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Throughput Maximization for OFDM Communication by Energy Harvesting

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ABSTRACT : Nowadays in wireless communication, the need for data transmission without signal degradation is desired. The reconceptualization of energy with the degraded data gives a new door for the researchers under jamming condition. Here, in this paper we explain an energy harvesting system with orthogonal frequency division multiplexing under hostile jamming condition .In the downlink, the receiver processes information and harvest energy from the received signal as well as the jamming interference through a power splitter. The gathered energy can then be used as an additional source of power to enhance the uplink transmission.

KEYWORDS: Energy Harvesting, Hostile Jamming, OFDM.

I. INTRODUCTION

Wireless communication is the thirst area in research with cent percentage data transmission. Due to portability, flexibility and coverage, the wireless communication preferred over its counterpart. Hostile jamming can cause significant degradation in wireless communication. Jamming presents a threat to the reliability of data transmission. To enhance the jamming resistance of OFDM systems, several encoding and decoding schemes have been proposed. Linear pre-coder and decoder were used to maximize the mean-square error (MSE) for OFDM system under multi-tone jamming. Recently, simultaneous wireless information and power transmission (SWIPT) technology has gained considerable attention in both industrial and academic fields. The SWIPT technique has been extended to multi-antenna systems, OFDM systems. For downlink SWIPT OFDM with power- splitting receiver used to maximize the energy efficiency.

II. LITERATURE REVIEW

In Energy Harvesting for Two-Way OFDM Communications under Hostile Jamming [1], the receiver harvests energy from the received signals with a power-splitting architecture in the downlink, which enhances uplink transmission. OFDM is fragile under hostile jamming. Power Allocation Strategies in Energy Harvesting Wireless Cooperative Networks [2], the harvested energy or power is allocated to multiple users in the network and their impact on the system is studied. Here, Energy harvesting and data detection cannot be done at the same time. In Cooperative Energy Harvesting Networks with Spatially Random Users [3], spatial randomness of users counts into consideration and energy is harvested using a relay in cooperative networks. But, practically conventional energy harvesting is not possible without access to natural resources. In Wireless Information and Power Transfer: Architecture Design and Rate-Energy Trade Off [4], Using dynamic power splitting information and power are transferred simultaneously in wireless channel. But, Practical implementation is not possible.

III. PROPOSED SYSTEM

The basic idea of the proposed scheme is that the receiver harvests energy from the received mixed signals with power splitting architecture in the downlink, and the harvested energy can then be used as an additional source of power to enhance the uplink transmission. Energy required for data transmission is randomly harvested by the OFDM system throughout the communication duration. During data transmission jamming may occur which leads to loss of energy. The energy management system utilized the optimal power allocation and power splitting ratio to maximize the sum rate of the uplink and downlink transmissions. We are harvesting the energy by using heuristic algorithm; thereby the overall performance of the OFDM system will be increased. By using the energy harvesting scheme the SNR and BER of OFDM system can be reduced.

III.I Block diagram of proposed system

The block diagram of the proposed system is shown in the Fig (1).

