PERFORMANCE ANALYSIS OF SC FDMA BASED ON LARGE SCALE MIMO SYSTEM

Ms. S. Kalaivani *Ms. T. Chitralekha* *Ms. B. Suganthi* *Mr. M. Vigneshwaran*

Electronics and Communication Engineering,
RVS College of Engineering and Technology,
Coimbatore, Tamilnadu, India.

Abstract—In recent years, there has been increasing need to reduce the complexity and to improve the performance of multiple access techniques. So the aim of the paper is to reduce the difficulties in Single Carrier Frequency Division Multiple Access (SC FDMA) based on MIMO systems. SC FDMA is a technique that has similar performance and essentially the same overall structure as those of an Orthogonal Frequency Division Multiple Access (OFDMA) system. Compare to OFDMA, SC-FDMA has low Peak-to-Average Power Ratio (PAPR) and for low PAPR, SC-FDMA is used in 3rd Generation Partnership Project(3GPP) Long Term Evolution (LTE) Standard for the uplink multiple access schemes. Therefore the objective is to reduce the Block Error Rate (BLER) and PAPR which can be performed by using Discrete Fourier Transform (DFT) which is based on Multiple Input Multiple Output (MIMO) system and consequently Signal to Noise Ratio (SNR) is increased .Here, a MATLAB simulation is used to analyze the BLER and PAPR when SNR varies simultaneously. It can be observed that DFT shows better performance for MIMO systems.

Keywords— MIMO, SC-FDMA, BLER, PAPR.

I. INTRODUCTION

Multiple Input Multiple Output (MIMO) could be a technique wherever multiple antennas area unit placed at each the tip of the communication system known as MIMO system. MIMO together with abstraction multiplexing builds the inspiration of most of the up-to-date wireless communication standards, like 3GPP LTE or IEEE 802.11n.Compare to single antenna systems, MIMO system offers higher information rates by transmittal multiple information streams and within the same waveband [6].

1.1 Blessing and curse of MIMO

There are 2 sorts of MIMO in wireless setting and that they area unit massive scale MIMO and standard MIMO. Massive scale or large MIMO is the employment of antenna arrays and arrays having orders of additional parts at the Base Station (BS) compare to little scale or standard MIMO systems.
Large scale MIMO technology offers vital enhancements in terms of spectral potency, link responsibility, and coverage compare to little scale MIMO system. particularly, information detection within the massive scale MIMO transmission is anticipated to be among the foremost vital tasks in terms of quality and power consumption, because the presence of many antennas at the baccalaureate. Smale scale MIMO deploys 2-4 antennas at each the tip of the wireless link.

MIMO (Multiple Input Multiple Output),as the name applies the technology that utilizes an array of antennas to transmit the signal over same frequency and on the receiving end an array of antennas to receive the signal.

1.2 Diversity and abstraction Multiplexing

There are 2 main sorts of MIMO and that they are diversity theme, abstraction multiplexing. Even within the presence of weakening conditions diversity theme is employed to extend link responsibility. Using totally different methods, the multiple signals being propagated and these signals are affected otherwise by the weakening. When the receiver recovers the first stream either by choosing the most effective received signal.[1] Alamouti theme is one among the foremost in style space-time continuous block codes used for 2x2 diversity writing.

Spatial multiplexing exploits an equivalent conception of multiple propagation channels; however the sole distinction is to extend the spectral potency rather than the link responsibility. [3]To recover the first signal writing is incredibly vital, as a result of receiver must be able to separate the information sent on every channel.

Obviously, an equivalent condition is employed once the propagation conditions between the transmitter and therefore the receiver are sensible.

The consequence of this multiplexing is a rise in turnout, by employing a 2x2 MIMO i.e.).two transmitter and 2 receiver configuration. In this, it's doable to double the turnout exploitation precisely the same RF channel information measure.

