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A Novel SUI Modelling for Multiuser OFDM-DCSK Modulation based Communication System

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Abstract

In this proposed method we successfully developed a multiuser OFDM-based chaos shift keying (MU OFDM-DCSK) modulation is presented. The LTE technique OFDM is nothing but it's a fourth generation language. Some drawback of the OFDM will cause the lower data rate in 4G language. In this system, the spreading operation is performed in time domain over the multicarrier frequencies. To allow the multiple access technique without using excessive bandwidth for transmission, each user has $N_p$previously developed private frequencies from the N available frequencies to transmit its reference signal and share with the other users the remaining frequencies available for transmission of its M spread bits. In this new design, $N_p$duplicated chaotic reference signals are generated mostly for the transmission of M bits instead of using M different chaotic reference signals is used for DCSK systems compared different than other systems. Afterthat, the given transmission data that $N_P << M$, the MU OFDMDCSK scheme increases spectral efficiency, uses less energy and allows multiple-access scenario. Therefore, the use of OFDM technique reduces the integration complexity of the system where the parallel low pass filters are no longer needed to recover the transmitted data as in multicarrier DCSK scheme. At last we get the bit error rate performance which is under multipath Rayleigh fading channels in the presence of multiuser and additive white Gaussian noise interferences. A MATLAB execution result shows us that the accuracy of our analysis and show the advantages of this new hybrid design.

Keywords—*Non-coherent spread spectrum communication system, multiple accesses, OFDM-DCSK, energy efficiency, performance analysis.*

I. INTRODUCTION

The demand for wireless communication services is in constant rise with decades of years. Multicarrier (MC) transmission, since it's the benefits of high spectral efficiency, hardiness to frequency selective attenuation parameter, and practicability of the transmission which is low-priced transceiver implementation could be a robust candidate for several different wireless applications which are important for wireless transmission. Many combinations in the mixtures of multi-carrier and Code Division Multiple Access (CDMA), square measure projected within the literature project given in[1], [2]. In MCCDMA, one-bit chips square measure adjoin M subcarriers within the frequency domain which is also given in [1], whereas for MC-DS-CDMA, time and frequency spreading is mostly employed (i.e. TF-domain spreading) [2]. The chaotic signals are shown to be fitted accurately to spread-spectrum modulation available for owing to their inherent band characteristic which is given in the references [3] [4] [5], mitigation of attenuation channels, electronic countermeasures resistance and low chance of intercept (LPI) are the terms which are explained in [6]. Additionally, chaos-based sequences which are calculated in this project offer smart results as compared to Gold and freelance and identically distributed sequences over the all transmission channel for reducing the peak-to-average power magnitude relation (PAPR) given in paper [7]. A projected system for reduction of the PAPR with a non-coherent receiver, named differential chaos shift keying (DCSK) system, within which chaotic synchronization isn't used on the receiver aspect, delivers a decent better performance in multipath channels given in paper[8]. Moreover, differential non-coherent systems for the transmission square measure higher suited than coherent ones for time and frequency selective channels for wireless communication in paper [9]. Within the DCSK system for wireless

transmission, every bit period is split into 2 equal slots of the period. Within the initial slot, a reference chaotic signal is distributed thorley. Counting on the bit being sent for the transmission, the reference signal is either perennial or increased by the issue −1 and transmitted within the second slot which is new slot considered in this paper. A big disadvantage of transmission using the DCSK modulation is that for every bit one reference and [*fr1] the bit period is spent causing non-information-bearing reference samples [3]. This may be accounted as being energy-inefficient and a significant rate reducer for transmission overhead. In [10], the spectral potency of the DCSK is improved, however the system receiver needs Associate in Nursing (radio frequency)RF electric circuit, that isn't straightforward to implement with the consideration of owing to the wide information measure concerned.
In a study to beat the matter of RF delay for the transmission overhead in DCSK systems, Xu et al. projected a Code Shifted Differential Chaos Shift Keying (CS-DCSK) system is used. In their system, the reference and also the info bearing signals area unit separated by Walsh code sequences, and so transmitted within the same slot to get the better performance. For such systems, there's no want for an electrical circuit at the receiver which is present at finish. Associate improved version of the high spectral potency DCSK system is bestowed, wherever chaotic codes area unit used rather than Walsh codes, with totally different receiver structures are used there for better transmission. Another style supported associate ultra-wideband system victimization chaotic signals for low complexness, low cost, low power, and low rate is bestowed. During this paper, we have a tendency to first introduce a replacement style of a multi-user, multi-carrier DCSK system (MC-DCSK) that is one of the famous one for transmission. On the transmitter facet, M subcarriers are used with the area unit assigned for every user, wherever one subcarrier is employed to transmittal the references slot, whereas the M − one different frequencies can carry the different transmitted bits for the user. The projected system solves the RF electrical circuit downside mentioned, provides from the properties of DCSK system present used in OFDM in terms of resistance to interference, will increase the information rate, and optimizes the transmitted energy of the DCSK system with an easy transmitter/receiver side present style. The analytical performance of the given derivation of DCSK communication system is studied in depth and also the transmission security is improved. During this paper implementation, for the house accessible, we have a tendency to concentrate our efforts to clarify the projected system style, wherever the analytical derivation as well as psychological feature multiple access techniques of MC-DCSK system are studied in future works. Covers the design of the multi-user MC-DCSK system.

II. LITERATURE SURVEY

ShiroKondo[1],in this paper they apply a multicarrier communication technique for better transmission to a direct-sequence CDMA system, wherever we are having an information sequence which is increased by a spreading sequence which can modulates multiple carriers, instead of one carrier which is having number of drawback. The receiver provides correlatorswhile transmission for every carrier in this system, and also the outputs obtained from correlators are combined with the given condition of maximal-ratio combiner in this transmission. These kinds of wireless communication are used for achieving better properties of exhibiting a narrowband interference suppression impact on transmission of data, beside hardiness to weakening, without. we have a tendency to use the data with band restricted spreading waveforms to achieve the properly stop self-interference, and also that we value system performance over a frequency selective signal transmission. Third Baron Rayleigh channel which is noisy channel within the presence of partial band interference.

Ajeesh P. Kurian [2],in this paper a unique direct sequence/spread spectrum (DS/SS) based communication system gives us the two-dimensional complicated valued chaotic Ikeda map because the spreading sequences we got from the transmission overhead. With this double spreading DS/SS system, the impact of multiple access interference will be lessened by selecting the spreading sequences with applicable cross-correlation properties. These studies are used to know that the planned system considerably outperforms the existing system with the Gold code DS/SS-BPSK system in synchronous channel conditions for transmission of the data. In asynchronous case of transmission through the wireless channel, the advance is substantial for low signal-to-noise ratio.

