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Performance Analysis of Energy Efficient NOMA

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Abstract - *A Non-orthogonal multiple access (NOMA) is a promising developing technology that can significantly improve the usage of spectrum and system capacity in heterogeneous wireless networks and empowers spectrum overlapping and permits particular users to simultaneously operate over a similar frequency band, and thus empowers huge connectivity. Power allocation assumes a key job in the successful deployment of NOMA. In the earlier power allocation schemes, the perfect channel state information (CSI) is thought to be realized which is hard to acquire in a realistic environment. For NOMA system super coding and successive interference cancellation procedures are utilized to separate the signals for uplink and downlink systems. In this paper, we propose a power allocation plan to boost the energy efficiency of small cells for downlink NOMA heterogeneous networks dependent on imperfect CSI, channel estimation is performed for NOMA system, Bit error rate(BER) is contrasted with perfect CSI and imperfect CSI and furthermore Carrier frequency offset (CFO) is plotted for NOMA system and also compares data rates of synchronous and asynchronous for downlink channel. The simulation results show the superiority and efficiency of the proposed plot contrasted with the prior techniques to improve overall efficiency of the NOMA system for 5G communications.*

***Key Words*: Non Orthogonal Multiple Access, Channel State Information, BER, CFO, 5G Communication**

1. INTRODUCTION

Most of the communication in today's world are wireless. The communication is provided by dividing the entire area into small cells and the main intention in the design of such systems is to efficiently raise the capacity of the channels. With the increase in the use of wireless appliances such as mobile phones in our daily lives, an adequate use of the available resources such as bandwidth is necessary so as to improve the efficacy of entire system. The multiple access scheme has a key role in the distribution of different user's data. This technique is basically categorized as Orthogonal and Non-Orthogonal multiple access (OMA and NOMA). The most recent among the schemes of handling several end users is Non-Orthogonal Multiple Access (NOMA) and it is trusted to provide an upsurge in transfer rate of information which can in turn be called as the operation rate or scale of information. A proper resource provided channels results in an enhanced way of communication without degrading the users distance criteria and there by destroying impartiality. In the type of scheme which deals with serving diverse end users with reserves being at right angle to each other, the reserves are time, frequency and code based which results in three different types of classification of further sub schemes. These schemes had no proper utilization of the resources which resulted as drawback such as wastage of frequency, constant operating rate, pre-assigned timing slots, reduced service level in case of increased number of users and many more which reduces the overall system sufficiency. NOMA technique provides high proficiency by supporting large number of users and has the extent to diversiform all the users who have favourable channel states with the other users who have unfavourable medium conditions and hence gives rise to a concept of being impartial to all the users.

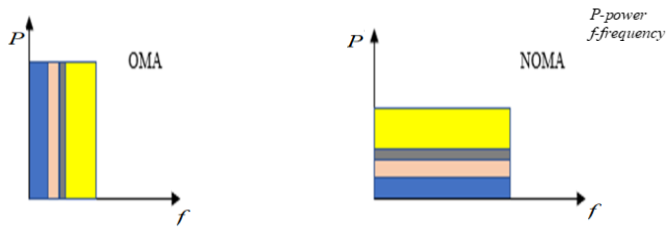

Fig 1 OMA and NOMA graphical representation

The Fig 1 shows the graphical representation of both OMA and NOMA strategies. The latter is considered as the best strategy to function with internet of things thereby increasing the connections of large number of devices. Fulfilling these demands also requires the number of users in a particular cell to be increased significantly without boosting the number of base stations in respective cells, satisfying users with needed operating rates and with minimum delay, and lastly the cost of all these must be kept affordable. To accomplish these requirements, it is important to increase spectrum proficiency, using all degrees of freedom-time, frequency, code, to reduce power usage, reducing tampering effect, so as to maximize the system efficiency. Several-carrier strategies such as Orthogonal Frequency Division Multiple Access (OFDMA) and individual carrier scheme such as Single Carrier Frequency Division. Multiple Access (SC-FDMA) has ability in converting entire bandwidth into sub channels which parallel, overlapping and non-evanescent. In order to improve the proficiency of spectrum, a new scheme is evolved which is NOMA. The superposition type of coding is used in this scheme which grants many users with time and frequency reserves simultaneously and uses consecutive interference elimination at the receivers. These features possessed by NOMA increases system capacity.

