| **Bernoulli binary generator** | |
| **Sample time** | **1/1200** |
| **Probability of zero** | **0.5** |
| **Initial seed** | **89** |
| **Data type** | **double** |
| **Convolutional Interleaver** | |
| **Sample time** | **1/1200** |
| **Row of shift register** | **6** |
| **Register length step** | **2** |
| **Initial condition** | **0** |
| **BPSK modulator** | |
| **Phase offset** | **0** |
| **Data type** | **double** |
| **Awgn channel** | |
| **Initial seed** | **67** |
| **Eb/No(dB)** | **10** |
| **No. of bits per symbol** | **1** |
| **Signal power (watts)** | **1** |
| **Symbol period** | **1** |
| **BPSK demodulation** | |
| **Phase offset** | **0** |
| **Decision type** | **Hard type** |
| **Convolutional deinterleaver** | |
| **Sample time** | **1/1200** |
| **Row of shift register** | **6** |
| **Register length step** | **2** |
| **Initial condition** | **0** |
| **Error rate display** | |
| **Computational delay** | **0** |
| **Receive delay** | **0** |
| **Display** | |
| **Format** | **short** |
| **decimation** | **1** |
| **M-FSK modulator baseband** | |

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| | |
|---|---|
| **M-ary number** | **8** |
| **Input type** | **integer** |
| **Symbol set ordering** | **binary** |
| **Frequency separation** | **6** |
| **Phase continuity** | **discontinuous** |
| **Samples per symbol** | **17** |
| **Output data type** | **double** |
| **M-FSK demodulator baseband** | |
| **M-ary number** | **8** |
| **Input type** | **integer** |
| **Symbol set ordering** | **binary** |
| **Frequency separation** | **6** |
| **Phase continuity** | **discontinuous** |
| **Samples per symbol** | **17** |
| **Output data type** | **double** |
| **DBPSK modulator** | |

## IV. CONCLUSION

I have outlined the basic principles of IDMA and the simulation results with the help of AWGN channel. Comparison is done on the basis of different modulation techniques. Based on the implementation of IDMA we found that M-FSK using the Kasami sequence generator is having least error rate is having least error rate and so it is most suitable modulation technique.

## FUTURE SCOPE

More IDMA scheme with far better performance and results can be evaluated. Different modulation techniques can be used with IDMA scheme and the scheme with highest performance can be found out. Different interleavers can be used in the scheme with different channels like rician channel, rayleigh channel and their performance can be evaluated.

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