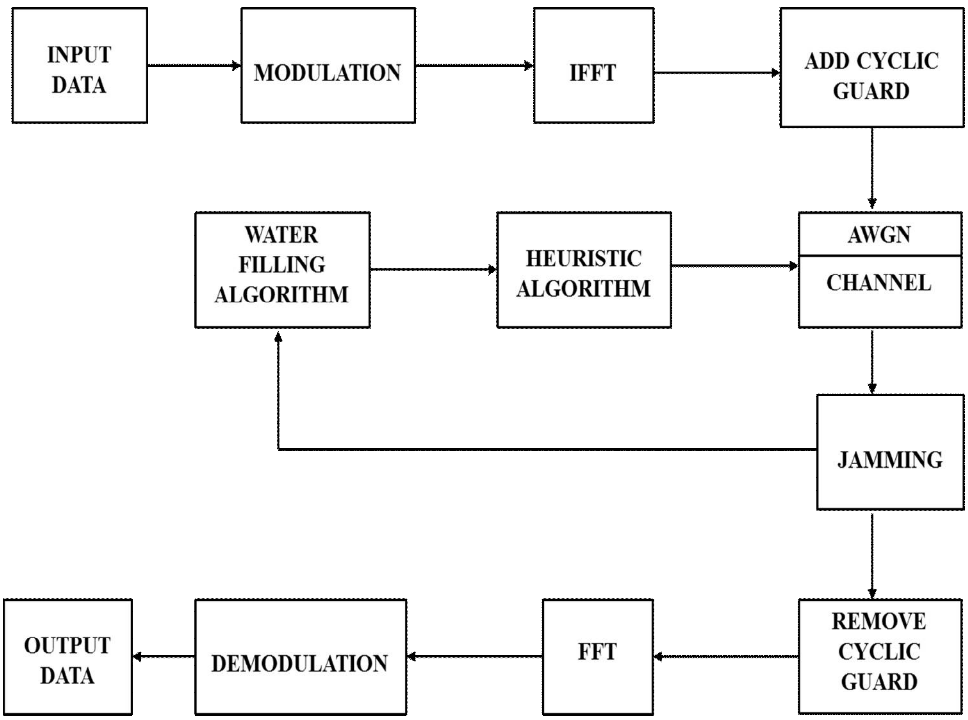

Fig 1: Block diagram of proposed system

Here, when the input data is given in the order of 10^6, it is modulated using QAM modulator and guarded with cyclic guard bits. The modulated data is sent over the channel. The proposed system at the receiver monitors the channel for any jamming of signals, if jamming occurred, it harvest the energy from that jammed situation. The energy management system utilized the optimal power allocation and power splitting ratio to maximize the sum rate of the uplink and downlink transmissions. The harvesting is done using heuristic algorithm. The heuristic algorithm is explained in the next section.

III.II The Heuristic Algorithm

We use heuristic function H:S×AR to affect the choice of the action in our HE-PDS. let H (s^n, a^n) denote the heuristic value. After the implementation of an action, the evaluation function E:S×AR is employed to reduce unnecessary exploration and En(s^n, a^n) is also used to indicate the feasibility of an executed in state s^n, which is referred to as the evaluation value. Let $F^n(s^n, a^n)$ denote the additional reward value, which instructs the additional value after executing action an in the state s^n.

In the HE-PDS learning algorithm, we modify the greedy action choice policy by heuristic function and evaluation function, which can be written as:

$$\pi(S^n) = \begin{cases} \text{argmsx}[Q(s^n, a^n) + \epsilon H(s^n, a^n) + \delta E(s^n, a^n)], if q \le p \\ a_{random} & , if\ q > p \end{cases} \quad (1)$$

As a general rule, the value of H(sn, an) used in HE-PDS learning algorithm should be as low as possible in order to minimize the error. It can be defined as:

$$H(s^n,a^n) = \begin{cases} maxQH(s^n,a^n) - QH(s^n,a^n) + \eta, if\ a^n = \pi^H(s^n) \\ 0 \qquad ,otherwise \end{cases} \qquad (2)$$

Where η is a small real value and $H(s^n)$ is the action suggested by the heuristic policy.

A randomize an action randomly chosen among the available state set S. To solve the action search problem, the greedy and continuously differentiable Boltzmann-Gibbs distribution is employed as the selection strategy. To increase the randomness of action selection and improve the efficiency of HE-PDS learning, the simulated annealing technique is employed to adjust the temperature, which is modulated as follows:

$$\begin{cases} T^0 = T^{max} \\ T^{n+1} = T^n \ X \lambda^k \end{cases} \qquad (3)$$

In this paper, we use the additional reward function to modify the immediate reward of PDS learning. For the sequence states $\{s^n$:n=0,1,…}, we define the feature vector value $T^n=\{t^{n1}, t^{n2}, \ldots, t^{nk}\}$ for state s^n, where t^{nk} is the k-th feature vector value for sn. The features of each state have various effects in the RL system. In order to express this impact of the differences, we need to weight each component of the feature value vector. Define weight vector $W^n=\{w^{n1}, w^{n2}, \ldots, w^{nk}\}$, where w^{nk} represents the weight corresponding to the k-th feature value vector in state sn.After the system executes the action, the additional reward function is expressed as.