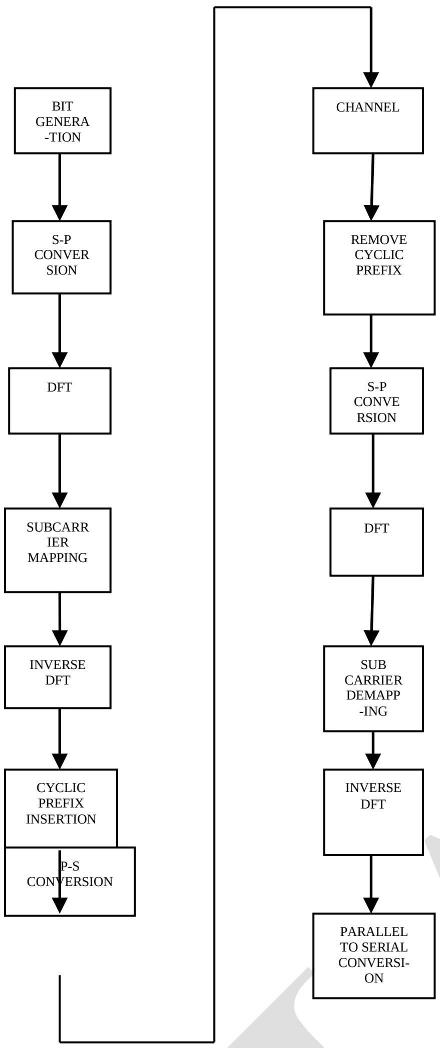

Fig 1: Flowchart for SC FDMA using DFT

Using 4x4, the turnout would be slight high compare to 2*2 MIMO exploitation an equivalent channel information measure, 2x2 MIMO and 4x4 MIMO, turnout reaches as 172.8 Mbps and 326.4 Mbps, severally.

II. MULTIPLE INPUT MULTIPLE OUTPUT

Multiple Input Multiple Output (MIMO), as the name applies is the technology that utilizes an array of antennas to transmit the signal over same frequency and on the receiving end an array of antennas to receive the signal. The crux of MIMO lies in its advantage of multipath propagation, a scenario that is considered the most destructive in wireless communications. MIMO is most fruitful where chances of signal scattering are high [2].

When two transmitters and two or more receivers are used, two simultaneous data streams can be sent, which double the data rate. Multiple receivers alone allow greater distances between devices. The IEEE 802.11n wireless standard, expected in 2009, uses MIMO to increase maximum speed to 100 Mbps and beyond, double the 802.11a and 11g wireless standards.

In lay man terms MIMO can be defined as an antenna technology that employs multiple antennas at the transmitter and receiver to enable a variety of signal paths to carry the data, choosing separate paths for each antenna to enable multiple signal paths to be used.

In mathematical terms, MIMO can be defined as,

$$Y(t) = H(t) * s(t) + n(t)$$

Where, Y(t) is the received signal, H(t) is the matrix of N x M Transceivers, * denotes the convolution property, s(t) is the transmitted signal and n(t) is the noise.

2.1 MIMO Operations

MIMO systems divide a data stream into multiple unique streams, each of which is modulated and transmitted through a different radio-antenna chain at the same time in the same frequency channel [4].

Through the use of multipath, each MIMO receive antenna-radio chain is a linear combination of the multiple transmitted data streams. The data streams are separated at the receiver using MIMO algorithms that rely on estimates of all channels between each transmitter and each receiver.

Each multipath route can then be treated as a separate channel creating multiple "virtual wires" over which to transmit signals [8]. MIMO employs multiple, spatially separated antennas to take advantage of these "virtual wires" and transfer more data.
MIMO can be used in two different modes:

1. Spatial diversity
2. Spatial multiplexing.

In spatial diversity mode, the same information is encoded into all transmit streams in such a way as to improve range of coverage. [5] An example of receive spatial diversity is Maximal Ratio Combining (MRC), where the signals from all receive antennas are combined after first re-aligning their phases.

