PROFICIENT RESOURCE ALLOCATION FOR MC-NOMA

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Abstract: With the increasing number of users using wireless applications, it is necessary to make the various user desired services such as internet, video conference, and many more applications to be available to users at any time they need with an acceptable scenario of waiting states. Multiple access techniques make this happen by distributing the channels to all the users accessing the network for which proper utilization of resources plays a key role. The newest category under this concept is Non-Orthogonal Multiple Access (NOMA) technique. The key idea of the proposed work is to efficiently utilize the resources allocated to the system in the whole process of communication. This is done through optimization of resources. The power optimization concept is given importance in this framework. The scenario of making the best use of power is framed as non-convex. The enhancement in the other objective function such as maximization of the probability of detecting the correct information at the receiver is also considered which is viewed as convex resource. The results are obtained by performing simulation using MATLAB and these are evident that the performance of NOMA is efficient and conveys that NOMA is having better performance than the conventional orthogonal scheme.

***Index Terms* - Multiple Access, Non-Orthogonal, User impartiality, Resource Allocation.**

I. 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 [5]. 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 un favourable medium conditions and hence gives rise to a concept of being impartial to all the users.

The Figure 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 subchannels 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.

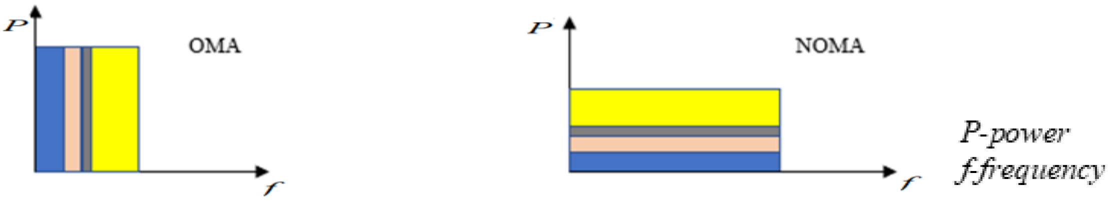

Figure 1:OMA and NOMA graphical representation

Some works are based on medium allotment to users but were not able to achieve efficacy in power. Some other research in this direction were carried out to optimize power but the results could not achieve the other related objective functionalities. When we deal with channels, it is important to determine the characteristics of the medium. The parameter that helps us in this endeavour is Channel State Information(CSI). This parameter helps us in finding out what the state of channel is-good condition or bad? Or requires less resources or no? This criterion helps in proper allotment of reserves. When the CSI is not known, the computations is to be carried out which can be analytical. This parameter can also be called as medium state information. The proposed work focusses on providing efficient resource distribution in non-orthogonal multiple access. The goal of this work is to make the non-orthogonal multiple access scheme proficient by proper allocation of resources to each of its users and thereby providing them with sufficient transfer rates at acceptable latency. The power levels of the carriers used in the multi carrier non-orthogonal scheme is to be maintained at a state such that sent and the received power states of signals are approximate and efficient to withstand with any obstacle coming in its way in the medium. The scope of this work is restricted to power efficient distribution and downlink scenario i.e., to the transmission of information from base station to the end users.

This rest of this article discusses about what the put forth work is and how it is carried out is shown in section II, section III discusses about the results and section IV about the conclusion and future research in this direction.

II. PROPOSED WORK

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.

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.

Figure 3 is a description of resource allocation strategy. The signals travels in space and may not reach destination in some cases due to various obstacles in its way. All the user's signals need to be provided with sufficient resources such that the signals are not faded away. When there is an information signal, the NOMA transmitter employs NOMA technique for multiple access and provides the signal with resources. There are mainly two challenges in this regard- one is frequency and other is distance. Hence, the transmitter part from modulation to the demodulation part in the receiver play a role in resource apportionment. Both these challenges can be resolved in a similar manner. In case of modulation part, first there is need to generate frequency gap for several users, assign values of spectrum, and update it if there are any changes such as addition or removal of users and accordingly a new boundary of frequency is defined and then demodulation is done to retrieve the signal sent. Similar approach is taken in case of the other challenge. To perform optimization of power, water filling power allocation scheme is used and to illustrate how the allocated power varies with the allocated spectrum, power spectrum of each carriers and transmitted signal is calculated.

