Spectral Efficiency Analysis of Non Orthogonal Multiple Access Scheme

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Abstract—In this paper I have compared the spectrum efficiency of OFDM and NOMA for both BPSK and QPSK modulation. On the basis of simulation results the merits and demerits of NOMA scheme over OFDM scheme are discussed. l compared the BPSK and QPSK modulation schemes and on the basis of results of simulation described the advantages and disadvantages of BPSK over QPSK.

Keywords—LTE; OFDM; fading; bandwidth; radio frame

I. INTRODUCTION

Orthogonal multiple access was a reasonable choice for achieving good system-level throughput performance. However, considering future radio access (FRA) in the 2020s, further enhancement to achieve significant gains in capacity and system throughput performance is a high priority requirement in view of the recent exponential increase in the volume of mobile traffic, e.g., beyond a 500 fold increase in the next decade and the need for enhanced delay-sensitive high-volume services such as video streaming and cloud computing. Thus, the 3GPP recently has initiated discussions on further evolution of LTE towards the future [1]. In order to continue to ensure the sustainability of 3GPP radio access technologies over the coming decade, new solutions must be identified and provided that can respond to future challenges.

In OMA (OFDMA) with the help of frequency-domain scheduling difference of channel gain is translated into multi-user diversity gain, but in NOMA the difference of channel gain is translated into multiplexing gains by superposing in the power-domain the transmit signals of multiple users of different channel gains [2]. NOMA is a multiplexing scheme that utilizes an additional new domain, i.e., the power domain, which is not sufficiently utilized in previous systems like FDMA, TDMA, CDMA, OFDMA etc. Non-orthogonality is intentionally introduced in terms of power-domain user multiplexing. The UE (User Equipment) has high channel gain is allocated less power and the UE has low channel gain is allocated more power. These large power differences play very important role in successful decoding and thus successful cancellation of the interference at the user with high channel gain. So the NOMA technology is a promising choice to tackle the future challenges towards currently being increase in mobile traffic & also in the next decade for 5G wireless network.

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

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

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

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

respective channel gains as h_1 , h_2 , ...h_N , then the transmitted signal in downlink power domain NOMA can be expressed as

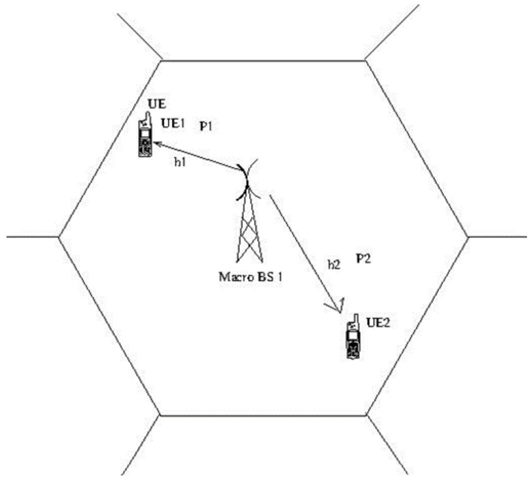

Fig.1

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 thesame 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.

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 . $\frac{h_i^2}{BN_0}$,

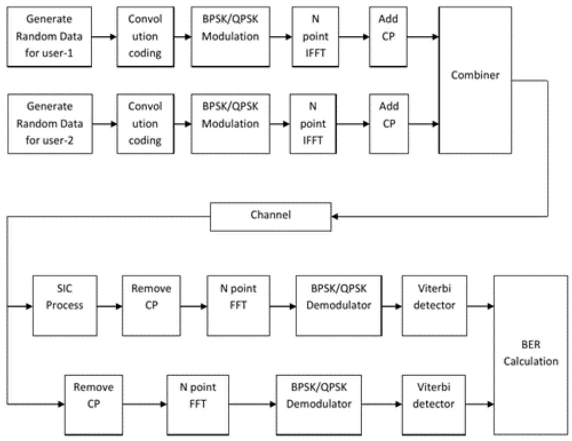

Fig 2

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

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Size of FFT (nFFT)	64
Number of Channels	52