In Spatial multiplexing mode, on the other hand, the TX antennas simultaneously transmit independent signals over the same frequency channel, resulting in increased spectral efficiency [7].

ISSN 2348 – 9928
Doi:01.0401/ijaict.2015.10.04 Published on 05 (1) 2018

III. CONTRIBUTIONS

This paper addresses the complexity issues in SC FDMA which is based on large scale MIMO system i.e., where multiple users communicate with the BS [5]. In recent years there has been increasing need to reduce the complexity and improve the performance of multiple access techniques and the complexity issues such as BLER and PAPR of a system [3]. The increased complexities such as BLER and PAPR causes the worst system performance i.e., SNR degradation. Here a Discrete Fourier Transform (DFT) is proposed to analyze the complexity issues in SC FDMA system. Using this method the reduction in BLER and PAPR can be performed i.e. increases the SNR when reducing the error in the system.

3.1 SC FDMA Using DFT

At transmitter side, the Fig 1 indicates the following operations,

Bit Generation

For given information corresponding bit can be generated as binary data.

Serial to Parallel Conversion

For performing modulation process the serial data can be converted into parallel.

Discrete Fourier Transform

After modulation the symbols are converted into frequency domain symbols.

Sub Carrier Mapping

Mapping is mainly used for making either row or column should be equal.

Inverse Discrete Fourier Transform

The symbols are again back converted into time domain symbols using IDFT

Cyclic Prefix Insertion

It's a circular extension of IDFT modulated symbols that used to copy the last L samples of IDFT modulated symbols in front of the signal.

Parallel To Serial Conversion

Data are again back converted i.e., parallel data can be converted to serial data.

Channel

A communication channel refers either a physical transmission medium such as wire or a logical connection over a multiplexed medium such as a radio channel to transfer information from transmitter to receiver side.

At receiver side, the reverse operation can be performed like cyclic prefix removal, serial to parallel conversion,DFT,sub carrier demapping, IDFT, parallel to serial conversion.

After performing the parallel to serial data conversion, the final data can be used for data detection at receiver side.

IV. RESULTS AND DISCUSSION

The results can be obtained by analyzing the performance of SC FDMA using DFT and corresponding parameters such as PAPR,BLER andSNR can be measured for various antenna configuration.

CASE (1):

U=4, BS=64

PAPR vs SNR:

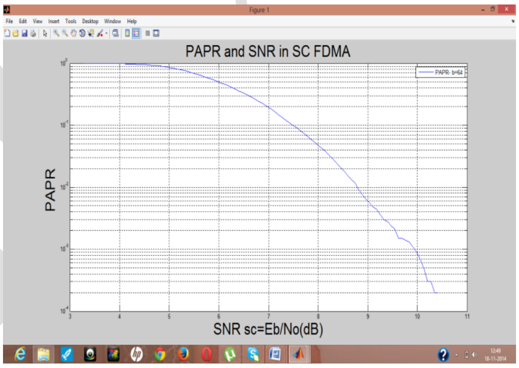

Fig 2 : PAPR and SNR in SC FDMA

The fig shows that the graph corresponding to SNR on x-axis and PAPR along the y-axis. It can be seen that at B=64 the PAPR gets reduced to 10^{-4} when SNR increased to 10.5 db.

CASE (1.1):

U=4, BS=64

BLER vs SNR:

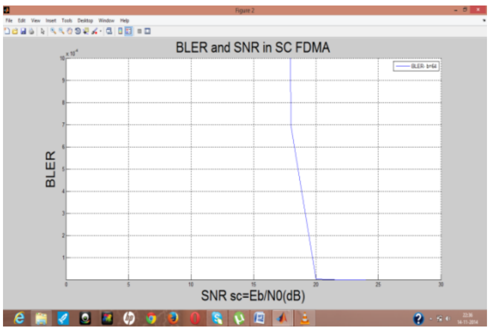

Fig 3: BLER and SNR in SC FDMA

The fig shows that the performance analysis between BLER and SNR. It can be seen that BLER is getting reduced when

Corresponding Author: Ms. S. Kalaivani, RVS College of Engineering and Technology, Tamilnadu, India.