Ramin Vali [3]in these paper they represented the accurate expressions for sequence acquisition in a chaos-based spread-spectrum system are derived using the statistical properties for transmission which are of the chaos-based spreading sequences. The expressions are validated with the help of comparing the analytical predictions of the acquisition performance compared with the value of the simulation results for three channel scenarios. Additive white Gaussian noise and Rayleigh fading channels which are already used for noisy channel data are considered in the first two scenarios. As the third scenario a blind chip interleaving serial search algorithm is proposed and system performance is shown to improve to such a great extent.

Weikai Xu [4] in this paper, differential chaos shift keying based wireless communication (DCSK-CC) system with almost two numbers of users is planned. The only relay cooperative networks for transmission with decode-and-forward relay is investigated within the planned system per two given number of cooperation protocols which are mainly forms the typical cooperation and coordinate system cooperation. Simulation results in matlab shows us that, through a standard cooperation mechanism, the planned system encompasses an outstanding advantage of fine bit-error-Rate (BER) quality assessment parameters for performance over the CDMA-CC systems that have one path correlation receiver, at constant rate with a high SNR vary over multipath physicist weakening channels. Meanwhile, it is given that typical cooperation may be a higher cooperation strategy which is nothing but is relative to coordinate system cooperation within the planned system.

Lin Wang [5]in this paper each the inherently band differential- chaos shift-keying (DCSK) modulation as well as there is use of the space time block code (STBC) techniques will give us the data in both spaces that may mitigate the impact of multipath weakening. By applying STBC at the chaotic section level present in transmission overhead, a completely unique analog STBC-DCSK theme is planned during the implementation of this paper. The planned theme may be a straightforward configuration that uses the advantages of combination of the benefits of STBC and chaotic modulation. The theoretical bit-error-rate (BER) performance we got by application of this method and also the extremely consistent simulation results demonstrate that the STBC-DCSK theme outperforms the traditional single-input-single-output (SISO)-DCSK theme by concerning five dB at a BER in the graph represented in this paper. A lot of significantly, the planned theme maintains constant low transceiver value because the SISO-DCSK theme. Consequently, this planned theme may be a low-priced various for wireless native space network which is nothing but wireless local area network (WLAN) applications in transmission.

Georges Kaddoum [6] in this paper new Multi-Carrier Differential Chaos Shift Keying (MC-DCSK) modulation system is used to provide the good trade-off between robustness, energy efficiency and high data rate, while still being simple in computational computation compared to conventional multi-carrier spread spectrum systems for transmission. This system can be seen as a parallel extension to the implemented DCSK modulation where one chaotic reference sequence is transmitted over a predefined subcarrier frequency signals.Multiple modulated data streams are transmitted over the remaining subcarriers of the original transmission. The receiver design given in this makes this system easy to implement where there is no need of radio frequency (RF) delay circuit to demodulate received data.

III. PROPOSED METHOD

A. DCSK Communication System

We explained in this section by explaining the DCSK communication system in order to understand the concepts behind the novel extension parts of the proposed system and to use this as a comparative benchmark to illustrate the achieved performance enhancements for the data transmission. As shown in below Fig. 1, within the DCSK modulator for transmission and which is, each bit $si = \{-1, +1\}$ is represented by two sets of chaotic signal samples for transmission, with the first set representing the reference signals, and the second carrying data siganl. If +1 is transmitted, the data-bearing sequence is equal to the reference sequence means indirectly it indicates the data sequence, and if -1 is transmitted, an inverted version of the reference sequence is used for data transmission.

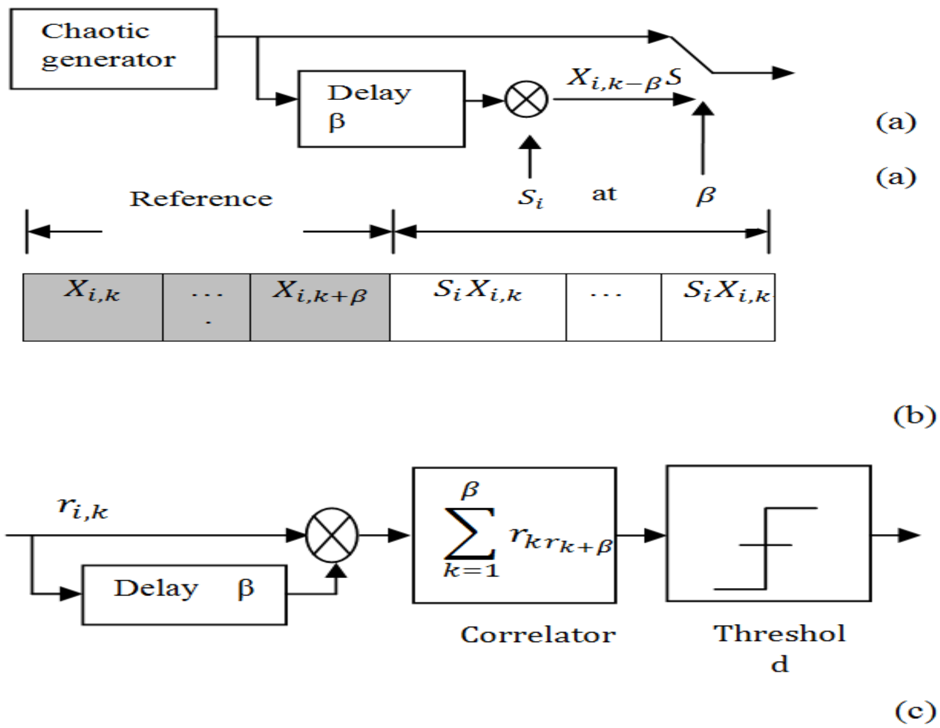


Fig.1. Block diagram for the transmission using structure of the DCSK communication system: (a) transmitter (b) frame (c) receiver.