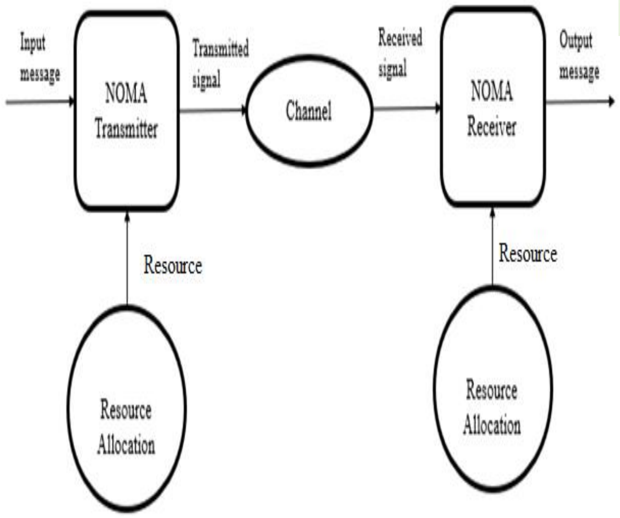

Figure 2: Proposed system block diagram

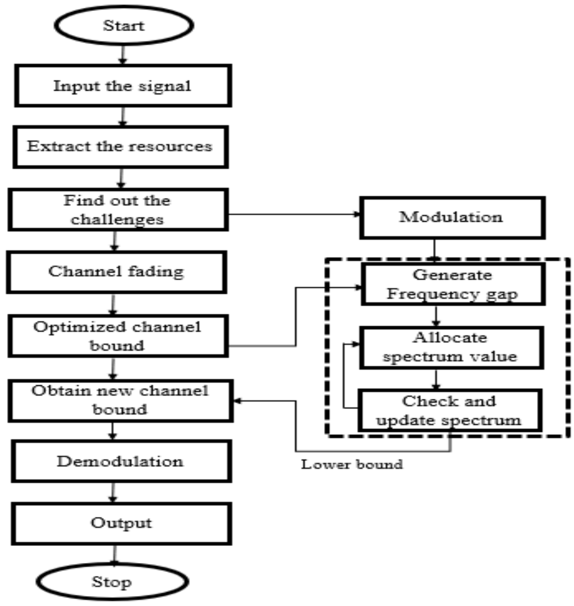

Figure 3: Resource allocation strategy

In the put forth scheme, to achieve the objectives up to the mark, software is used and hardware components to work with this software is used. The software tool used in MATLAB and the hardware is a computer system with standard specifications.

Table 1: Software used

Operating system	Windows 10
Coding Language	MATLAB
Tool	MATLAB R2014a

To do the project, sufficient space of 4GB random access memory and 500 GB storage, and Intel Celeron processor operating at 1.4GHz with cache memory of 2MB is being used with a display of 15.6" HD. Since, a laptop with the required specifications is used, there is no need of extra keyboard or mouse. The operating system is windows 10. The processor speed helps in the speedy computations of problems involved in the MATLAB code being created for the network of non-orthogonal multiple access.

Table 2: Hardware components used

System	Intel core i3
Hard disk	1 TB
Monitor	15.6”
Input devices	Keyboard. Mouse
RAM	4GB

The above methodology is implemented with the use of the tools as shown in table 1 and table 2. The main program and the associated functions are created using MATLAB language. The main program is divided into various sections with each section describing the particular task to be performed in the NOMA network. These tasks are described below:

A. Creation of MC-NOMA network: This step involves the development of network which is employing a non-orthogonal strategy for multiple user’s operation. The number of base station is considered to be one in one particular network. The users number can be anything. In the project, the proposed scheme is tested for a network of radius equal to 500 m and the number of users considered for simulations are four in number. The position of users in the network changes every time because the users are in motion. Because of this, an un-static allocation of associated resources is provided. Location of base station is at the center of the network.

