

Adaptation of Cognitive Radio Network

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Abstract: The cognitive radio network came to solve the spectrum scarcity problem ,through arrival of the unauthorized users to the unlicensed spectrum to take advantage of the unused spectrum and avoiding interference with authorized users, the objective of this paper are adaptation of CRN by book the empty spectrum for primary users and secondary users thus use the best spectrum, and use four goals in order to access the optimal system : the minimize ber , the maximize throughput, the minimize transmission power, the minimize interference, each goal represent function ,and thus we get to the optimization system. after the execution of the simulator the result were obtain in terms of chart which show : the unused spectrum used by the secondary user, thus we solved problem of spectrum scarcity .And the function of maximize through put increase exponentially with decrease the BER, and the function of minimize ber increase exponentially with decrease the BER thus subcarrier N increase exponentially with increase the function of minimize ber ,and subcarriers N increase exponentially with increase the function of minimize power and the function of minimize interferences .

Keywords: Cognitive Radio Network (CRN), Wireless Networks, Adaptation, Primary User (PU), Secondary User (SU), BER , Throughput, Transmission power, Interference.

1. Introduction

CRN a wireless network, consisting of a transceiver, it can detect available channels of communication in an intelligent way and also discover other channels if there channels occupied, thus the interference will be less [1]. CRN has ability to change the transmitter parameters based on the environment in which it operates [2]. The Information gathered from the basic network uses to determine the RF environment thus sensing the spectrum , and detect spectrum users and primary users after that will discover unused spectrum and will be used by secondary users[3]. The CR uses cognitive radio device ,and able to configure different parameters, depending on the surrounding environment. Cognitive network does not have a fixed frequency, does not have the priority in the reach of the primary network, but occupies the available spectrum and exploits it. the basic idea of the cognitive network is exploiting the spectrum to be used in an optimal way to take advantage of it , This leads to increased use of the frequency spectrum, but we face many challenges such as interference between users [4].

Sugata Sanyal , Rohit Bhaduria and Chittabrata Ghosh in 2009 Secure Communication in Cognitive Radio Networks , the authors focus on cognitive network applications, also multiple methodologies which give a safe network to get continuous reliability without presence of eavesdropping and leaking information [5]. and Victor Balogunhe in Moscow, November 2010 ,Challenges of Spectrum Handoff in Cognitive Radio Networks, the author studied Challenges of spectrum delivery and that by investigation and verification from the performance of the TCP ,in order to solve TCP deterioration problem of secondary user, while trying the secondary user to the delivery channel when reaches the user primary [6]. and Yuehong Gao in Trondheim ,December 2012 , Performance Analysis of a Cognitive Radio Network ,the author Using Network Calculus work on performance analysis of a multi-channel cognitive radio secondary network in order to ensure a certain level of service guarantee in the cognitive radio system[7].

2. Mathematical Model

For multicarrier system with N independent subcarriers , the objective function are defined as:

$$f_{\min_ber} = 1 - \frac{\log_{10}(0.5)}{\log_{10}(P_{be})} \quad (1)$$

Where pbe is the average BER over N independent subcarriers [8].

$$f_{\max_tp} = \frac{\sum_{i=1}^N \left[\frac{L_i}{L_i + O + H} \times (1 - P_{ber}^i)^{(L_i + O) \times R_{ci} \times TDD_i} \right]}{N} \quad (2)$$

Where O and H are static packet overheads for the PHY and MAC layers, LI is the packet length , Rci is the coding ratio, and TDDi is the time division duplex value for channel i. For the maximum throughput multicarrier fitness function in Equation(2), all carrier fitness scores are summed together then divided over the total number of carriers, N, to get the average fitness score over all subcarriers [8].

$$f_{\min_interference} = 1 - \frac{\sum_{i=1}^N [(P_i + B_i + TDD_i) - (P_{\min} + B_{\min} + 1)]}{N \times P_{\max} + B_{\max} + 100} \quad (3)$$

This forces the system to Improve the overall system fitness . the minimize interferences fitness function in Equation(3) [8] .

