Analysis of Non Orthogonal Multiple Access Scheme in Downlink

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Abstract**—**Non-Orthogonal Multiple Access (NOMA) has been recently proposed for 3GPP Long Terms Evolution (LTE) and has been considered as a key enabling technique for 5G cellular systems. In NOMA, by exploiting the channel gain differences, multiple users are combined into power domain at transmitter and transmit non-orthogonally on the same bandwidth resource and (Successive Interference Cancellation) SIC is applied at the receivers to detect the message signals. In this paper I have discussed about the downlink NOMA scheme. After that I discussed about NOMA scheme, its working and transceiver. Then I analyzed the BER performance of NOMA for both BPSK and QPSK modulation scheme.

Keywords—NOMA; SIC; downlink ; interference;

I. INTRODUCTION

Recently there has been interest in non orthogonal multiple access scheme (NOMA) over the orthogonal multiple schemes in wireless communication. In this time- frequency resources are shared non -orthogonally among the users in the system.
It means that the same resources may be utilized by the other users. In OMA limited number of users can be supported as the orthogonal resources are limited. In OFDMA the system bandwidth is orthogonally divided among the the users and hence limited users can be supported. On the other hand NOMA has no such restrictions. It depends only how successfully SIC (successive interference cancellation) can be done. Some of the well known work on NOMA are [1- 7] .

The authors in [1] deals with performance of NOMA with a successive interference cancellation (SIC) receiver as the baseline receiver scheme for robust multiple access, considering the expected evolution of device processing capabilities in the future. Based on system-level evaluations, this paper show that the downlink NOMA with SIC improves both the capacity and cell-edge user throughput performance. This paper also shows discussed possible extensions of NOMA by applying jointly multi-antenna/site technologies with the receivers to achieve a further capacity gain. The authors in [2] discusses the concept and practical considerations of non-orthogonal multiple access (NOMA) with a successive interference canceller (SIC) at the receiver side. They also clarify the benefits of NOMA over orthogonal multiple access (OMA) such as OFDMA adopted by Long-Term Evolution (LTE). Practical considerations of NOMA, such as multi-user power allocation, signaling overhead, SIC error propagation, performance in high mobility scenarios, and combination with multiple input multiple output (MIMO) are discussed. They also show under multiple configurations that the system-level performance achieved by NOMA is higher by more than 30% compared to OMA.

In [3] authors presents key recent research breakthroughs on interference cancellation and highlights system-level considerations for future multi-user receivers. This paper also shows on multi-user receivers has become increasingly comprehensive, the bottleneck for the adoption of multiuser receivers has increasingly become issues relating to complexity and implementation of multiuser detection. In [4] mathematically comparison between the optimum sum rate performance for NOMA and OMA systems, with consideration of user fairness. Firstly, the closed-form optimum sum rate and the corresponding power allocation policy for NOMA systems have been derived, by using the power splitting method. Secondly, the fact that NOMA can always achieve better sum rate performance than that of traditional OMA with optimum power allocation but equal user time/frequency allocation has been validated, by a rigorous mathematical proof. Moreover, the major analytical results have been extracted from those mathematical proofs. Finally, computer simulations have been conducted to validate the correctness of these analytical results and show the advantages of NOMA over OMA in practical Rayleigh fading channels.

Authors in [5] proposes BASIC, a lightweight multi-user uplink transmission strategy that does not require tight synchronization or exchange of samples among nodes, which makes it an attractive alternative compared to its counter parts. BASIC exploits receiver diversity by controlling the data rates of the clients. A novel greedy algorithm is pro- posed for data

II SYSTEM MODEL

We consider downlink NOMA based cellular system. It is assumed that N UEs are assumed to be uniformly distributed in the cell of interest. In the downlink power domain NOMA the channels having good strength are alloted less power and vice versa. If a base station transmits x the received received on a UE can be expressed as

$$y = hx + w \qquad (1)$$

where h is the channel gain and W is the AWGN with its PSD be No . Thus if N number of UEs are there with their respective channel gains as h_1 , h_2 , ...h_N , then the transmitted signal in downlink power domain NOMA can be expressed as

$$x = \sqrt{P_1}x_1 + \sqrt{P_2}x_2 + \text{.................} + \sqrt{P_N}x_N \quad (2)$$

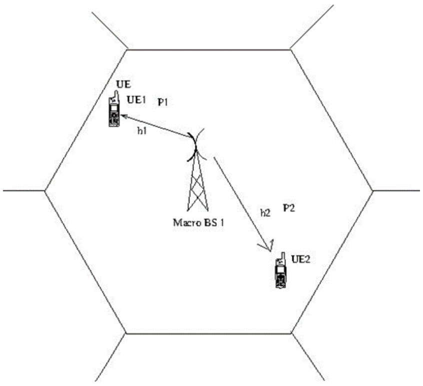

Fig.1

In the downlink the total power alloted to all UEs is equal or less than the downlink power at the base station/eNB. At the receiver sides all UEs receives the composite signal as the same band/ whole bandwidth is used by all UEs. At the receiver of each UE SIC is done in order to recover the intended signal and rejecting the unintended by SIC process.The process of SIC at the receiver is based on the normalized channel gain , where h_i is the channel of a particular UE. $\frac{h_i^2}{BN_0}$,

In downlink NOMA system, the users have high channel gain allocated low power levels whereas users have low channel gain allocated high power levels. At each receiver, the strong interferences are mainly due to the low channel gain users. The user who has lowest channel gain has no need to suppress any interference. However the user has highest channel gain will suppress all the interference .