ISSN 2348 – 9928
IJAICT Volume 5, Issue 1, January 2018
Doi:01.0401/ijaict.2015.10.04 Published on 05 (1) 2018

SNR increases. BLER is minimum when the SNR value is 20 db.

CASE (2):

U=8,BS=128

PAPR vs SNR:

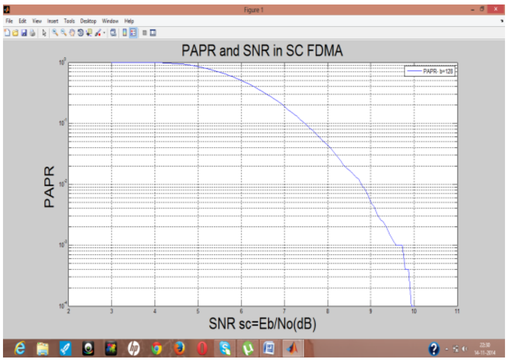

Fig 4 : PAPR and SNR in SC FDMA

The fig shows that the graph corresponding to SNR on x-axis and PAPR along the y-axis. It can be seen that at B=128the PAPR gets reduced to 10^{-4} when SNR decreased to 9.8 db.

CASE(2.1):

U=8,BS=128

BLER vs SNR:

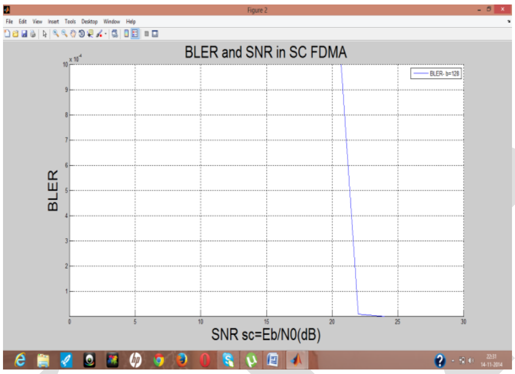

Fig 5 : BLER and SNR in SC FDMA

The fig shows that the performance analysis between BLER and SNR. It can be seen that BLER is getting reduced when SNR increases .BLER is minimum when the SNR value is 22.5 db.

CASE(2.1):

U=8,BS=128

BLER vs SNR:

The Fig 5 shows that the performance analysis between BLER and SNR. It can be seen that BLER is getting reduced when SNR increases .BLER is minimum when the SNR value is 22.5 db.

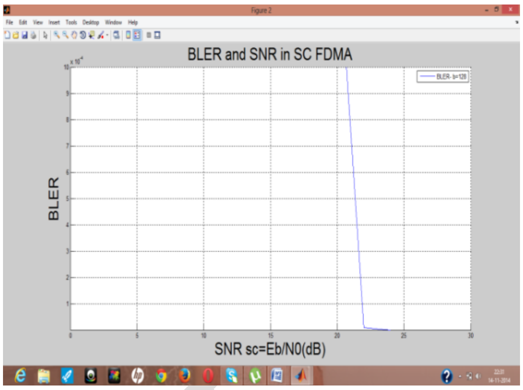

Fig 6 : BLER and SNR in SC FDMA

CASE(3.1):

U=12, BS=256

BLER Vs SNR:

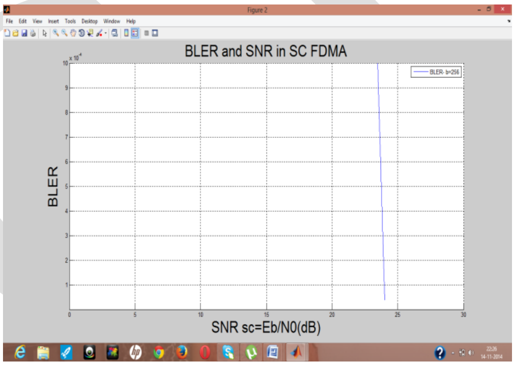

Fig 7 : BLER and SNR in SC FDMA

The fig shows that the performance analysis between BLER and SNR. It can be seen that BLER is getting reduced when SNR increases. BLER is minimum when the SNR value is 25 db.