$$f_{\min_power} = \left[1 - \alpha \times \frac{\sum_{i=1}^N (P_{\max} + B_{\max}) - (P_i + B_i)}{N \times P_{\max} + B_{\max}} + \beta \times \frac{\sum_{i=1}^N \log_2(m_{\max}) - \log_2(m_i)}{N \times \log_2(m_{\max})} + \lambda \times \frac{\sum_{i=1}^N R_{s\max} - R_{s_i}}{N \times R_{s\max}} \right] \quad (4)$$

Where, N is the number of carriers, Pi is transmit power on subcarrier h , and Pmax is the maximum possible transmit power for single subcarrier. Similary, mi is modulation index used on subcarrier I and m max is the maximum modulation index available, Bi is bandwidth allocated to channel I, and Bmax and Bmin are respectively, the maximum and minimum bandwidths the radio can transmit over instantaneously> Rsi is symbol rate on channel I and Rsmax and Rsmmin are the maximum and minimum symbol rates available. the minimize power fitness function in Equation (4) [8]

3. Computer Model

Descriptive analysis and mathematical model shown as Computer model :

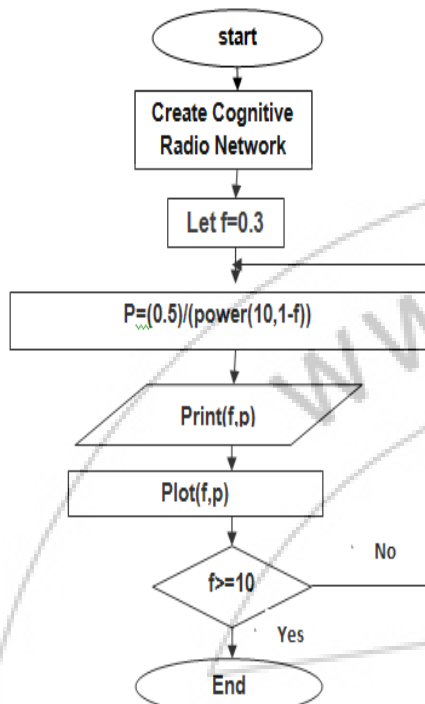


Figure 1: average BER over N independent subcarriers

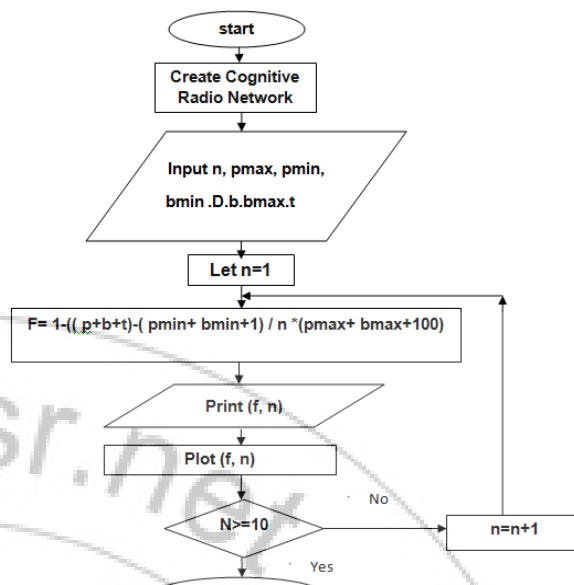


Figure 3: f_min_interference

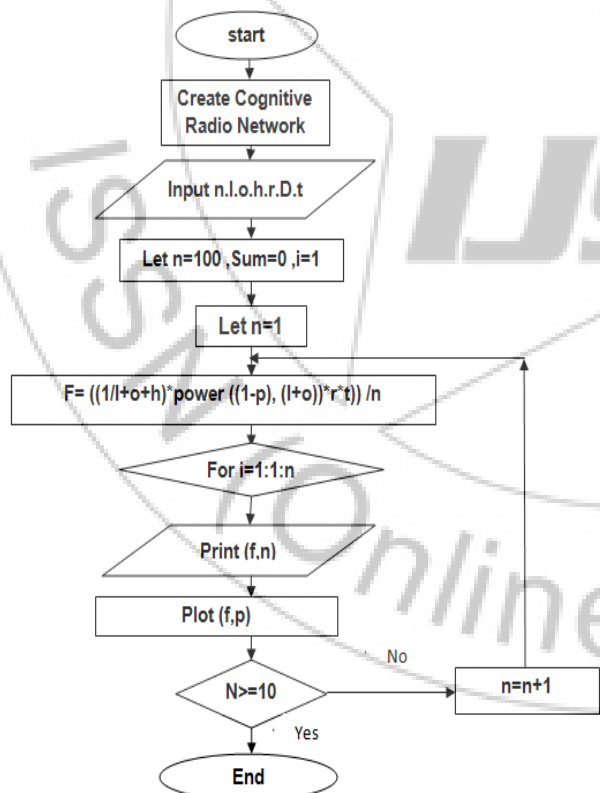