2. EXPOSED SYSTEM

Figure 2 gives the overall information of resource apportionment in the proposed project. It consists of NOMA transmitter and receiver. The transmitter comprises elements as same as any other transmitter but the only difference here is the use of multiple access strategy which in this case is NOMA and hence the name. Transmitter has power supply circuit, modulator, amplifier and antenna system. Since, the goal of this project is to optimize the sources of communication system, only modulation part is considered for simplicity. The NOMA scheme is feasible and consistent with the existing modulation techniques. The modulation used in this project is binary phase shift keying. The signal is first multiplexed and modulated. After modulation is done, the carrier signal carrying the information message is allotted power.

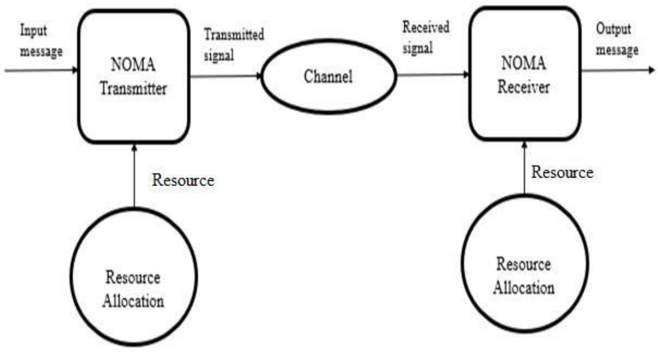

Fig 2: Proposed system block diagram

The power allocation strategy used here is based on non-convex as the parameters whose enhancement to be done are not convex and the solution for this will have many ideal points. Water filling power allocation is used which defines that – allocate variable power to each of the channel being created. The channel is nothing but the medium which is present for communication to take place. In the put forth scheme, a channel is formed which is designed to provide a required transfer rate of 23 bits/sec/Hz. The noise or other tampering is added in the channel region. Once the transmitted signal reaches the receiver, various operations takes in to decode the message. The receiver will perform operations opposite to that of the transmitter and extracts the originally sent data. The successive interference cancellation technique is used to decode the messages. The receiver type considered is maximum likelihood receiver and the decoding of messages is based on convex allotment of resources but it exhibits disadvantages like power complexity problem, Frequency fading, inter symbol interference etc..To avoid this different methodologies are explained in proposed system.

3. PROPOSED SYSTEM

NOMA uses superposition coding at the transmitter such that the successive interference cancellation (SIC) at receiver can separate the users both in the uplink and in the downlink channels. Superposition coding at the transmitter and successive interference cancellation (SIC) at the receiver makes it possible to utilize the same spectrum for all users.

3.1 Superposition coding and successive interference cancellation techniques

Superposition coding at the transmitter and successive interference cancellation (SIC) at the receiver makes it possible to utilize the same spectrum for all users. At the transmitter site, all the individual information signals are superimposed into a single waveform, while at the receiver, SIC decodes the signals one by one until it finds the desired signal. The three information signals indicated with different colors are superimposed at the transmitter. The received signal at the SIC receiver includes all these three signals. The first signal that SIC decodes is the strongest one while others as interference. The first decoded signal is then subtracted from the received signal and if the decoding is perfect, the waveform with the rest of the signals is accurately obtained. SIC iterates the process until it finds the desired signal.

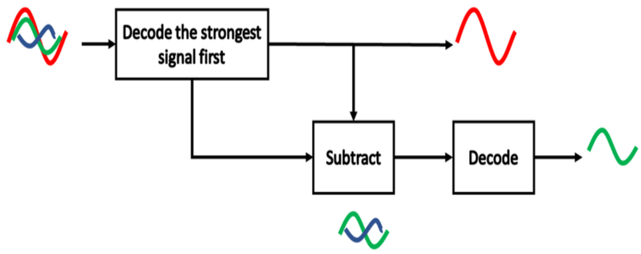

Fig. 3: Superposition coding and successive interference cancellation techniques

In NOMA downlink, the base station superimposes the information waveforms for its serviced users. Each user equipment (UE) employs SIC to detect their own signals.