Let 2β be the spreading factor in DCSK system, defined as the number of chaotic samples sent for each bit, where β is an integer. During the i^{th} bit duration, the output of the transmitter $e_{i,k}$, become

$$e_{i,k} = \begin{cases} x_{i,k} & for\ 1 < k \leq \beta \\ s_i x_i, k - \beta & for\ 1 < k \leq 2 \end{cases} \quad (1)$$

Where,$x_k$is the chaotic sequence used as reference and $x_k - \beta$ is the delayed version of the reference sequence x_k. Fig. 1 illustrates that the received signal rk is correlated to a delayed version of the received signal given by the $x_k + \beta$ and summed over a half bit duration T_b (where $T_b = 2\beta T_c$ and T_c is the chip time) to demodulate the transmitted bits for transmission. The received bits are recovered with the help of computing the sign of the output of the correlator, as illustrated in Fig. 1 (c). As shown in Fig. 1, half of the transmitted energy and half of the bit duration time are spent sending the given data non-information bearing reference. Therefore, the data rate of this architecture is seriously reduced compared to other systems using the same bandwidth, leading to a loss of energy and spectral efficiency.

B. Chaotic Generator

In this proposed work, a second-order Chebyshev polynomial function (CPF) is used which is given as,

$$x_{k+1} = 1 - 2x_k^2 \quad (2)$$

This map is chosen for the easy for transmission used to generate chaotic sequences and the good performance [10]. In addition, chaotic sequences are normalized so that the mean values are all zero and their mean squared values are unity, i.e., $E(x_k) = 0$and $E(x_k^2)$

C. The MU OFDM-DCSK Transmitter

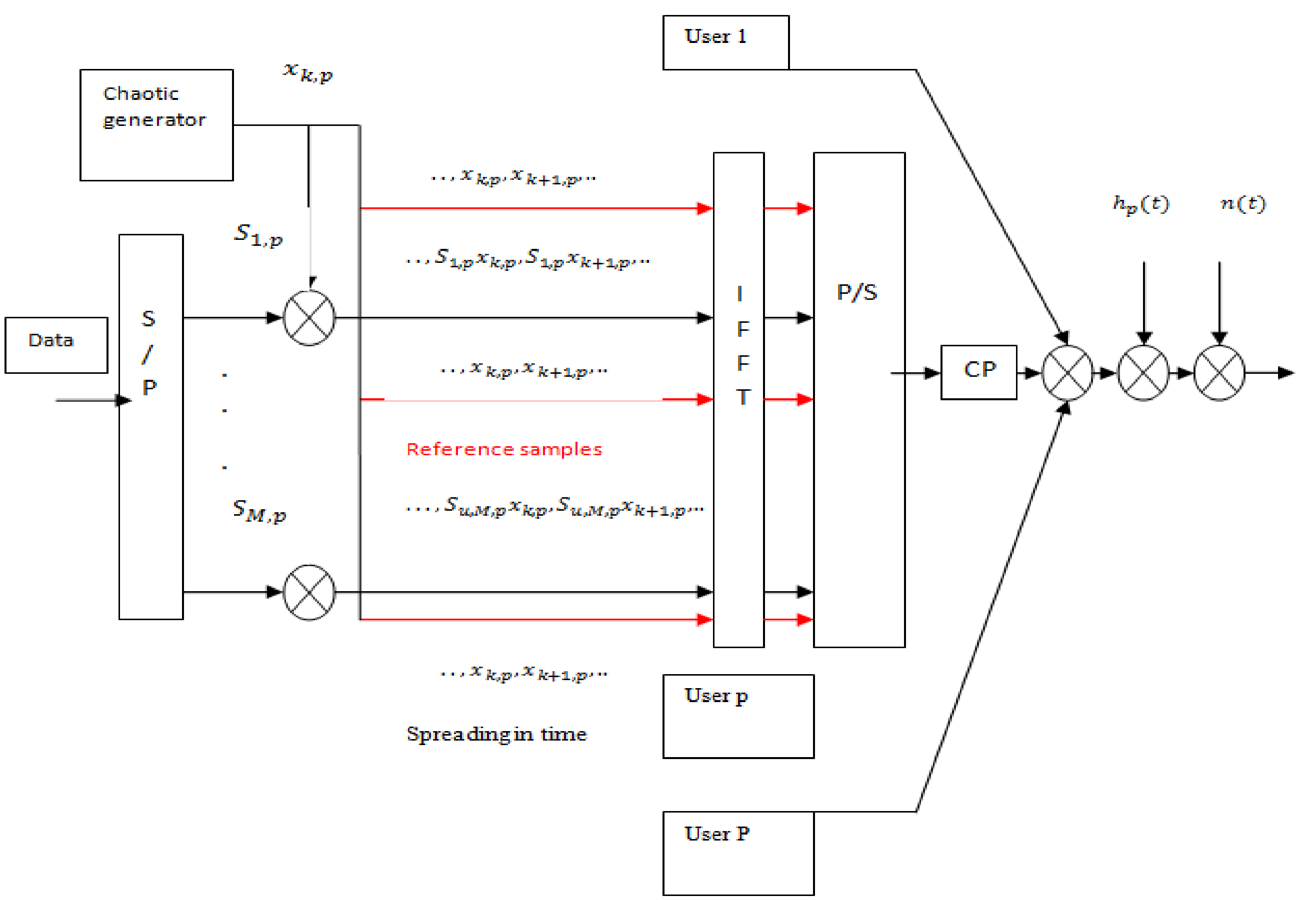
In this section we are going to gift the letter of the alphabet OFDM-DCSK style. The aim of the projected system is to cut back the hardware complexness of the MC-DCSK projected to extend the info rate, to cut back the transmitted bit energy, to control in multi-user situation, to profit from the properties of OFDM modulation and to perform with none got to RF delay circuits or advanced channel estimators. The structure of the modulator and also the transmitted signal are shown in Fig. 2 and Fig. 3. during this system, we tend to take into account web subcarriers among that N subcarriers at the central spectrum are used for transmission and also the remaining $N_t - N$ subcarriers that are situated at the 2 edges of the spectrum kind the guard band and also the unused subcarriers$N_t - N_u$. In our theme and for P users, PN_P frequencies out of N subcarriers ar accustomed transmit the P totally different reference signals. The sides and also the center of the spectrum ar allotted to transmit the reference signals of various users and also the remaining NS frequencies ar shared to transmit the unfold information. As shown in Fig. 3, the distribution of the reference signal over the predefined personal frequencies follows the comb-type pattern style. In fact, the comb-type style permits the receiver to own a quick adaptation to the channel once this lattice changes in time from one OFDM image to a different. it's necessary to notice that totally different unrelated reference signals of P users are employed in constant fashion as pilot signals spreading codes of the OFDM-DCSK system. Therefore, with this style, solely the reference signals (i.e. pilots) of various users are separated within the frequency domain to permit multiple access communications. As shown in Fig. 3, the spreading operation is finished within the time domain.