Figure 2: f_min_throughput

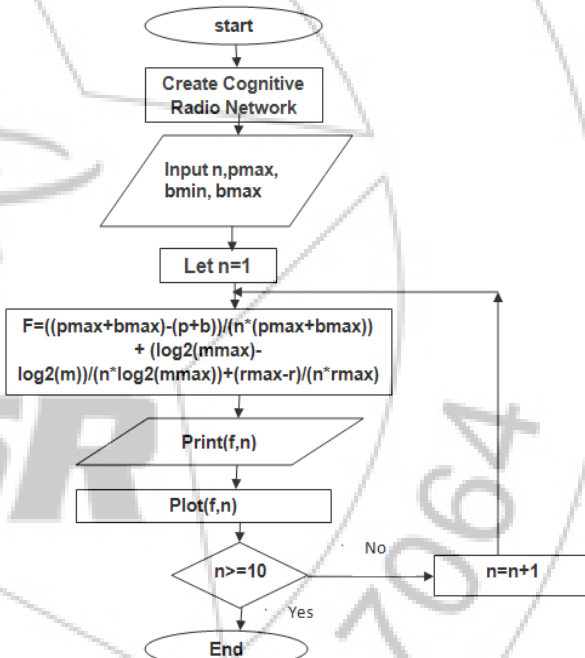


Figure 4: f_min_power

4. Simulator Environment

| Parameters | Value |
|---------------------------------------|------------------------------|
| Frequency minimum | 0.3 up to 1(MHz) |
| Packet length (Li) | 4byte, 8byte, 16byte, 32byte |
| MAC layer (H) | Randomize |
| Physical layer (O) | Randomize |
| Coding Radio (Rci) | 8QAm,16QAM,32QAM,64QAM |
| Time division duplex (TDDi) | 5sec, 10dec, 15sec, 20sec |
| Total number of carrier (N) | 10 up to 100 subscribers |
| Transmit power (Pi) | Randomize |
| Maximum possible transmit power(Pmax) | Randomize |
| Bandwidth allocated to channel (Bi) | Randomize |

| | |
|---|-----------|
| Maximum & minimum bandwidth the radio can transmit over (Bmax,Bmin) | Randomize |
| Bandwidth allocated channel i(Bi) | Randomize |
| Modulation index used on subscribers (mi) | Randomize |
| Symbol rate on channel I (Rsi) | Randomize |
| Minimum, maximum symbol rate available (Rs-max,Rs-min) | Randomize |

5. Result

The computer models was implanted using matlab software program after execution of the program ,we get the flowing result:

