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Improved Quality of Service for Mixed Traffic OFDMA –SWIPT System using Log-Normal Distribution

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Abstract*: Resource allocation is a protuberant, unavoidable feature for all future communication systems .It is important to maintain true communication between sources to destination without any loss. The Quality of Service (QoS) is also another important factor for any type of mixed and multi user communication. In this paper, OFDMA – SWIPT is considered for mixed traffic communication to data transfer and power (energy) gathering. SWIPT can be operated in two modes for data transfer and power calculation, those are Time Switching (TS) and Power splitting (PS). One of the methodologies for resource allocation can be done by using either PS-SWIPT or TS-SWIPT. By comparing PS-SWIPT and TS-SWIPT under various parameters like PAPR (peak to average power ratio), Channel state information (CSI), Quality of service (QoS), Bit Error Rate (BER) and TS-SWIPT system is best suited method. In this methodology the error rate becoming more, The present SWIPT system is best suited for limited users, if the number of users and mixed traffic is applied then Quality of service (QoS) will decreases. In proposed system, efficiency of the SWIPT OFDM system with Log-Normal function is analyzed. After adding Log-Normal distribution function if we use mixed traffic then QoS will be increasing, in simulation results it is proved.

Keywords: Log-Normal function, Quality of Service (QoS), Orthogonal Frequency Division Multiple Access (OFDMA), Simultaneous Wireless Information and Power Transfer (SWIPT).

I. INTRODUCTION

In conventional communication system it is required to maximize the SINR (signal to interference noise ratio), which develops QoS. For single transmitter and receiver it is easy to get required SINR value. But, when the number of users is increasing the system will become more complex. The solution for reducing the complexity is OFDMA system. In OFDMA by using subcarrier allocation algorithm [1] we can obtain better SINR value with multi user.

For traditional system only single user is assumed, OFDMA with SWIPT it is best suitable method for multi user. Where SWIPT was operated in two modes, Time Switching (TS) and Power Splitting (PS). SWIPT method can be used for simultaneous data transfer and gather the energy [2]. In these two methods, TS-SWIPT method is best suited for mixed traffic communication.

Naturally the power for communication system was supplied from power sources. After imposing OFDMA-SWIPT power gathered from received signal. The resource allocation about these two methodologies was given in section III.In OFDMA system with misalignments with respective to receiver can be solved with stochastic geometry connective model [3]-[4]. The asynchronous data due to power splitting (PS) method can makes the difference in QoS of the system.

In SWIPT the power splitting mode splits the power and data in relay mode which make data is asynchronous and delayed by time. By transmission mode adaption (TMA) [5] protocol unparalleled data can be parallelized.

II. SYSTEM MODEL

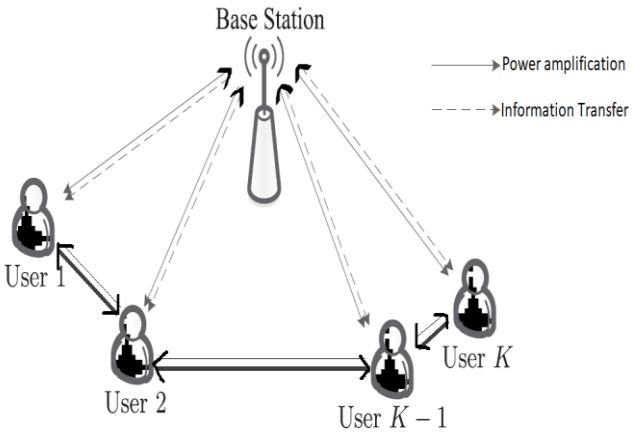

Figure 1: System model.

We consider a system shown in figure 1 [1], which consists of multi- users' i.e. K with mixed traffic. It is assumed that all OFDMA system channels are using Nakagami-m fading [3]. The number of subcarriers is L and required condition for IFFT in OFDMA system that $L \geq K$. The number of subcarriers in each channel is greater than the number of users so that Inter Symbol Interference (ISI) can be removed. In this system from base station to users the channel makes full-duplex communication. Information transferring between user to user, user to base station and vice versa. The gathered power at the receiving end should be greater than zero $Z_k \geq 0$.

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III. PRESENT SYSTEM

A. RESOURCE ALLOCATION FOR PS-SWIPT

In Power Splitting- SWIPT [8], which splits the received signal into two, parts one for decrypt information and another for power gathering.