This will require β number of IFFT operations to transmit the M spread bits with a spreading factor of β. In addition, since each user shares a part of his bandwidth with the other users, this reduces the total required bandwidth but increases MAI. However, MAI can be reduced by increasing the spreading factor value. As shown in Fig. 3, the OFDM-DCSK symbol duration Ts is given by

$$T_s = N\beta T_c \qquad (3)$$

Where $T_{OFDM} = NT_C$is the time duration of OFDM symbol. After each IFFT operation the parallel signal is converted into a serial sequence and a cyclic prefix is added to eliminate the intersymbol interference and to allow a simpler frequency domainprocessing.Hence, the OFDM-DCSK system benefits from the non-coherent advantages of DCSK and the spectral high data rate of OFDM modulation.

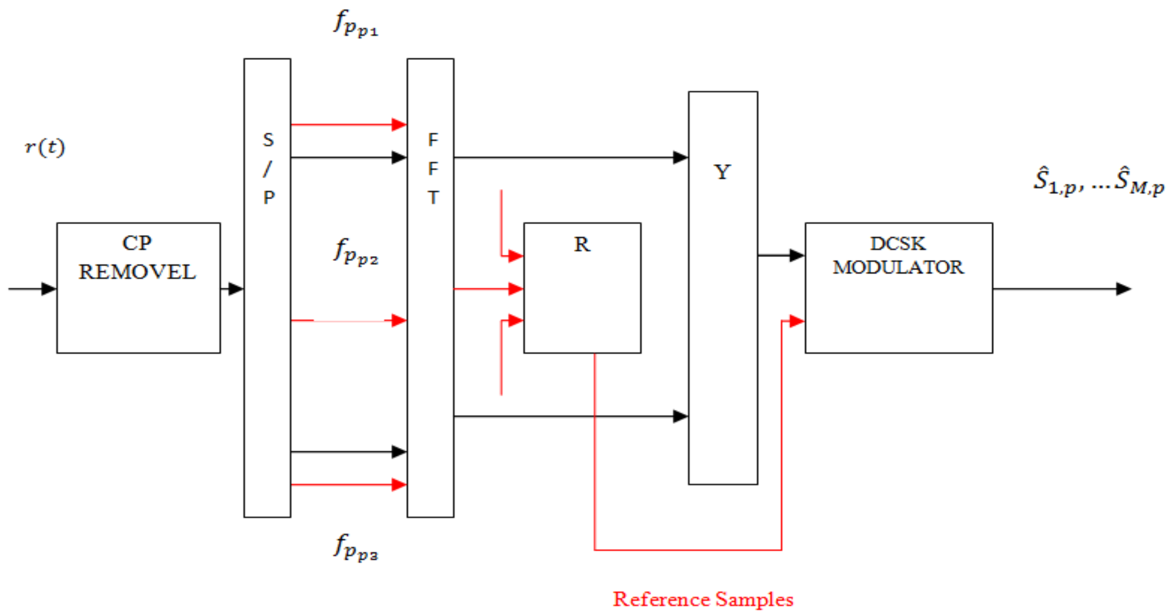
As shown in Fig.2, the chaotic sequence $X_p = [x_{i,p}, \ldots . x_{k,p}, \ldots, x_{\beta,p}]$ is transmitted over NP frequencies which are used as reference signal and spreading code for the M bits of user p.



Hence, the M bits stream of user p are spread due to multiplication in time with the same chaotic spreading code $x_p(t)$.

$$x_p(t) = \sum_{k=1}^{\beta} x_{k,p}\, g(t - kT_c) \qquad (4)$$

Where $\beta$the spreading is factor, $g(t)$ is the shaping filter which is assumed to be rectangular in this paper and $T_c$is the chip duration.



(b)Receiver Structure of User P

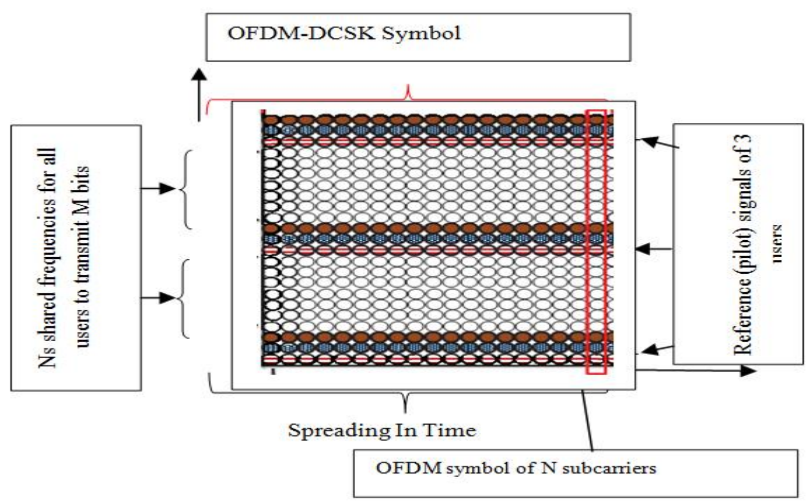


Fig.3. Signal structure with comb-type reference sequences for the p^{th} user

Fig,2. Block diagram of MU OFDM-DCSK system

For simplicity, the insertion and removal of cyclic guard prefix or postfix is used in this system with period but not expressed in our mathematical equations. Therefore, the transmitted signal of the pth user of OFDM-DCSK system is given by

$$e_p(t) = \sum_{v=1}^{N_P} \sum_{k=1}^{\beta} x_{k,p} e^{2\pi j f\, P_{p_v}(t-kT_c)} g(t-kT_c) + \sum_{\substack{i=1 \\ i \neq p}}^{M} \sum_{k=1}^{\beta} x_{k,p} s_{i,p} e^{2\pi j f\, s_{p_i}(t-kT_c)} g(t-kT_c) \qquad (5)$$

where $e_p(t)$ represents the transmitted OFDM symbol of user p, $f_{p_{pv}}$ is its vth private frequency used to transmit the reference chaotic signal $x_{k,p}$, N_P is the number of private frequencies per user, $fs_{p_i}$is the i^{th}shared public frequency of the $N_S = (N - PN_P)$remaining public frequencies to transmit the i th bit of the M block of bits. Hence, the maximal number of transmitted bits per user must be equal to the number of shared frequencies NS, (i.e. M $\leq N_S$). As described mathematically in the above formula, the spreading operation is done in time domain where β number of IFFT operations are required to transmit an OFDM-DCSK symbol ofN_P reference signals with M spread bits. Finally, for a given number of users P, the maximum number of allowed subcarriers to transmit the data would be