B. Definition of Carriers: As it is a multiple carrier network, more than one carrier exists. Two carriers are considered for simplicity and total number of sub carriers considered are 64 including both used and unused carriers with 48 carriers being used for data.

C. Information processing at transmitter: Once the carriers are defined. The modulation process takes place. A randomly generated data is considered as message and is divided into four blocks of size equal to the number of subcarriers. Each of this data blocks are modulated using binary phase shift keying. Same data is modulated on both the carriers. The power spectrum is calculated for individual carriers and then a combo of carriers is generated and power spectrum of this combo is calculated. This gives the distribution of energy of the signal over different frequencies and is obtained by using Fourier transform function.

D. Power allocation: Power is distributed among both the carrier signals considered and a chart is plotted based on values of power levels which shows that carrier 1 and carrier 2 are provided with almost equal amount of power with a very little of allowed differences in distribution which is needed to isolate them. The power distribution strategy is based on well-known hypothesis called water filling. This hypothesis has a key aspect in communication pertaining to resource allocation. It increases the capacity of the channel by allotting more power to channel having maximum channel gain.

Consider the factor of Power(P) dependent on internal ratios of analysis under communication channels(C), where channel, C consists of independent and interdependent properties and elements such as antennas, routers, switches, channel linkage, users and others. In general, we represent this as,

$$C=(c_{1,}c_{2,}\ldots\ldots\ldots\ldots\ldots\ldots\ldots.,c_n) \quad (1)$$

where C_i is a particular item under channel,C outputting with Power, P and hence Power is proportional to channel, i.e., P α C
Hence, power increases with the increasing Channel, C. On optimization, we get,

$$O_p \propto O_c \quad (2)$$

This is called as primary equation.
Optimizing channel, we get,

$$O_C=\sum_{i=1}^{n}\left[\frac{\partial Ci}{\partial P}\right] \quad (3)$$

Where n is the number of subcarriers.
From (3) and (2) we get,

$$O_P=\sum_{i=1}^{n}\left[\frac{\partial Ci}{\partial P}\right] \quad (4)$$

Optimization of this resource provides various other functionalities such as transfer rate and channel assignment enhancements. Consider a channel, C which is functioning at the frequency, f and rate of information being at r. the channel has scheduled with resources and the users are in turn provided with sub channels. This is also a resource. Let this be noted by s. Then we can describe channel as a function of frequency f, rate r, and scheduled channels s.

$$C= \{f, r, s\} \quad (5)$$

When each of the channel is optimized we get, $O_C=O_{\{f, r, s\}}$

$$O_C=O_f+O_r+O_s \quad (6)$$

From (3), the (6) becomes,

$$\sum_{i=1}^{n}\left[\frac{\partial Ci}{\partial P}\right]=O_f+O_r+O_s \quad (7)$$

The Left side of the equation is equivalent to O_p from (4) and hence is given by,

$$O_P = O_f + O_r + O_s$$

Substituting all the individual optimized functions in this equation, we obtain the overall function which is called as optimization function and is given by,

$$O_P = \sum_{i=1}^{n} \left[\frac{\partial Ci}{\partial f} + \frac{\partial Ci}{\partial r} + \frac{\partial Ci}{\partial s} \right] \quad (8)$$

The above equation is called as the optimization function. It has optimized power factor on its left side of the equation which when optimized produces acceptable results in turn by the efficient allocation of resources which gives proficiency in allocating the channels to all the users in an impartial manner. This optimization also aims to achieve equal transfer rate for all the users.

E. Channel processing: The channel is created by the definition of channel parameters and a function called channel realization is used which generates small and large-scale fading. The Rayleigh channel is formed. The channel has Rayleigh fading because it has several users in the receiving side and hence the name of the channel. The parameters related to signal to noise ratio, channel distribution and medium information is computed.