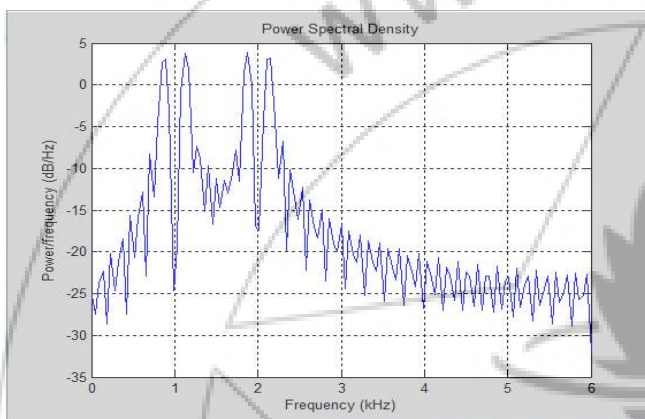


Figure 5: Exploit the empty spectrum by two primary users

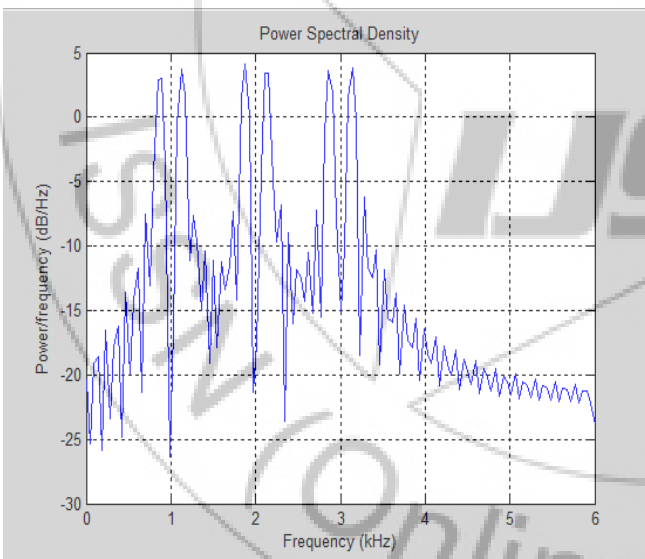


Figure 6: Exploit the empty spectrum by two primary users and one secondary users

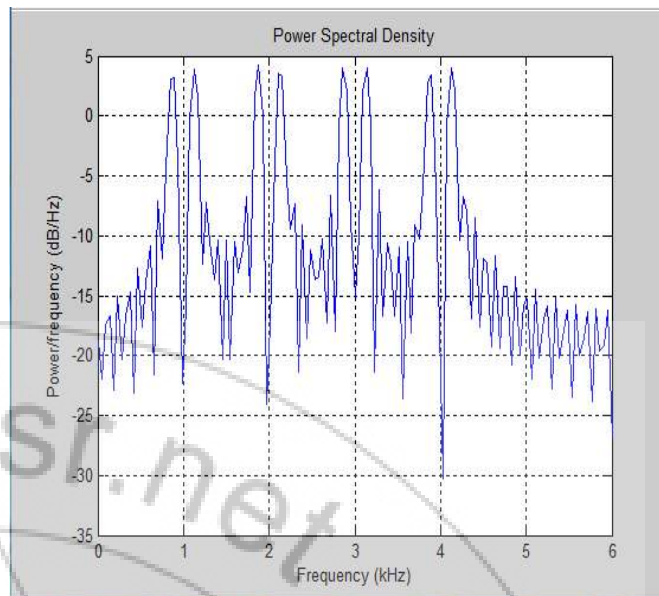


Figure 7: exploit the empty spectrum by two primary users and two secondary users

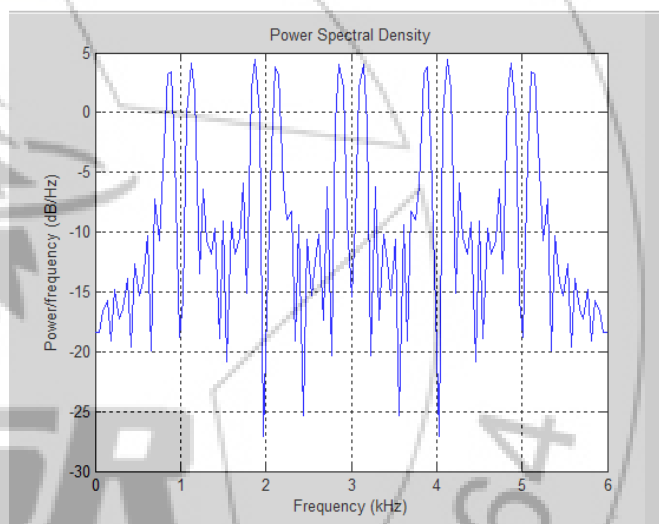


Figure 8: exploit the empty spectrum by two primary users and three secondary users