$N_S = N_t - N_{cp} - PN_P$ (6)

Where N_{cp} and N_P represent the number subcarriers dedicated to transmit the cyclic prefix and the pilot signal respectively and N_u represents the number of unused subcarriers which is defined according to the used standards (i.e.$N = N_t - N_{cp} - N_U$). It is assumed that the OFDM-DCSK signal is transmitted over a multipath fading channel, the equivalent impulse response of the channel for the p^th user is

$h_p(t) = \sum_{l=1}^{L_p} \sum_{k=1}^{\beta} \alpha_{p.l.\left\lceil\frac{KNT_c}{T_h}\right\rceil}(t)\delta(\tau - \tau_{p,l})$ (7)

Where $T_{h,p} = X_p NT_C$ is the time where the channel coefficient α p is maintained constant during the transition of X_p OFDM symbols of user p and ⌈·⌉ is the ceiling operator.In our paper the complex channel coefficients are zero mean and follow Rayleigh distribution given by

$F(\alpha|\sigma) = \frac{\alpha}{\sigma^2} e^{-\frac{\alpha^2}{2\sigma^2}}, \quad \alpha \geq 0,$ (8)

Where $\alpha > 0$ is the scaling factor of the distribution representing the root mean square value of the received voltage signal before envelope detection. The received MU OFDM-DCSK signal over the wireless channel is given by

$$r(t) = \sum_{p=1}^{P} h_p(t) \otimes e_p(t) + n(t)$$

Where P is the total number of users, ⊗ is the convolution operator and n(t) is a circularly symmetric complex Gaussian noise with zero mean and power spectral density of N_0.

IV. SIMULATION RESULTS

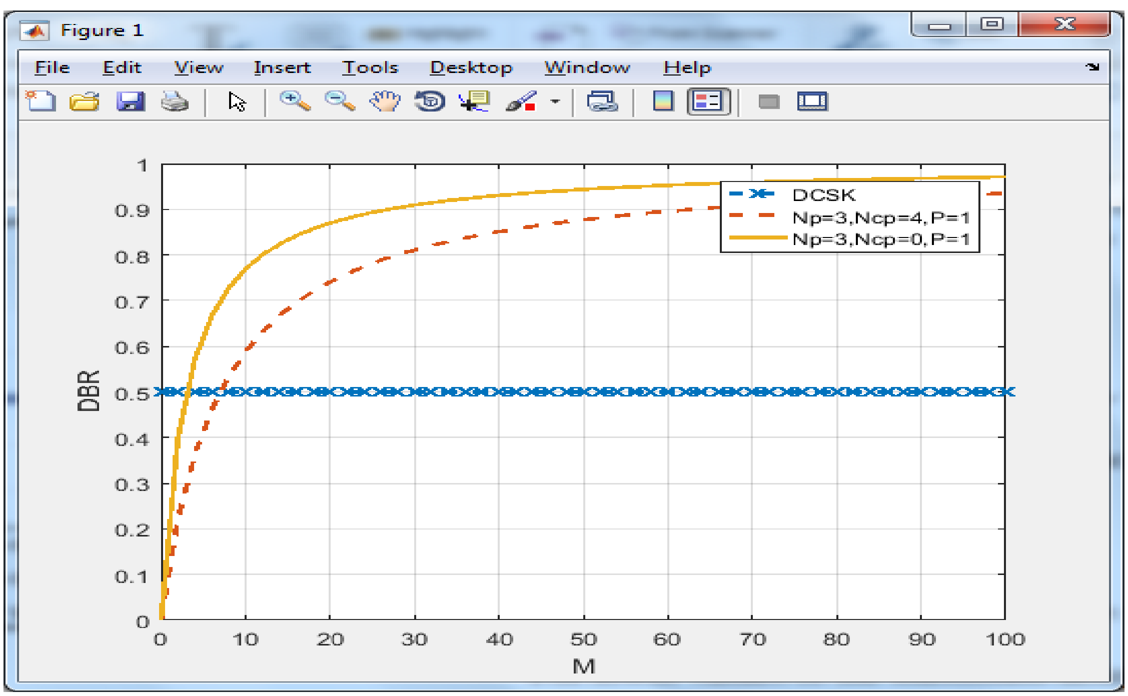


Fig.4. DBR performance versus number of data subcarriers M present in transmission.

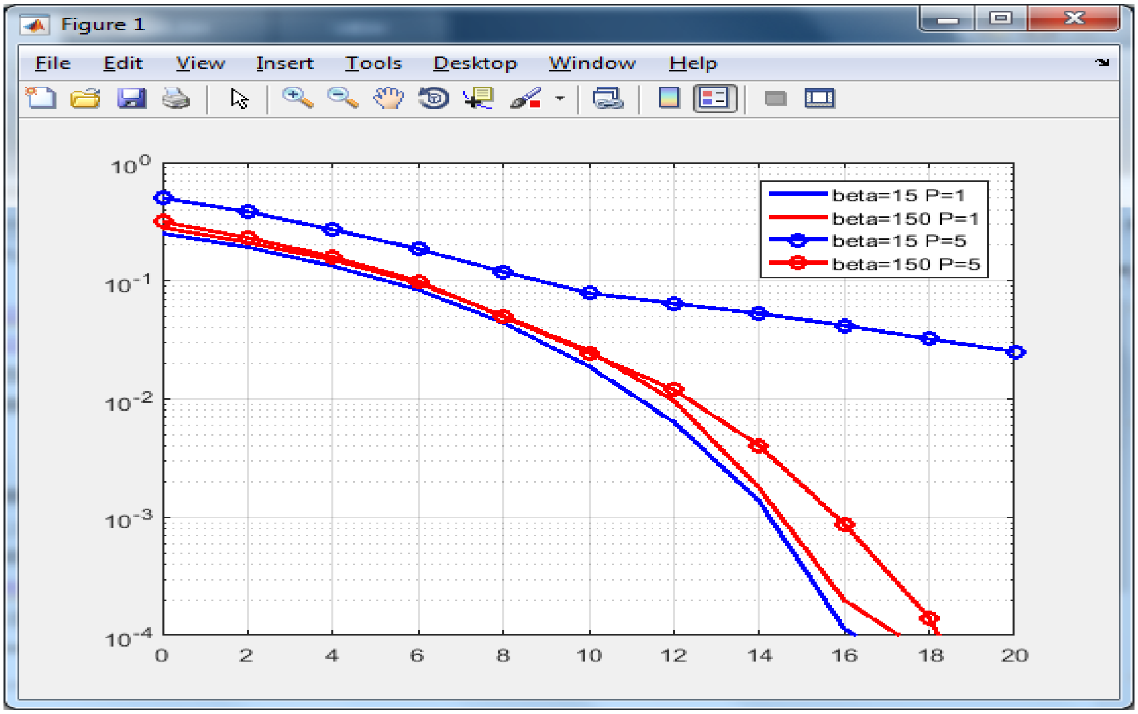


Fig. 5. Simulation and analytical BER performance over AWGN channel of proposed MU OFDM-DCSK system for different spreading factor values(Different beta and p values)