$$F^n = (W^n)^T.T = w^{n1}.t^{n1} + w^{n2}.t^{n2} + \cdots + w^{nk}.t^{nk} \qquad (4)$$

Where F^n is a scalar value. If $F^n>0$, the system earns a positive reward. While $F^n<0$, the environment gives a negative reward. So we can modify the reward function as follows:

$$R^{n1} = R^n + F^n = R^n + w^{n1}.t^{n1} + w^{n2}.t^{n2} + \cdots + w^{nk}.t^{nk} \qquad (5)$$

Where R^n is the immediate reward in each time slot. Hence, we can update the Q value using the following formula:

$$\tilde{Q}^{n+1}(\tilde{s}^n) \leftarrow (1-\alpha^n)\tilde{Q}^n(\tilde{s}^n) + \alpha^n[R^{n1}(\tilde{s} + \gamma Q^n(s^{n+1}) \qquad (6)$$

As a general rule, the value of H (s^n, a^n) used in HE-PDS learning algorithm should be as low as possible in order to minimize the error.

III.III Water Filling Algorithm

In this section, the Simplified Iterative Water Filling (SIWF) algorithm for multiuser MMSE-precoded MIMO a system with inter-stream interference is used for realizing the system. To find an effective algorithm of optimizing per-user power allocation under inter-stream interference, we invoke some iterative approaches to solve the Karush-Kuhn-Tucker (KKT) system of the non-convex optimization problem. When the inter-stream interference is regarded as noise, the K-user optimization problem to maximize the sum capacity can be expressed as

$$max \sum_{i=1}^{k} log_2 \left[1 + \frac{p_i \left\|\overline{h_{i,j}}\right\|^2}{\sigma_n^2 + \sum_{j=1(j\neq 1)}^{k} p_j \left\|\overline{h_{i,j}}\right\|^2}\right]$$
$$\text{s.t } \sum_{i=1}^{k} p_i \leq p_t$$
$$p_i \geq 0 \qquad (7)$$

Where i, j h is an effective channel gain experienced by the signal of the j-th user that interferes with the i-th user and PT denotes the total power constraint.

IV. SIMULATION RESULTS

IV.I FULL BAND JAMMING

The input to be given to the OFDM system is 10^6 data including audio, video, data signals etc. The performance of proposed system in terms of sum rate or data rate is compared under full band jamming. The analysis is done after applying heuristic algorithm. The negative part is taken into consideration because the energy obtained due to jamming is given as a feedback. The table 1 and 2 represents jamming variance for different sum rate for full band jamming condition for both existing and proposed system.