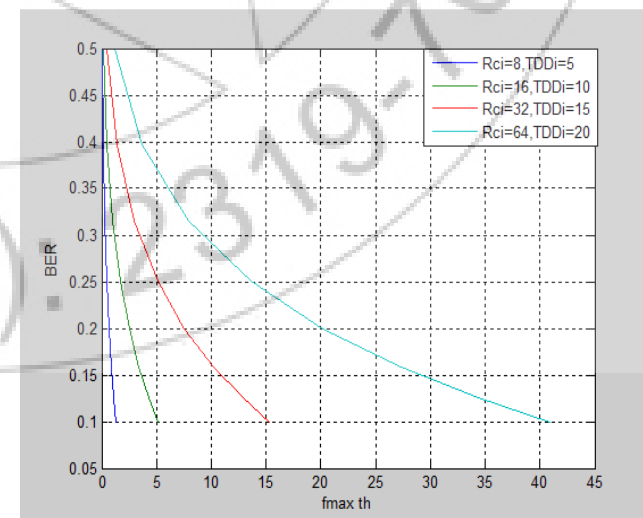


Figure 9: relationship between maximum through put and BER at $L = 4$

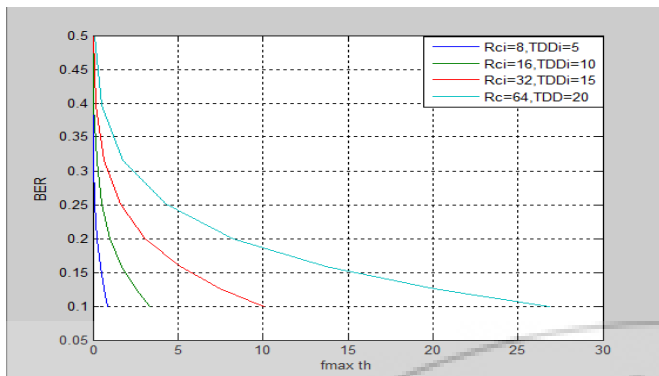


Figure 10: relationship between maximum through put and BER at $L = 8$

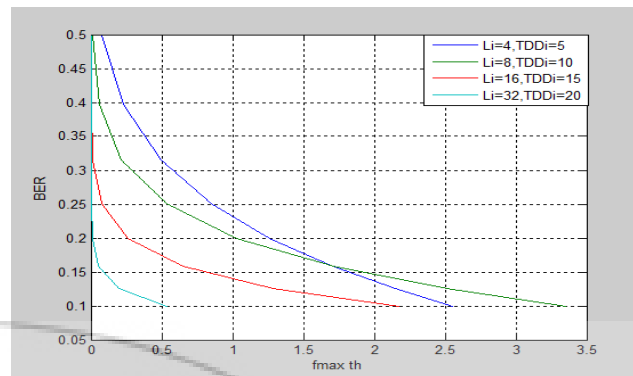


Figure 14: relationship between maximum through put and BER at $Rc = 16$

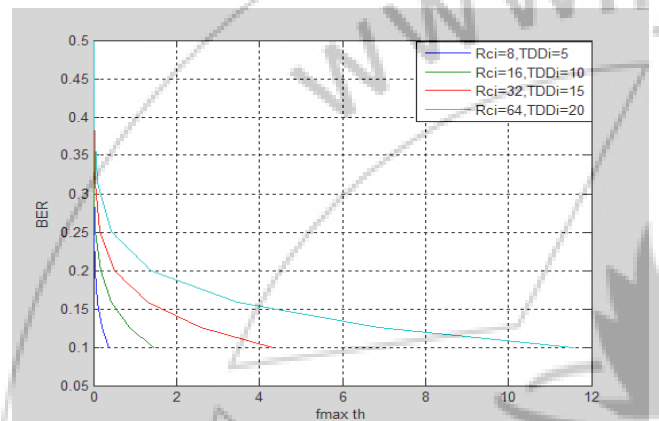


Figure 11: relationship between maximum through put and BER at $L = 16$

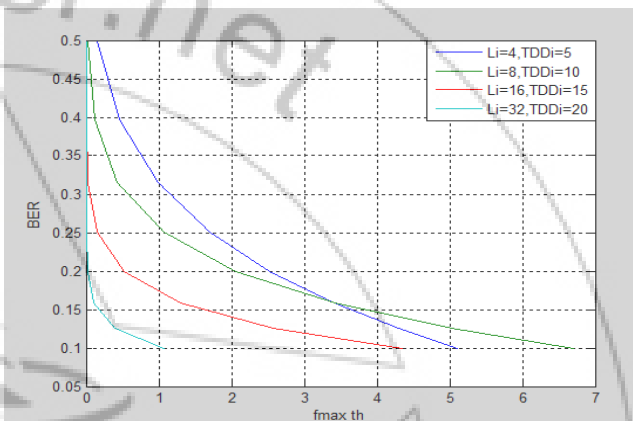