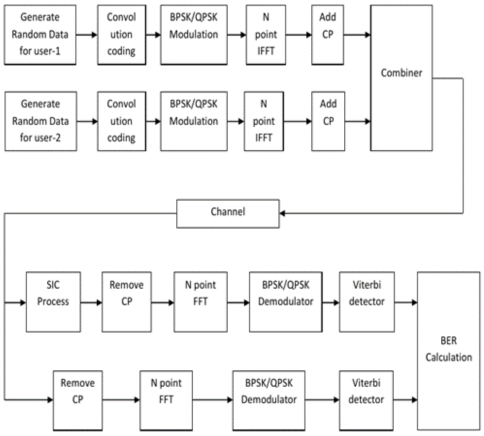

Fig. Simulation Block Diagram for NOMA Scheme

VI. RESULTS AND THEIR ANALYSIS

Parameters	Values
Size of FFT (nFFT)	64
Number of Channels	52
Number of Pilot	12
Number of Symbols	1000
Coding rate	1/2
Number of Samples in CP	16
OFDM Symbol Size	80

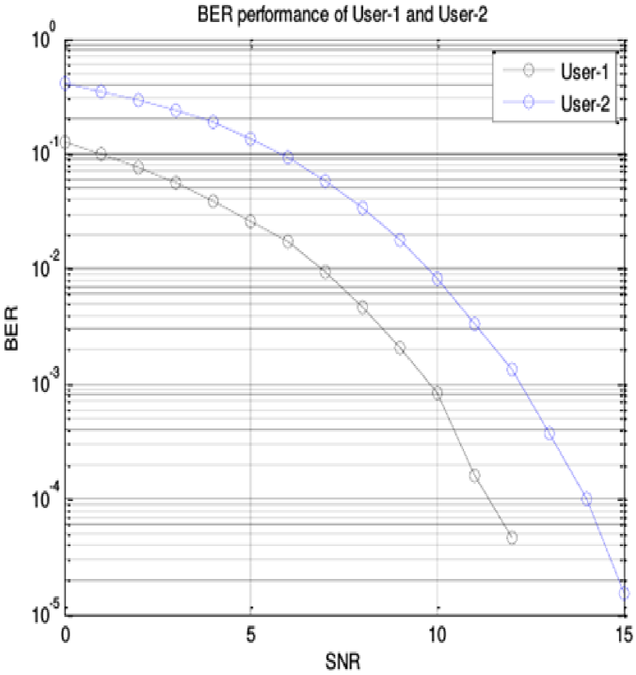

Fig. BER performance of User-1 and User-2 in NOMA with BPSK

The first simulation result is the BER performance of user 1 and user 2 in NOMA system with BPSK for the parameters given in the above as shown in fig. It is seen in this fig.that the performance of user 1 is better than the user 2.

In NOMA system the performance of user with high power is better than the performance of user with lower power. We allocated more power to user 1 and less power to user 2. So the user with more power will experience less less interference while the user with less power will experience more interference.

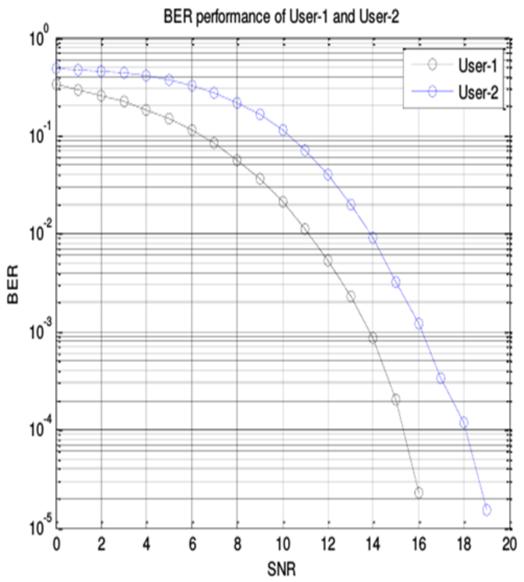

Fig.3 BER performance of User-1 and User-2 in NOMA with QPSK

The second simulation result is the BER performance of user 1 and user 2 in NOMA system with QPSK for the same parameters given in the table as shown in fig. .

We can see in this fig. also that the performance of user 1 is better than the user 2.The reason is same for the better performance of user 1 than user 2 as we discussed in case of NOMA with BPSK.

However we can compare the BER performance of individual user in case of NOMA with different modulation scheme. On comparing the graphs plotted in fig.2 and fig 3 that the individual BER performance of each user is better in case of NOMA with BPSK as compared to NOMA with QPSK, the reason is simple that the QPSK has less phase margin than the BPSK

VII. CONCLUSIONs

In this work I analyzed the performance of NOMA and OFDM systems by considering the signal modulation BPSK as well as QPSK over Rayleigh fading channel. The performance is given as a plot between BER and SNR. It is seem that the performance in BPSK is better than the performance in QPSK in both cases NOMA and OFDM. The reason of better performance in BPSK is that bits are separated by each other by 180° so that the phase margin in BPSK is more than the QPSK because in QPSK the bits are separated by 90°. Because of this reason it is easy to detect the bits with less error in BPSK while the detection of bits is difficult in QPSK as with less error as compared to BPSK.

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