V. CONCLUSION

Single Carrier Frequency Division Multiple Access (SC FDMA) which utilizes single carrier modulation at transmitter side and frequency domain equalization at receiver side [4].SC FDMA system which has overall same structure as OFDM but differs only the use of DFT modules before OFDM modulation in order to perform pre coding. Compare Orthogonal Frequency Division Multiplexing (OFDM) SC FDMA has low PAPR and high data rate. [9] SC FDMA is a bandwidth efficient signaling scheme for wireless communication compare to other multiple access techniques. But a general problem found in SC FDMA is that BLER, PAPR. The complexity issues which leads to degradation in SNR and transmission efficiency. The complexity issues can be reduced by using Discrete Fourier Transform (DFT) in SC FDMA system which is based on large scale MIMO system [6]. The SNR get increases when BLER, PAPR get reduced and thus it has been observed that DFT shows better performance for SC FDMA scheme which is based on MIMO system.

ISSN 2348 – 9928
Doi:01.0401/ijaict.2015.10.04 Published on 05 (1) 2018

References

[1] Beiyin, Michael Wu,Guohui Wang, Chris Dick, Joseph.R.Cavalloro, Christ Studer (2014), "A 3.8 Gb\s large scale MIMO detector for 3GPP LTE advanced, " in proceeding of IEEE International Conference On Acoustics, Speech And Signal Processing(ICASSP),pp:3879-3883.

[2] Bolcskei.H,Studer.C (2010), "Soft Input Soft Output (SISO)single tree search sphere decoding," IEEE Transaction Information Theory, vol. 56,pp:4287-4842.

[3] Fang.Y.E.YibingLi,XinGoi (2012), "BLER performance of various algorithms in LTE uplink," Journal of computational information system,vol.7,pp: 2691-2699.

[4] GamaladabeslFadeel,Mohamed Salah, Zakin.B, Nossair(2009), "PAPR reduction in SC OFDMA Systems,"13 th International conference on Aerospace sciences and Aviation Technology,pp:1-12.

[5] HlaingMinn, Pochuen Yen (2012), "PAPR reduction for bandwidth aggregated OFDM and SC FDMA System," IEEE Wireless Communication and Networking Conference,pp:1363-1368.

[6] M.Abdased,MahomodIsmail,RosdiadeeNordin (2010), "PAPR performance comparison between localised and distributed based SC FDMA Techniques," Proceedings of World Cong. on Multimedia and Computer Science,pp:1-32.

[7] Nix.A,Noune.M (2010),"SC FDMA uplink transmission scheme in the 3GPP LTE," General communication technology,vol.2,pp:852-857.

[8] Ngo.H.Q,Larsson.E.G,Marzetta.T.L. (2012), "Energy and spectral efficiency for very large scale MIMO systems," Submitted to the IEEE Transactions on communication, vol.2,pp:1112-3810.

[9] Rao.R.M,Tarn.H,Dick.C (2009), "A low complexity square root MMSE MIMO detector," in processing of 44 th asilomar conference on signals and systems and computers, vol.5,pp:1467-1475.

[10] Wu.D, Liu.D (2008), "Implementation of programmable linear detector for MIMO OFDM," in Processing IEEE International Conference on Acoustics,Speech,Signal and Processing(ICASSP),vol.3,pp:5396-53

Corresponding Author: Ms. S. Kalaivani, RVS College of Engineering and Technology, Tamilnadu, India.