F. Information processing at receiver: The information processed travels through the medium where noise is added to it. This may vary the power levels and this variation is shown by plotting a resource block and seeing the variation of power levels in carriers. The demodulation of messages is done for all the combination of digits formed with minimum bit error rate. The same process is followed to decode the both the carriers considered.

Finally, the charts distinguishing the performance pertaining to error distribution with number of users and also the performance of the proposed scheme to distribute channels among various users in contrast to conventional scheme is visualized.

III. RESULTS

Simulation parameters considered are shown below:

Table 3: Simulation parameters

Radius, m	500
Number of users considered	4
Number of carriers used	2
Bandwidth, MHz	20

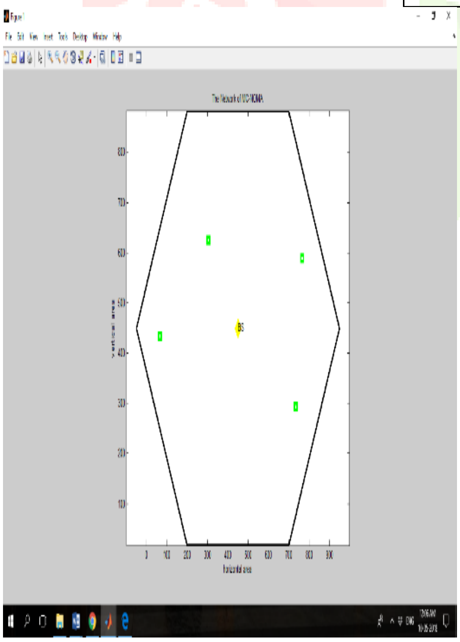

Figure 4: Creation of MC-NOMA network.

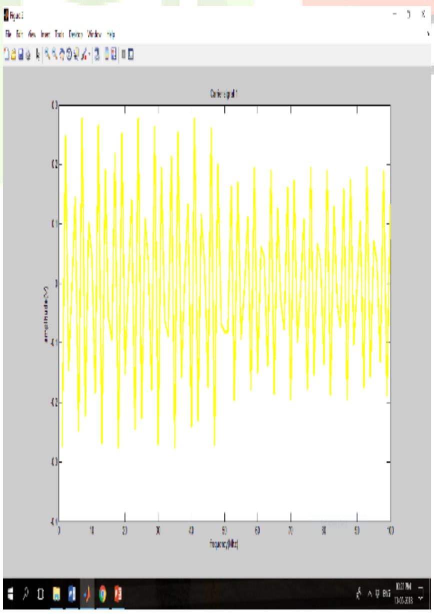

Figure 5: Carrier 1 waveform.

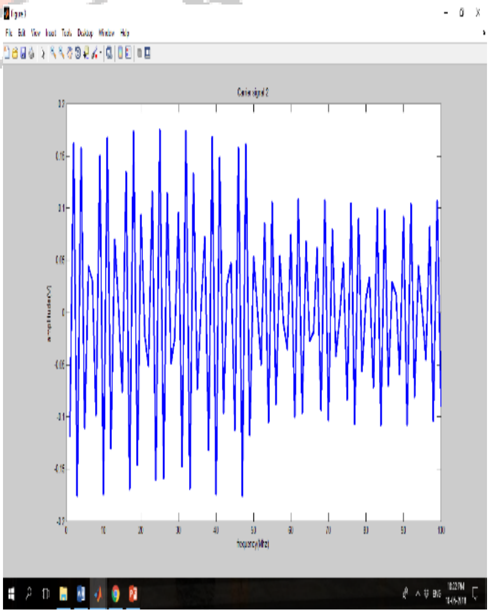

Figure 6: Carrier 2 waveform

Figure 4 represents the non-orthogonal network which uses multiple carriers to transmit the information message to the receiver. Downlink scenario is considered. The entire cell is shape is considered as hexagonal as it is the shape that reduces the wastage of resources. The cell is designed to consider users, base station and other elements needed to have huge efficient connectivity between the users. Any number of users can be considered to exist within one cell. The cell is created to have base station whose location is at the center of the cell whose radius is defined. The square boxes in green color are the users and the yellow diamond at the center of the cell is base station. The Fig 5 and Fig 6 represents the carrier waveforms.