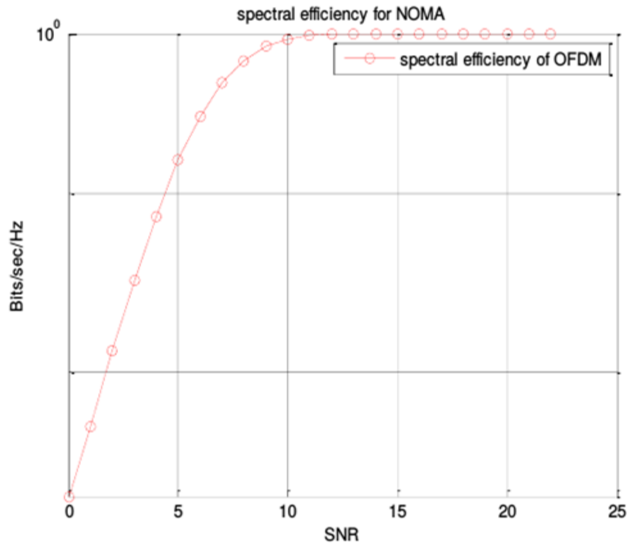

Fig. 3 Spectral Efficiency of NOMA System with BPSK Mapping

The parameters given in table are used to simulate the results for spectral efficiency of OFDM system with BPSK mapping. The plot is between SNR and spectral efficiency is shown in fig.

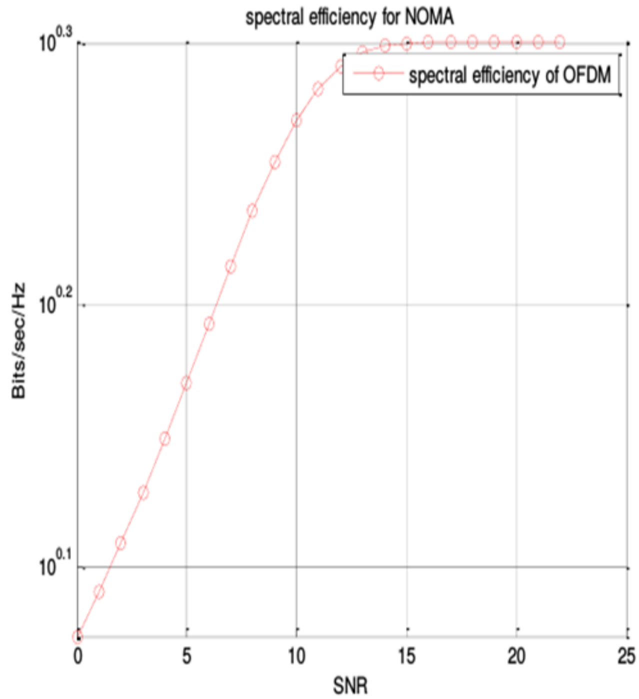

Fig. 4 Spectral Efficiency of NOMA System with QPSK Mapping

The simulation result for NOMA system with QPSK mapping is shown in fig. 4. which is plot between Spectral efficiency verses SNR.

VII. CONCLUSIONS

In this paper I have analyzed the spectrum efficiency of NOMA and OFDM systems with both modulations BPSK and QPSK over Rayleigh fading channel. In BPSK we transmit 1 bit/symbol while in QPSK we transmit 2 bits/symbol so that we are sending double bits of BPSK modulation in QPSK modulation while the numbers of symbols are same in both cases so that we are utilizing the band efficiently in QPSK as compared to BPSK. Hence the spectrum efficiency of QPSK is twice of the BPSK system. In simulation result it is seen that the spectrum efficiency with QPSK is twice of that BPSK in both cases OFDM as well as NOMA also.

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