3.2 Downlink process:

In the network, all UEs receive the same signal that contains the information for all users. Each UE decodes the strongest signal first, and then subtracts the decoded signal from the received signal. SIC receiver iterates the subtraction until it finds its own signal. UE located close to the BS can cancel the signals of the farther UEs. Since the signal of the farthest UE contributes the most to the received signal, it will decode its own signal first.

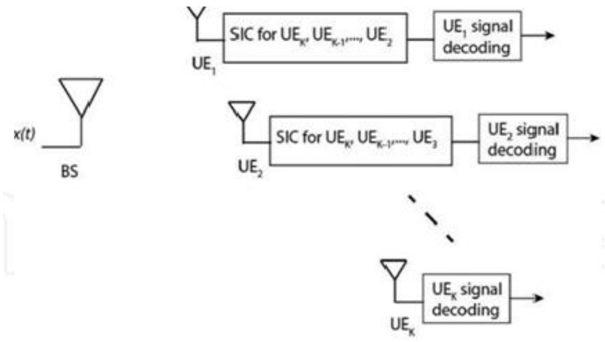

Fig 4. Downlink NOMA for K users

The transmitted signal by the BS can be written as

$$\mathbf{x(t)} = \sum_{n=1}^{k} 1.\sqrt{\propto_n P_T x_n}$$

$$P_n = \propto_n P_T$$

$xn\,(t)$ = individual information conveying OFDM waveform, $_n$ is the power allocation coefficient for the UE$_n$, P_T is the total available power at the Base Station. P_n The power allocated to each UE$_n$

The received signal at the UEn is

$$y_n(t) = x(t)\,g_n + w_n(t)\,g_n$$

Channel attenuation factor for the link between the BS and the UEn

$W_n(t)$ = the additive white Gaussian noise at the UEn with mean zero and density N_0(W/Hz)

The signal to noise ratio (SNR) for UE$_K$

$$\text{SNR} = \frac{P_k\, g_k^2}{N_0 W + \sum_{t=1}^{k-1} P g_i^2\, k}$$

Where w is the transmission bandwidth.

3.3 NOMA for uplink

Uplink implementation of NOMA is slightly different than the downlink. Figure 4 depicts a network that multiplexes K UEs in the uplink using NOMA. This time, BS employs SIC in order to distinguish the user signals.

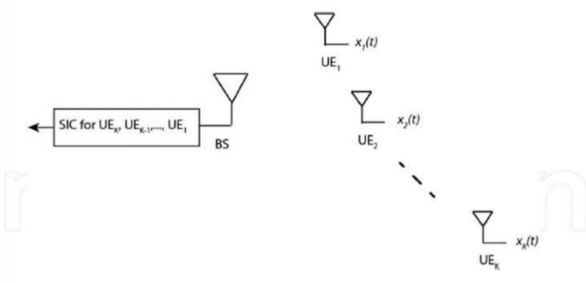

Fig 5 Uplink NOMA for K users

When NOMA is used, the throughput (bps) for each UE can be written as,

$$R_n = W\log_2\left(1 + \frac{P_n g_n^2}{N + \sum_{i=n+1}^{k} P g_i^2}\right)$$

When the total bandwidth and power are shared among the UEs equally, throughput for each UE for OFDMA becomes.,

$$\mathbf{R_n = W_n \log_2\left(1 + \frac{P_n g_n^2}{N_n}\right)}$$

Where, $\mathbf{W_n} = \frac{W}{K}$ and $N_n = N_0 W_n$

The sum capacity for both OFDMA and NOMA can be written as

$$R_T = \sum_{n=1}^{k} R_n$$

4. RESULTS AND DISCUSSIONS

The figure 6 shows the MATLAB simulation results for heterogeneous cells for large number of users, where this represents the clustering of two or more cells depending on how they are close to each other by maintaining a minimum distance, where multicells may suffer from inter symbol interference (ISI) and inter carrier interference (ICI) between the cells, to avoid this problem minimum distance is maintained between the cells, so that spectral efficiency(SE) and energy efficiency(EE) of the system is increased.