Figure 15: relationship between maximum through put and BER at $Rc = 32$

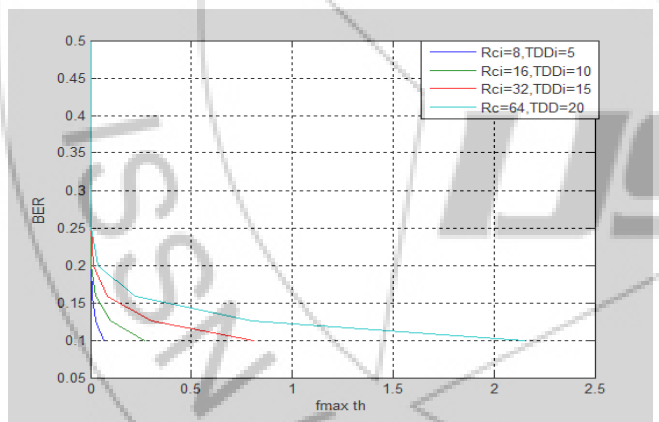


Figure 12: relationship between maximum through put and BER at $L = 32$

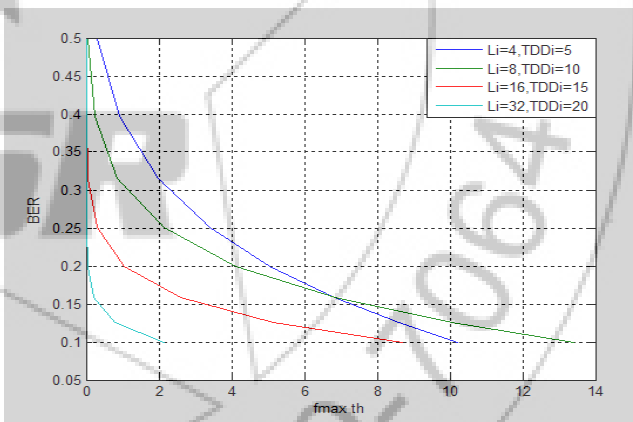


Figure 16: relationship between maximum through put and BER at $Rc = 64$

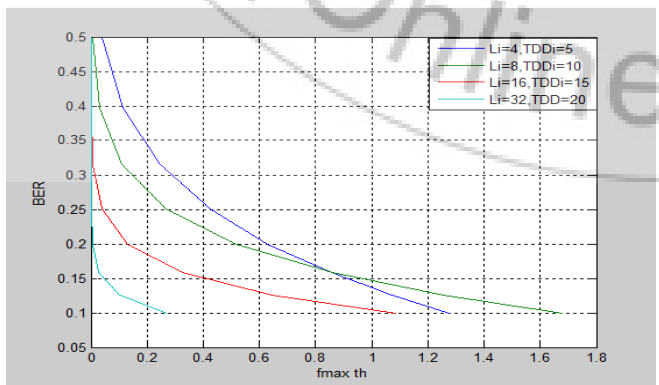


Figure 13: relationship between maximum through put and BER at $Rc = 8$

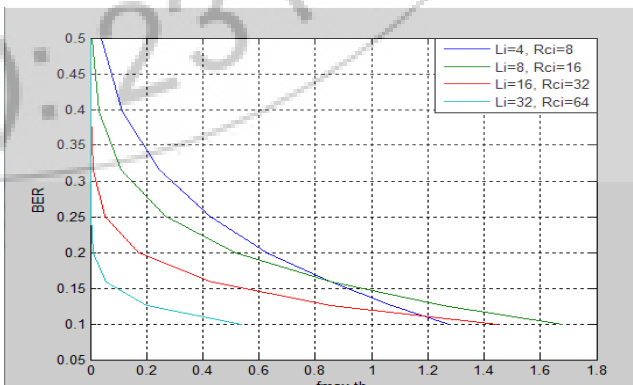