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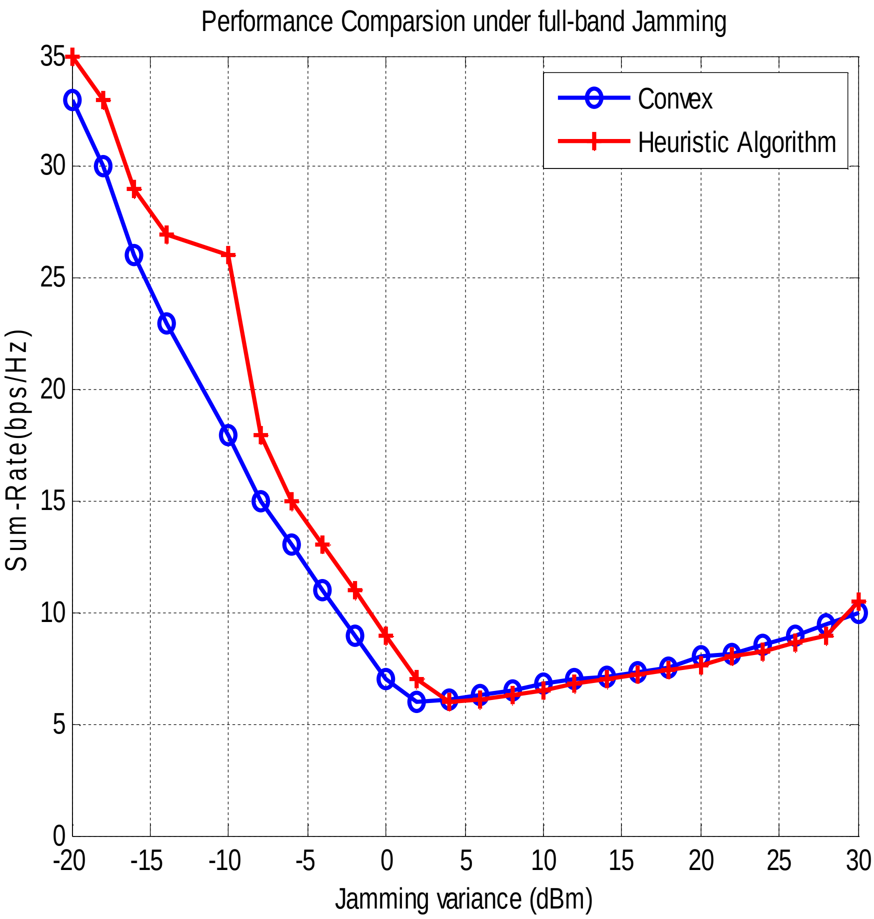

Fig 2 Performance Comparison of Jamming variance and Sum Rate for Existing and Proposed System

SUM RATE (bps/Hz)	JAMMING VARIANCE (dB)
32	-19
26	-14
13	-9
7	4

Table 1 Full band jamming for existing system system

SUM RATE (bps/Hz)	JAMMING VARIANCE (dB)
35	-17
23	-13
10	-7
5	5

Table 2.Full Band jamming for proposed

Here the power splitting ratio is compared with jamming variance for both existing and proposed system (heuristic). In proposed system (heuristic) the power splitting ratio suddenly increases to a high value which is

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completely different from that of power splitting ratio of existing system. Thus after applying heuristic the power splitting ratio of the OFDM system is increased to a greater extent.