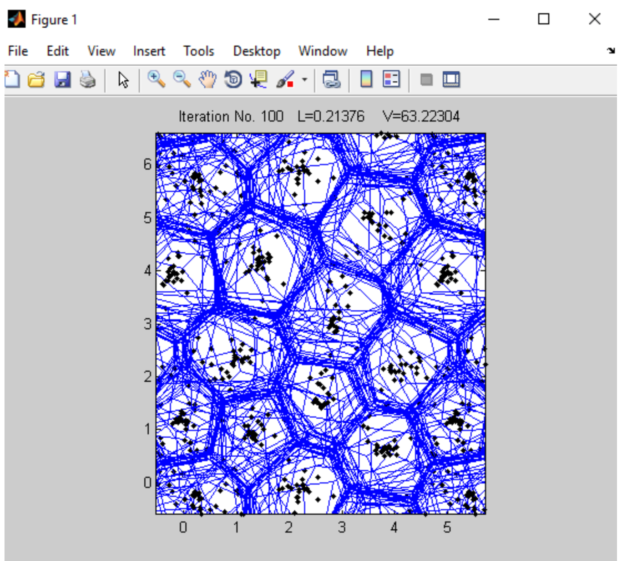

Fig 6. MATLAB simulations showing heterogeneous networks

In figure 6 shows simulation result for heterogeneous cells where iteration is varying from 1 to 100, L is varied from 0 to 0.21376, V is and from 0 to 63.22304. This are used for different number of users communicating themselves with specified distance, so resources can be reused in the cells.

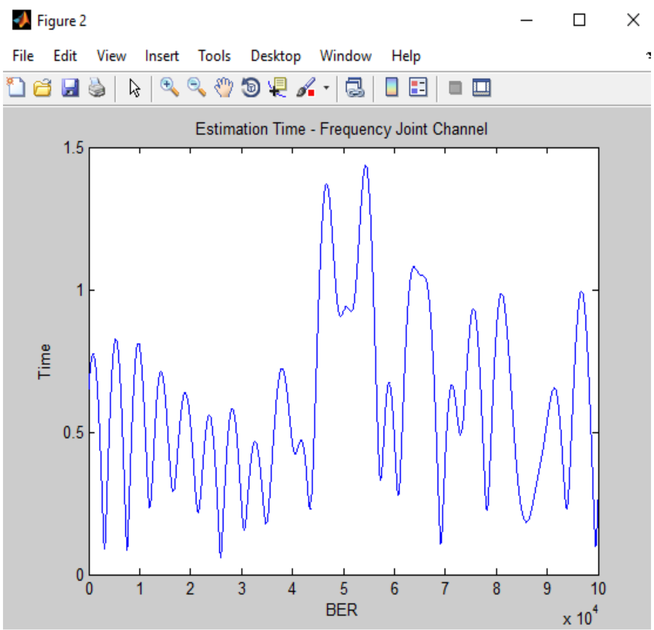

Fig 7. MATLAB simulations showing channel estimation at different BER value

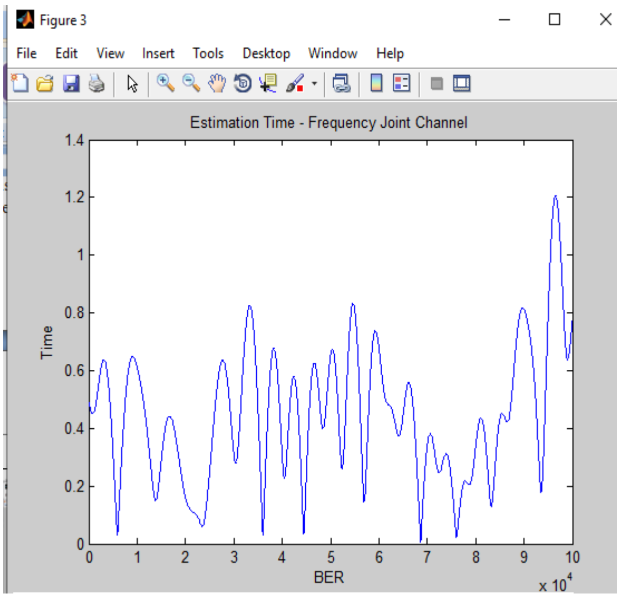

Fig 8. MATLAB simulations showing channel estimation at different BER value

Figure 7 and Figure 8 shows MATLAB simulation of BER curves for various values. It can be seen that channel estimation is done for time-frequency joint channel, it is verified for different values of BER and respective graphs are plotted here.