Figure 17: relationship between maximum through put and BER at $TDD = 5$

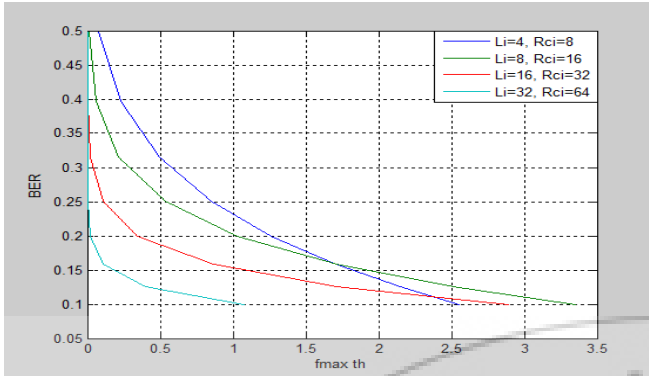


Figure 18: relationship between maximum through put and BER at TDD = 10

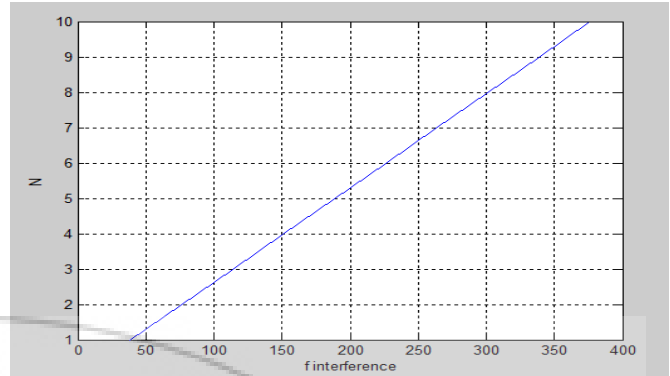


Figure 22: relationship between f_{min} interferences and subcarrier N

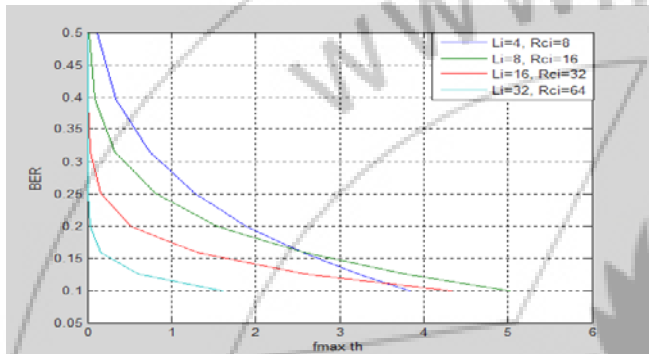


Figure 19: relationship between maximum through put and BER at TDD = 15

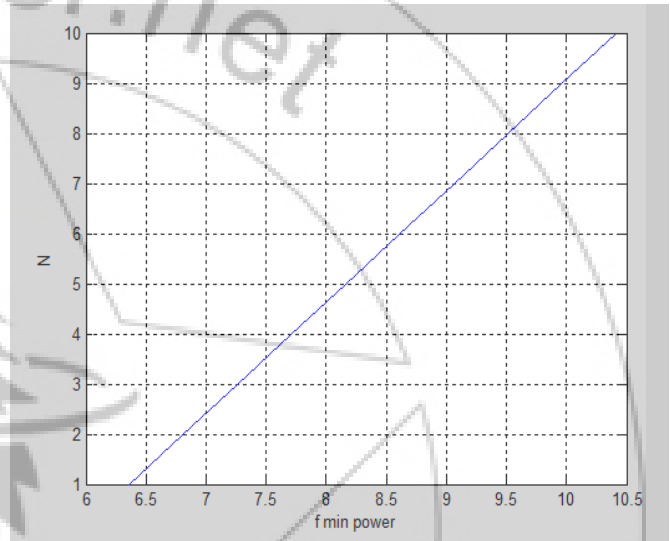


Figure 23: relationship between f_{min_power} and subcarrier N .