IV.II JAMMING POWER

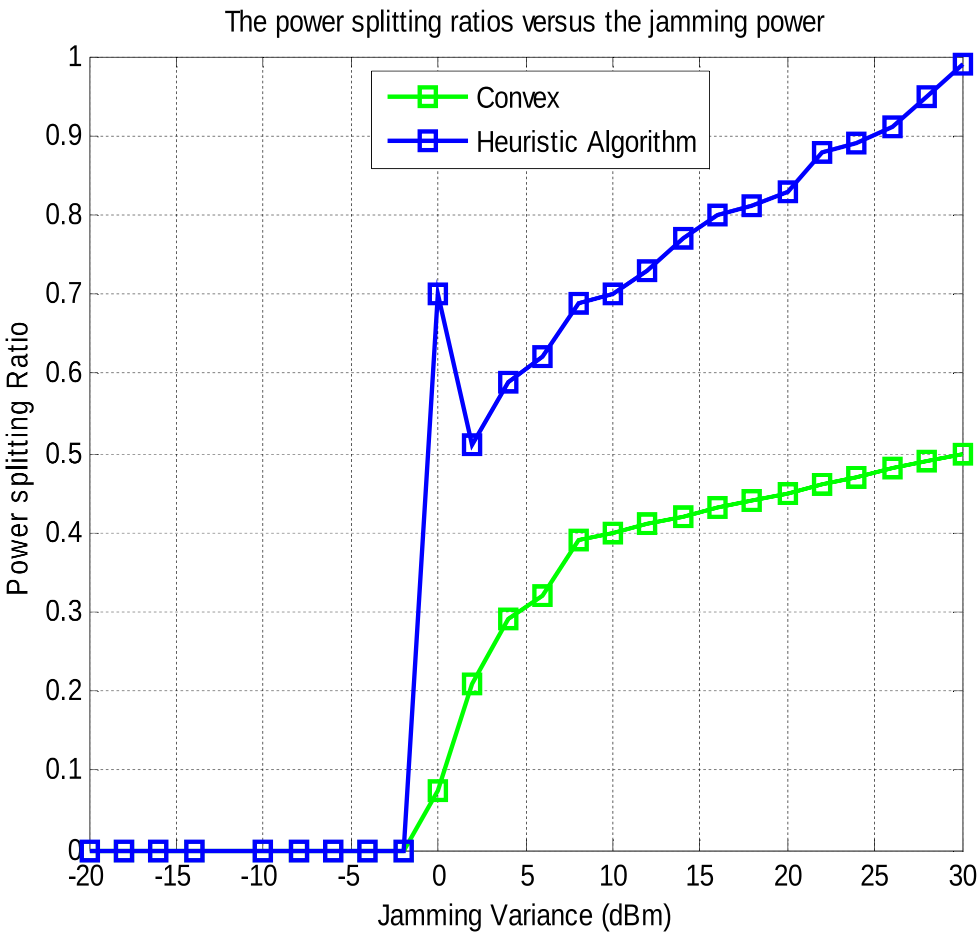

Fig 3 Jamming variance and Power Splitting Ratio Comparison for the Existing and Proposed System

	POWER SPLITTING RATIO	JAMMING VARIANCE (dB)
Existing system	0.4	18
Proposed system	0.7	20

Table 2 Total Jamming Power

Here the power splitting ratio is compared with jamming variance for both existing and proposed system (heuristic). In proposed system (heuristic) the power splitting ratio suddenly increases to a high value which is completely different from that of power splitting ratio of existing system. Thus after applying heuristic the power splitting ratio of the OFDM system is increased to a greater extent.

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IV.III PARTIAL BAND JAMMING

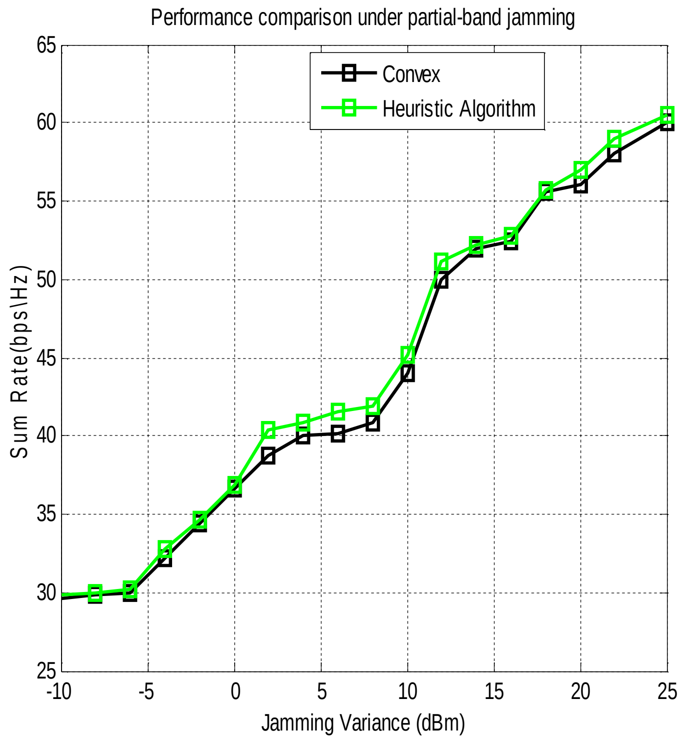

Fig 4 Performance Comparison under Partial-Band Jamming

SUM RATE (bps/Hz)	JAMMING VARIANCE (dB)
30	2.5
40	5
50	15

Table 3: Partial-Band Jamming for the Existing System

SUM RATE (bps/Hz)	JAMMING VARIANCE (dB)
30	5
40	7
50	17

Table 4: Partial-Band Jamming for the Proposed System

The table 3 and 4 represents jamming variance for different sum rate for partial band jamming condition for both existing and proposed system. The performance of proposed system in terms of sum rate or data rate is compared under partial band jamming. The analysis is done after applying heuristic algorithm. In the proposed system the data rate increases as the jamming increases because of energy harvesting. Thus the performance of OFDM system is better after applying heuristic algorithm.