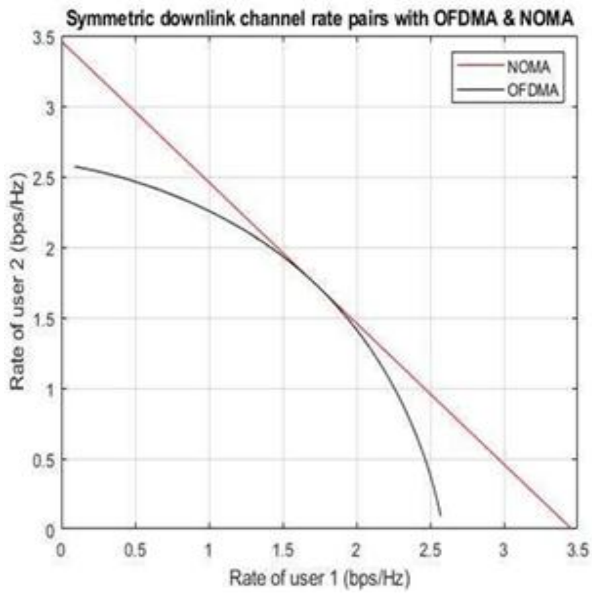

Fig 9. MATLAB simulations for symmetric downlink channel

The figure 9 and figure 10 shows the MATLAB simulation result for Symmetric and asymmetric downlink channel data rate pairs respectively which compares the NOMA and OFDMA systems, in that red color curve represents data rate of NOMA system, black color curve represents data rate of OFDMA.

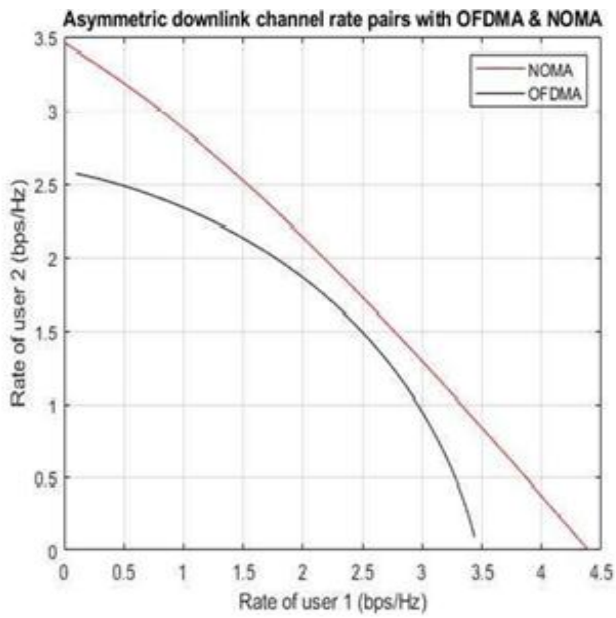

Fig 10. MATLAB simulations for asymmetric downlink channel

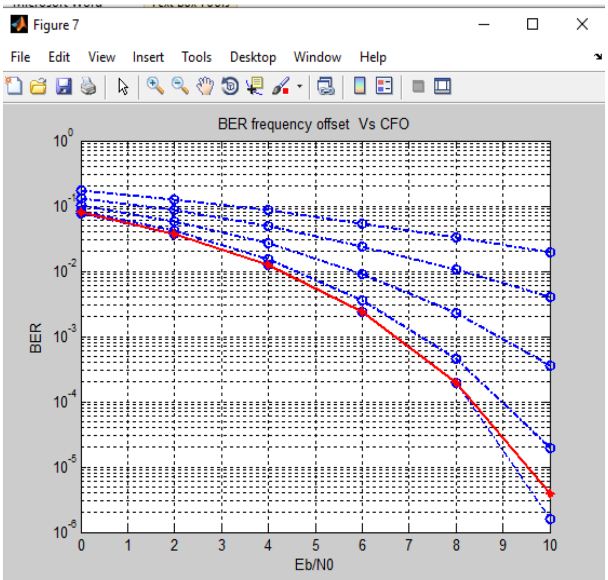

Fig 11. MATLAB simulations for plotting BER vs CFO

Figure 11 shows the MATLAB simulation analyses for the performance bit error rate and carrier frequency offset, the signal to noise ratio is plotted for different values of lengendary values which reduces the noise in the NOMA system also increases the efficiency of the system.