Here we decided to use OFDM system with number of subcarriers are allocated to each user *L=1,2,……n.* The users will share all the power which is retrieved from SWIPT [1]. (Note: the same OFDM system is assumed for TS-SWIPT [2])

Problem of resource allocation is given by,

$$min_{\{R_{k,n}\}} \sum_{k=1}^{K} \sum_{n=1}^{L} R_{k,n} - - - (1)$$

$$£\sum_{n=1}^{L} \sum_{k^l}^{K} R_{k^l,n} h_{k,n} \geq E_k \ \ldots\ldots k=1,2\ldots\ldots L, \text{---(2)}$$

From (2), the resource allocation to subcarrier of any number L. the channel power R_n for subcarrier n is the perfect solution which given by (1),

The problem is given by,

$$\min_{\{R_n\}} r \sum_{n=1}^{L} R_n - - - - - - (3)$$

Such that,

$$0 \leq R_n \leq R_{pk}, \qquad n = 1.2 \ldots \ldots .. L - - - - (4)$$

$$£\sum_{n=1}^{L} R_n h_{k,n} \geq E_k, k = 1, , , , , , K - - - - (5)$$

To achieve maximum power R_{max}, the primitive and primary object is to workable to PS-SWIPT [8]-[9]. In equation (5), the function of non- linearity can be solved by interior point method (IPM) [6]. IPM algorithm [6] is the best suitable algorithm for solving linear and non- linear optimization problems. By converting around and surface value of non-linear optimization we can achieve maximum throughput.

B. RESOURCE ALLOCATION FOR TS-SWIPT

In Time Switching- SWIPT [8] - [9], resource allocation can be done on the basis of TDM access. Where the time will be shared between data transfer and gathered power energy harvest). TS-SWIPT is the best suitable and efficient method for resource allocation comparing to power splitting. Time is shared between two different tasks so that there will be no data manipulation or data interference.

The problem of resource allocation is given by,

$$\min_{\{R_{K+1,n}\}} r \sum_{n=1}^{L} R_{K+1,n} - - - - - (6)$$

Such that,

$$£\sum_{n=1}^{L} R_{K+1,n}\, h_{k,n} \geq E_k, \ k = 1, \ldots \ldots, K — (7)$$

$$0 \leq R_{K+1,n} \leq R_{pk}, \qquad n = 1, \ldots \ldots \ldots, L - - - (8)$$

The functional value of equation (6) is should be less or equal to R_{max} and it is belongs to linear equation which can be analyzed by interior point method [6] (IPM) as discussed above.

We define $q_{k,n} = \tau_k R_{k,n}, k = 1, \ldots\ldots, K+1, n = 1, \ldots L$ and reformulate the problem as

$$\min_{\{\tau_k\},\{q_{k,n}\}} \frac{1}{K} \sum_{k=1}^{K} X_k(\tau_k, \{q_{k,n}\}) - - - - (9)$$

$$£\sum_{i\neq k}^{K+1} \sum_{n=1}^{L} q_{i,n} h_{k,n} \geq E_k \ , \ k = 1, \ldots \ldots K. - - (10)$$

$$\sum_{k=1}^{K+1} \sum_{n=1}^{N} q_{k,n} \leq R_{max} - - - - - - - - - (11)$$

$$0 \leq q_{k,n} \leq \tau_k R_{pk}, k = 1, \ldots . K+1, for\ all\ n - (12)$$

$$\sum_{k=1}^{K+1} \tau_k \leq 1 - - - - - - - - - - - - - (13)$$

$$0 \leq \tau_k \leq 1, k = 1, \ldots K+1 - - - - (14)$$

Where

$$X_k(\tau_k, \{q_{k,n}\}) = \frac{\tau_k}{N} \log_2 \left(1 + \frac{q_{k,n} h_{k,n}}{\tau_k N_o B}\right) - - (15)$$

IV. PROPOSED SYSTEM

In this section, we compare investigated SWIPT methods under single user and multi user. For simplicity single user is investigated in present system but that makes system so simple, which is not possible in reality. If we use for multiuser the system complexity will become more, which increases error rate i.e. reduces the quality of service (QoS).

In proposed system, we investigated mixed traffic and multiuser communication system OFDM system. By adding Log-normal distribution function to the existing system we can increase the Quality of Service (QoS).

Log- normal function is given by [7],

$$\text{X(f)} = \frac{1}{x\sigma\sqrt{2\pi}} \exp\left(-\frac{(\ln(x-\mu))^2}{2\sigma^2}\right) - - - - (16)$$

By using the above function (16), we have investigated proposed system under max number of users in mixed traffic where the bit error rate reduced and delay of the channel also decreases.

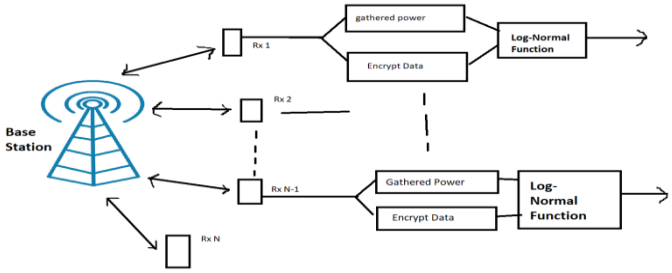

Figure 2: The proposed system model with Log – Normal function

The system model [2] with Log-Normal function [7] is given in figure 2. In proposed system Time Switching-SWIPT is considered. From base station the information will be sent to receiver, by applying SWIPT methodology at the receiving end power will be gathered and data was encrypted. After applying SWIPT, the signal to interference noise ratio (SINR) will be less. Due to this quality of service is degrading. For typical communication system it is obligatory that proper SINR value. After SWIPT applied the data will be given to Log- Normal function [7] to maintain proper SINR value.