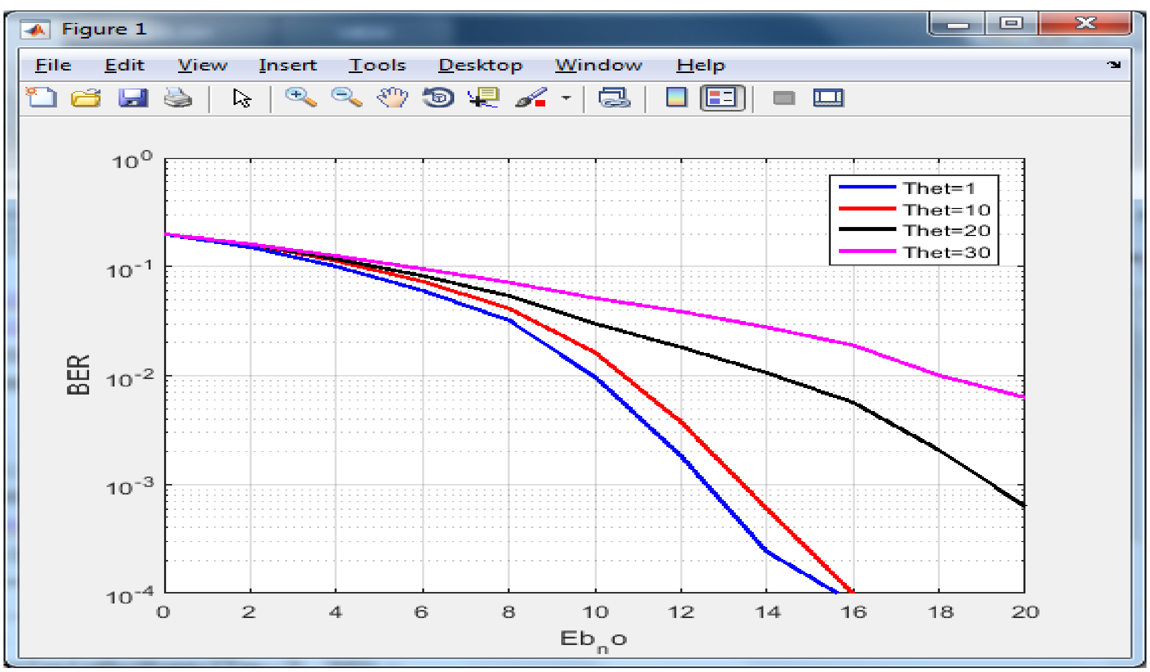


Fig. 6. Simulation and analytical BER performance over AWGN channel of proposed MU OFDM-DCSK system for different theta values (theta=1, 10, 20, 30)

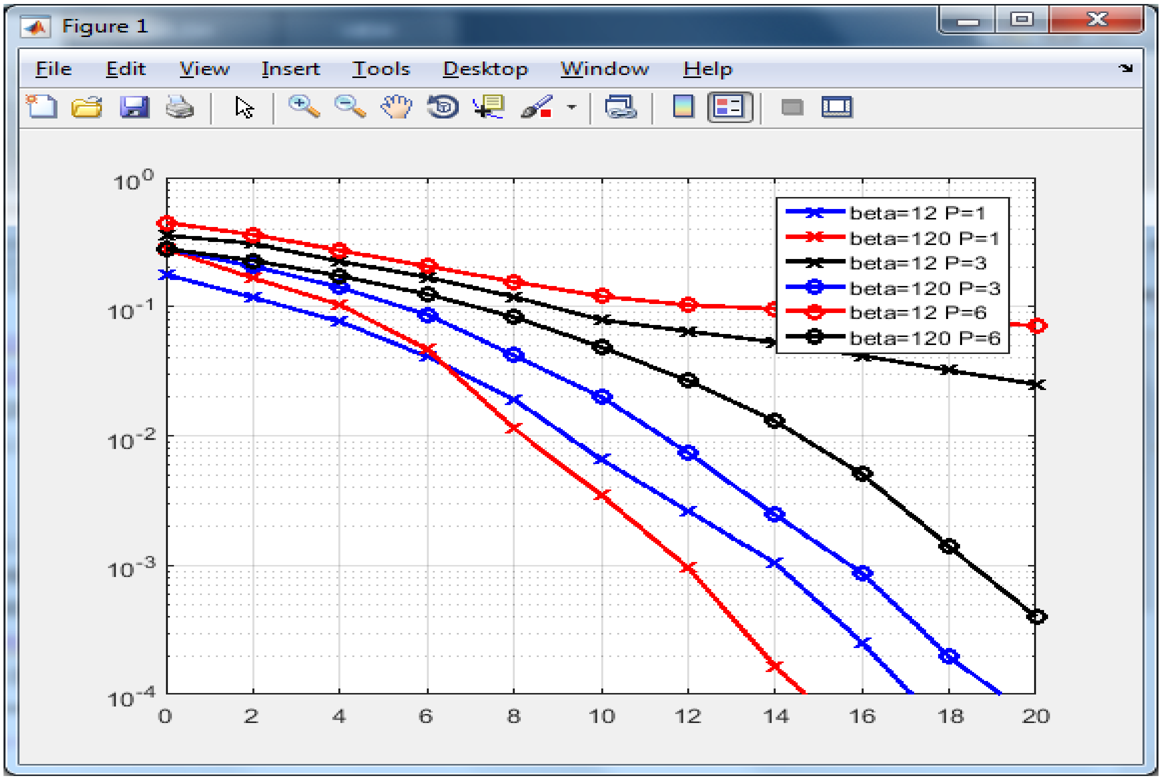


Fig. 7. Simulation and analytical BER performance of proposed MU OFDM-DCSK for different β = 12, 120, M = 49, Nt = 128 in multipath Rayleigh fading channels with L p = 3, χ = 3, and equal average power gain.