5. CONCLUSION

NOMA based system provides the ability to use the same frequency spectrum for data transmission of multiple users within a single cell to achieve high spectral efficiency, energy efficiency and broad coverage for potential cellular wireless applications. The OFDM system and NOMA systems are studied and compared, and overcome disadvantages of OFDM, the overall performance of NOMA are improved, The Channel estimation is done for NOMA system and implemented using MATLAB. BER performance of perfect and imperfect channel state information (CSI) are also analyzed using MATLAB and Carrier frequency offset(CFO) implemented, Data rate of symmetric and asymmetric downlink channel are compared and plotted using MATLAB resulting to improve the overall performance of NOMA system. Future work is the implemented system can be verified for different next generation 6G and the data rates , all features of system come with more improvement in terms of energy efficiency and spectral efficiency of the NOMA system.

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REFERENCES

[1] Ming Zeng, Nam-Phong Nguyen, Octavia A. Dobre, Zhiguo Ding, ,H. Vincent Poor "Spectral and Energy Efficient Resource Allocation for Multi-carrier Uplink NOMA Systems" IEEE transactions on vehicular technology - 2019.

[2] Xin Song, Li Dong , Jingpu Wang, Lei Qin, Xiuwei Han, "Energy Efficient Power Allocation for Downlink NOMA Heterogeneous Networks With Imperfect CSI" IEEE access March-2019.

[3] Vinay K. Trivedi, Khaled Ramadan, P. Kumar, M.I. Dessouky, "Enhanced OFDM-NOMA for next generation wireless communication: A study of PAPR reduction and sensitivity to CFO and estimation errors" Article in AEU - International Journal of Electronics and Communications (IJEC) January-2019.

[4] Mohammad Reza Zamani, Mohsen Eslami, Mostafa Khorramizade "Energy Efficient Power Allocation for NOMA with Imperfect CSI" Article in IEEE Transactions on Vehicular Technology , November 2018

[5] Z. Ding, Y. Liu, J. Choi, Q. Sun, M. Elkashlan, H.V.Poor, "Application of non-orthogonal multiple access in LTE and 5G networks" IEEE Commun. Mag., vol. 55, no. 2, pp. 185–191, Feb. 2017.

[6] S. M. R. Islam, M. Zeng, O. A. Dobre, K. Kwak, "Resource allocation for downlink NOMA systems: Key techniques and open issues" April 2018.

[7] UtkuOzmat, Oguz Ulgen, Emre Gunaydin, "Bit Error Rate Analysis of Non-Orthogonal Multiple Access (NOMA) Technique in 5G with Different Power and User Scenarios" Advances in Wireless and Optical Communications 2018.

[8] Linglong Dai, Bichai Wang, Zhiguo Ding, Zhaocheng Wang, Sheng Chen, LajosHanzo , "A Survey of Non-Orthogonal Multiple Access for 5G" 2018.

[9] Muyiwa B. Balogun, Fambirai Takawira, Olutayo O. Oyerinde, "Uplink OFDM Based NOMA Plagued with Carrier Frequency Offset Errors" IEEE Xplore July 26, 2020.

[10] Yizhi Tan, Jingrong Zhou, and Jiayin Qin "Channel Estimation for Non-orthogonal Multiple Access Systems" IEEE Signal Processing Letters, Vol. 23, No. 12, December 2016.

[11] S. M. Riazul Islam, Ming Zeng, Octavia A. Dobre " NOMA in 5G Systems: Exciting Possibilities for Enhancing Spectral Efficiency" IEEE 5G Tech Focus: Volume 1, Number 2, June 2017.