The power spectrum of the combined carrier is obtained which indicates the variation of signal with frequency. The waveform is symmetric and has peaks at the approximately same power level but at different frequencies. This estimate is not much noisy as it is only the carrier signals. The power spectrum is calculated using the inbuilt MATLAB function over the entire carrier signals. The average value of the power spectrum of combined carrier is calculated. The peak power value varying with frequency is achieved at around 11 dBm in power scale.

The spectrum of the transmitted waveform is similar to the averaged waveform but at optimized power level. Fig 9 is a three dimesional view of resources being allocated to the carriers acrrying the information and it keep varying unless it reaches the destination.

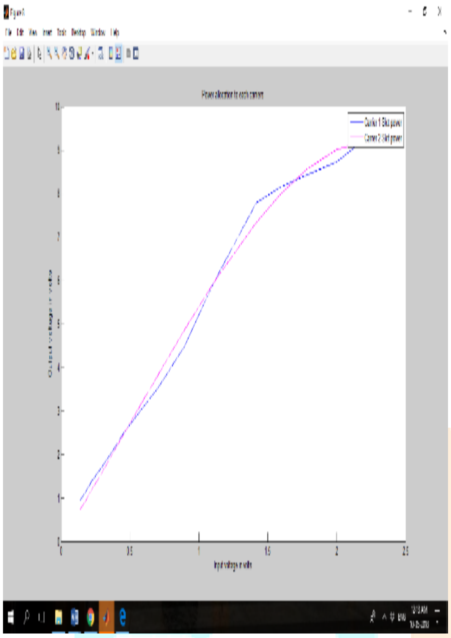

Figure 7: Carrier power levels

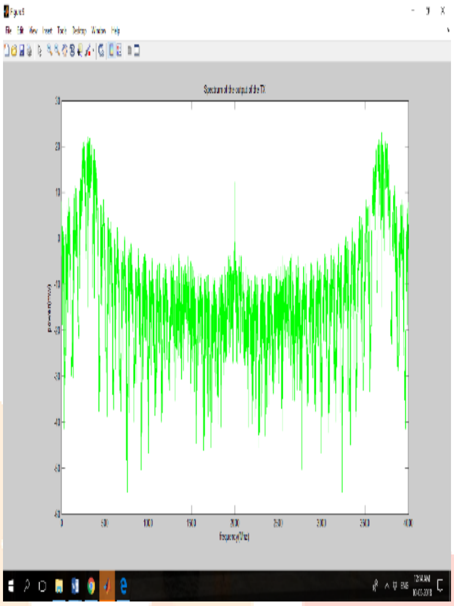

Figure 8: Transmitted signal waveform

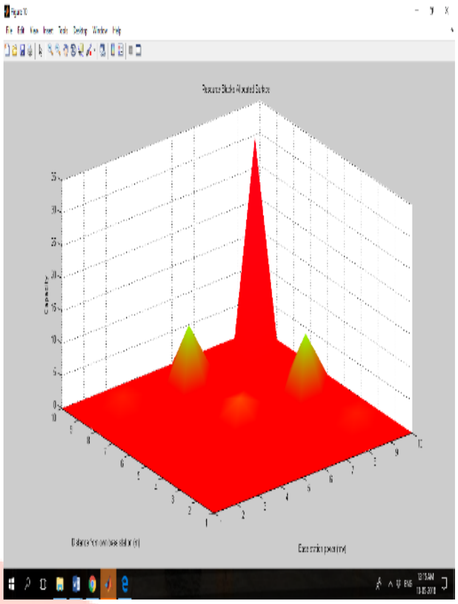

Figure 9: Resource block

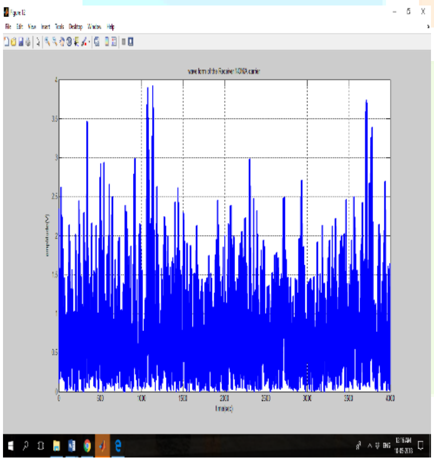

Figure 10: Received waveform

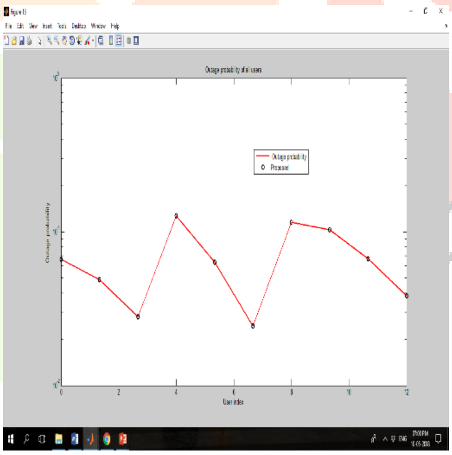

Figure 11: Outage probability of users

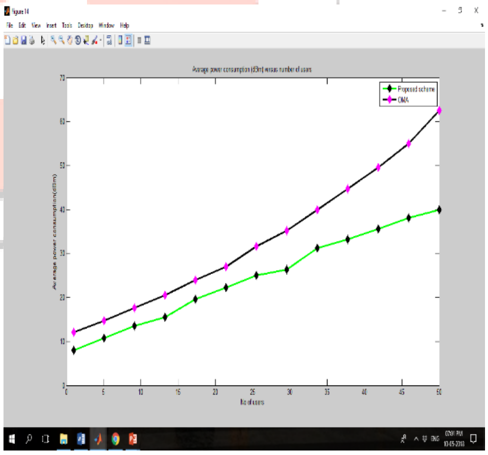

Figure 12: OMA vs NOMA

Figure 10 is the received waveform being detected at the receiver. The Fig 11 shows how exactly is the received waveform in match with the transmitted one and is up to the mark. The outage probabity considered is 0.12. From the above analysis of the results obtained, for 4 users considered in a cell with 2 carriers, the average value is found as 13mw and hence the carriers are provided with power such that the received waveform has sufficient power of around 0.302watts to completely determine the sent information. Hence, power proficiency is achieved. The Fig 12 is the last result of the simulations and it clearly shows that the power is optimized efficiently in contrast to the conventional scheme.

III. CONCLUSION

This course of work provides reserves for multicarrier non-orthogonal multiple access in a scenario of transmitting the information signals from base station to the end users. The key features of non-orthogonal multiple access strategy can be obtained with efficient resource allotment among all the carriers such that all the users in the network are equally provided with sufficient transfer rates of information and achieving minimum outage. The outcome of this proposed work is shown as simulation results obtained through implementation using MATLAB software. The last result concludes that this scheme is much proficient than the traditional schemes. The non-orthogonal technique of serving multiple users can be combined with different technologies that can efficiently enhance the overall execution of the system by increasing the spectral proficiency and the optimization of resources in this direction can be considered as future scope of this work. Also, a proposal to improvise the internal segmentation of bandwidth for rationalized processing can be considered.

From this, we can conclude that whatever the number of users be, non-orthogonal multiple access scheme is more efficient than the traditional scheme and difference in power for the two schemes is shown which means non-orthogonal scheme requires only less amount of power to achieve the same characteristics as the conventional scheme which in contrast requires relatively more power for operation.

IV. ACKNOWLEDGMENT

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