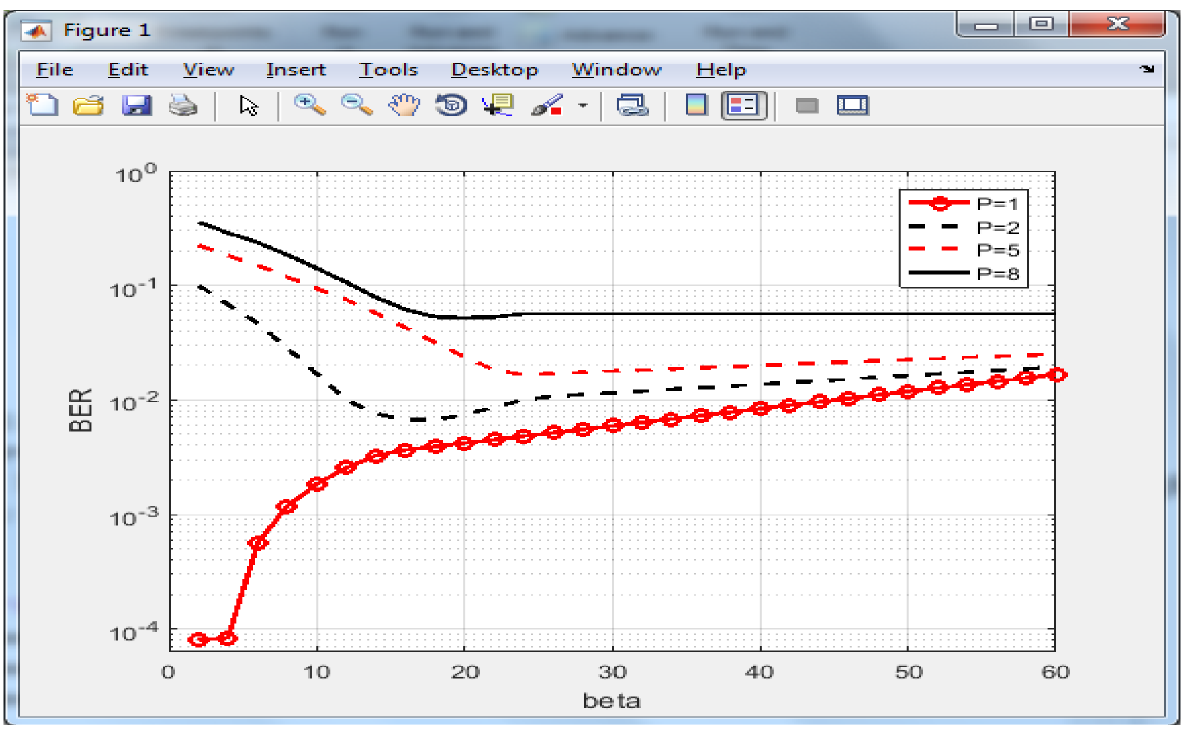


Fig. 8. BER values shown against the spreading factor β for Eb/N0 = 12 dB, Nt = 128 and M = 49.