For N number of users, K number of subcarriers, mean (m) and variance σ^2 , then after imposing mixed traffic the function is given by,

$$S_r(r) = \int_0^{\infty} \frac{2}{r(m)} \left(\frac{m}{w}\right) y^{2m-1} \exp\left(-\frac{mr^2}{w}\right) - - - (17)$$

for r=0,1,…..N-1

Where *m: 0≤m≤1*.

Simulation results will show that the proposed method SWIPT with Log- Normal function is best suitable method for real time OFDM system communication with mixed traffic.

V. SIMULATION RESULTS

In this section, we compared the proposed method with present method. The system parameters where the number of users K=100. The distance between transmitter and receiver is 100m. The Recian fading path is assumed for channel.

To find the bit error rate here we conducted experiments with SWIPT and Log Normal functions. Table 1 shows the values of BER comparison with different SINR values with number of users L=100.

Table1: BER comparison Log-Normal and TS – SWIPT

SINR	SWIPT (BER)×10^{-4}	Log- Normal (BER)×10^{-4}
0	1.25	0.92
0.5	1	0.8
1	0.95	0.63
1.5	0.62	0.55
2	0.4	0.31
2.5	0.25	0.2
3	0.18	0.15
3.5	0.12	0.11
4	0.11	0.09
4.5	0.1	0.09
5	0.09	0.08
5.5	0.08	0.06
6	0.07	0.04

Figure 3 & 4 illustrates that the outage performance of different methods under various number of users. As the numbers of users are increasing the BER values are decreasing for proposed method with Log-Normal distribution. In this we have investigated and simulated the results for power splitting (PS-SWIPT) and (TS-SWIPT).

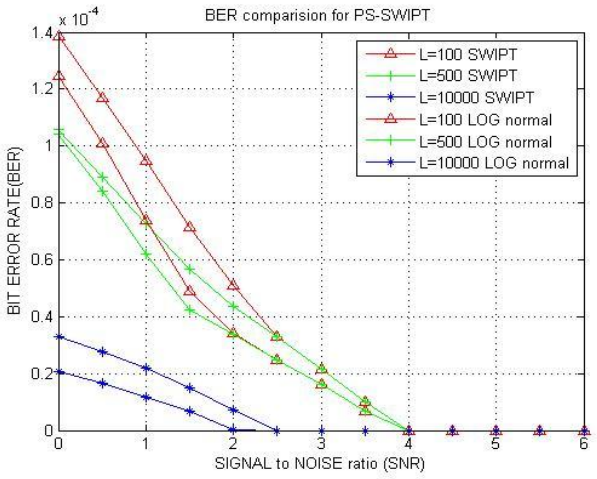

Figure 3: Comparision of proposed scheme(Log- Normal) with present system(PS-SWIPT).

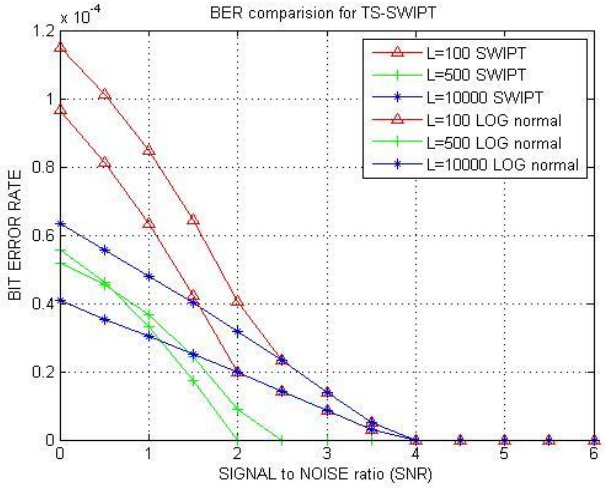

Figure 4: Comparision of proposed scheme(Log- Normal) with present system(TS-SWIPT).

VI. CONCLUSION

In this paper, we presented a new methodology to get better Quality of Service (QoS). From extracted bit error rate values it is proved that error rate is reduced by applying log normal function. Simulation result shows that as SINR value increasing the Bit Error Rate (BER) value is minimized. We proved that, by adding Log normal function the Quality-of-Service (QoS) got improved. The outage performance of mixed traffic multi user OFDM system is compared with traditional method and showed that proposed system is bust suitable for resource allocation in mixed traffic OFDM system. In future, proposed system may be investigated with different modulation schemes, fading paths and coding schemes.

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