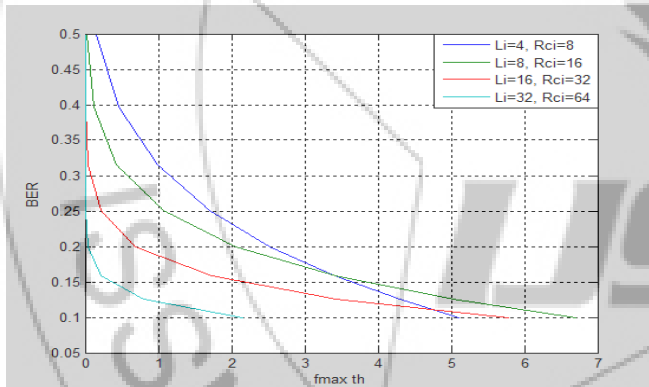


Figure 20: relationship between maximum through put and BER at TDD = 20

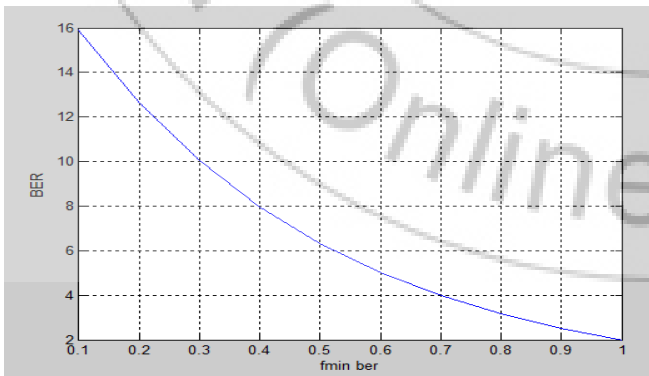


Figure 21: relationship between f_{min_ber} and BER .

6. Discusses and Result

The first and second user represent primary users entered to exploit the allocated frequency band the, And thus the remaining frequencies are still unallocated , and the Third user which represent secondary user exploited the unallocated frequency, and the fourth user which represent secondary user exploited the unallocated frequency , and the fifth user which represent secondary user exploited the unallocated frequency. And thus all users exploited all frequency spectrum .through put increase When $L = 4$ because the function of maximize through put increase comparing to $L = 8, L = 16, L = 32$, and through put increase When $Rc = 64$ because the function of maximize through put increase comparing to $Rc = 8, Rc = 16, Rc = 32$, and through put increase When $TDD = 20$ because the function of maximize through put increase comparing to $TDD = 5, TDD = 10, TDD = 15$, and subcarriers N increase exponentially with increase the function of minimize ber, the function of minimize power and the function of minimize interferences

7. Conclusion

We used five users the first and second user represent primary users are entered to exploit the allocated frequency band and the remaining spectrum represent unused spectrum

which will be used by Third , fourth and fifth users ,and thus all spectrum is used, but increasing the users Lead to increasing interference , but there must be a balancing between users and interference and take advantage of spectrum with less interference . and we compared between four goals ,through put increase When $L = 4$ because the function of maximize through put increase the BER decrease exponentially Figure (9), through put increase When $R_c = 32$ because the function of maximize through put increase the BER decrease exponentially Figure (15), through put increase put When $TDD = 20$ because the function of maximize through put increase the BER decrease exponentially Figure (20), relationship between the function of minimize ber and BER when the subcarriers N increase the function of minimize ber increase exponentially Figure (21), When subcarriers N increase the function of minimize interferences increase exponentially Figure (22) ,and When subcarriers N increase the function of minimize power increase exponentially Figure (23).

References

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