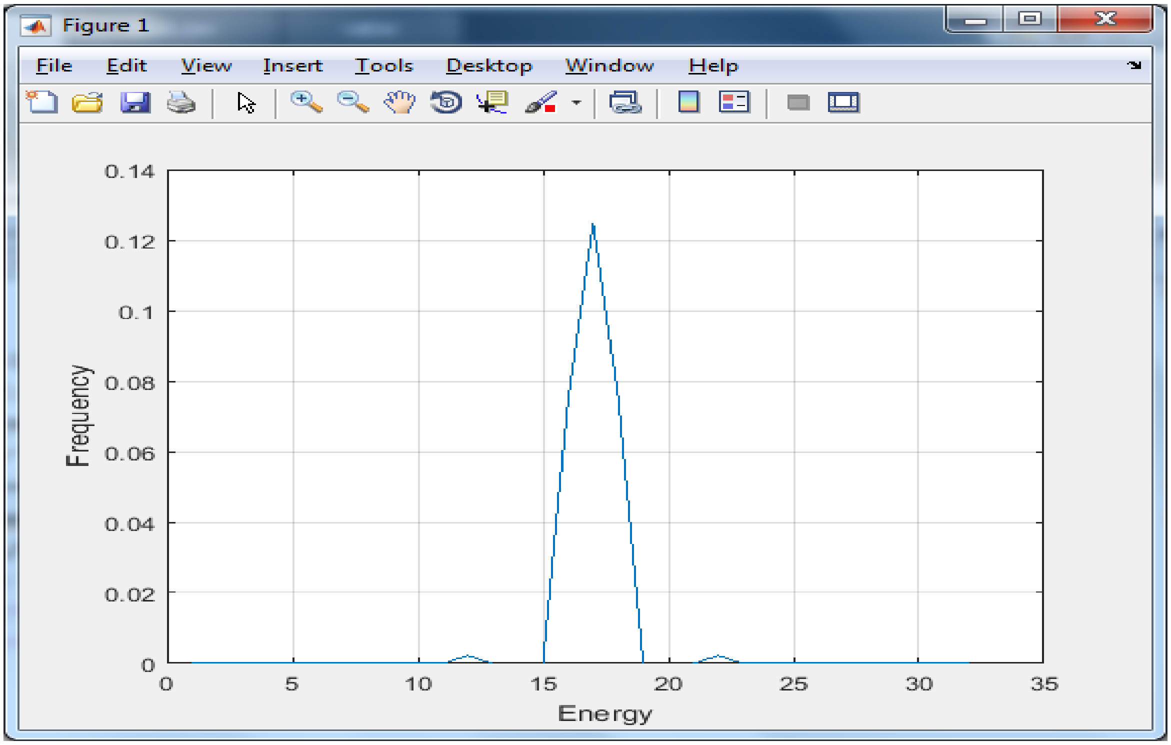


Fig.9 performance of system using Energy versus frequency graph

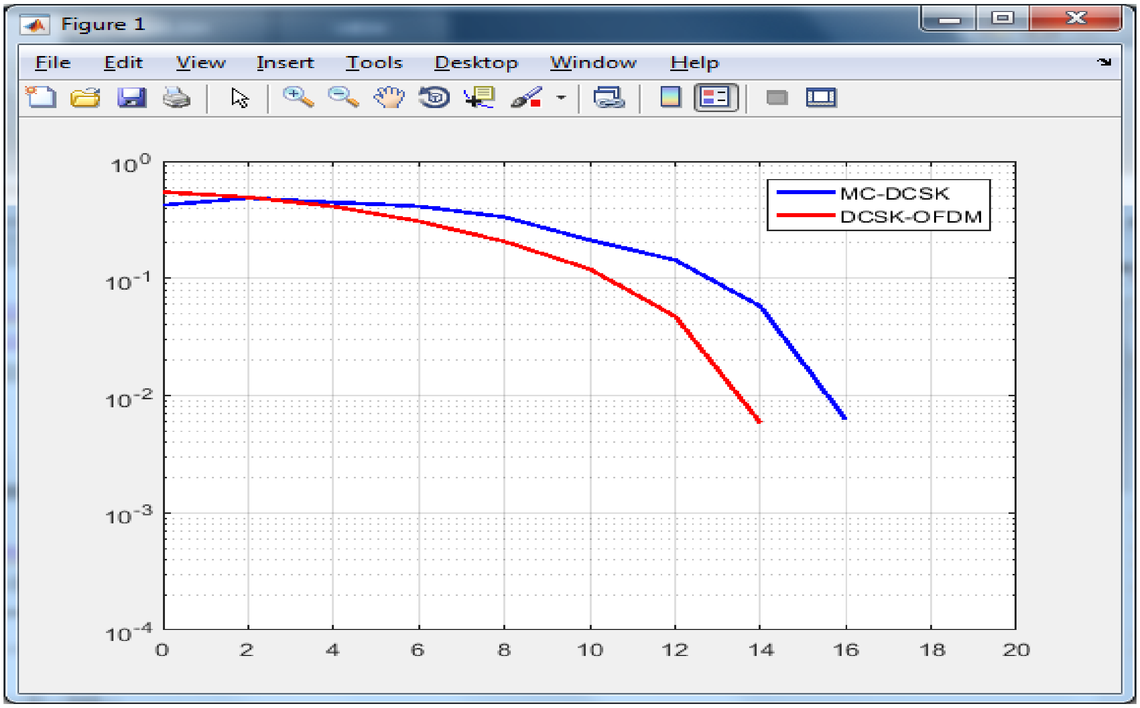


Fig10. BER performance of existing and Proposed

For extension

As extension there is use of SUI modeling. With the help of which proposed results get improved. In SUI modeling there is consideration of different transmission parameters such as antenna diversity, antenna correlation, antenna gain.

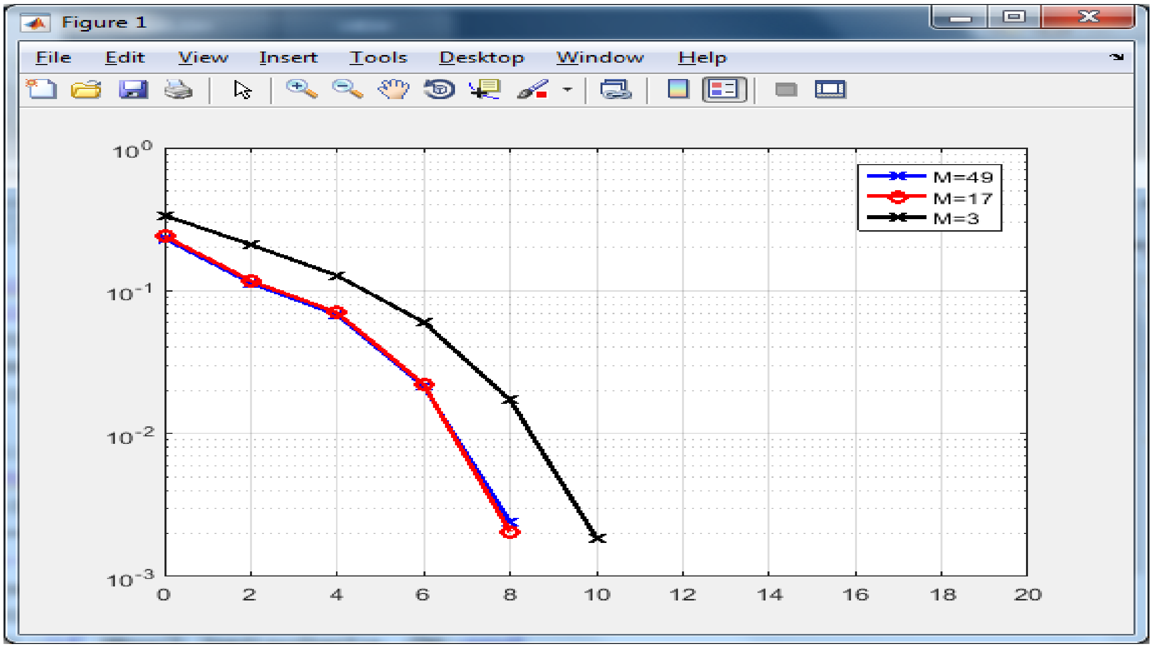


Fig. 11 BER performance of the extension work

V. CONCLUSION

In this paper we successfully proposed the multi-user OFDM-DCSK which is recent technique used to overcome the drawback of the OFDM.This new development of OFDM aims to get increasing the spectral and energy efficiencies, allowing multiple access transmission, reducing complexity by using IFFT/FFT operations instead of parallel matched filters as in MC-DCSK and solving the RF delay line problem faced in conventional DCSK schemes. The main objective of this project development is to assign N_P non-public subcarriers to every user and leave the remaining NS = N – PNP subcarriers as shared public subcarriers. The non-public subcarriers are wont to transmit the reference signals of the users, whereas the general public subcarriers are shared with different users to hold information while used for transmission. For a person user, solely N_P replicas of the chaotic reference signal are want to transmit M bits, rather than victimization M reference signals as tired DCSK system with sing the condition (N_P<< M). The energy potency of the planned work is analyzed as well as the DBR comes with the assistance of it for the further calculations. Our results of MATLAB simulations shows us that given condition of M > 50 subcarriers, the energy loss in transmission of the given reference signal is a smaller amount than 100 percent of the entire bit energy. The performance of the planned system is studied in this project and bit error rate expressions for AWGN and multipath Third Baron Rayleigh weakening channels square measure derived in this paper. Simulation results being matched to theoretical BER expressions affirm our derivation approach advantages. In addition, the obtained results highlight the importance of the comb-type vogue to use the time diversity of wireless channels. To examine the performance of the planned system thereto of DCSK, MC-DCSK and OFDM-DCSK, the simulated BERs square measure designed where results show a performance of PAPR is inside the planned system compared to rival systems. Considering the necessity and demand of future wireless communications to multiuser communications at reduced system of measurement and energy costs, the planned OFDM-DCSK system as promising technique which is shown.

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