As the jamming increases (negative side) the sum rate also increases rapidly for both existing and proposed system. But the proposed system (heuristic) differs highly from that of existing system that is it has a better performance.

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IV.IV SNR Vs BER Output

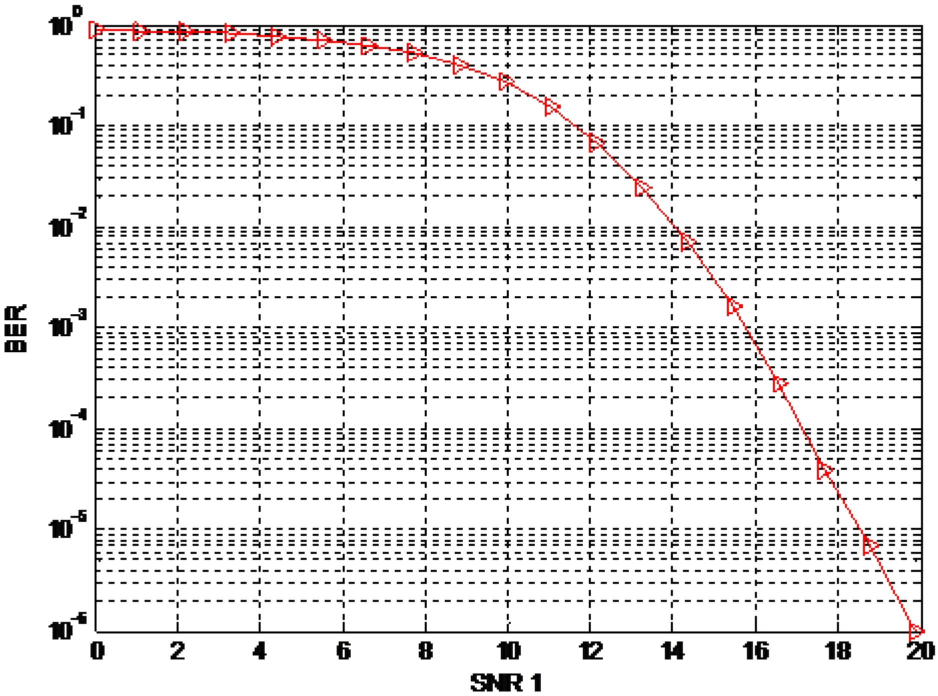

Fig 5 SNR Vs BER Output

The simulation output for BER vs SNR is shown in the figure 5. Here the bit error rate (BER) is plotted against the signal to noise ratio (SNR). The aim of reducing the BER is shown in this simulation result. The BER is reduced to 10^-6 that is if 1 crore data is transmitted only one data is lost. Reducing the BER leads to better transmission. The value of SNR should be less than 20 dB. Increase in value of SNR beyond this leads to degradation.

V. CONCLUSION

This project involves harvesting energy from the received mixed signals with power splitting architecture in the downlink, and the harvested energy can then be used as an additional source of power to enhance the uplink transmission. The energy management system utilized the optimal power allocation and power splitting ratio to maximize the sum rate of the uplink and downlink transmissions. We are harvesting the energy by using heuristic algorithm; thereby the overall performance of the OFDM system will be increased. By using the energy harvesting scheme the SNR and BER of OFDM system can be reduced.

Future wireless communication system must be very efficient spectrally to support number of users with high data rate. It is more sensitive to carrier frequency offset and drift than single carrier systems. To overcome this we can use NC-OFDM which is the promising technique for future generation of wireless communication system. In NC-OFDM the carriers which suppress the primary transmission is suppressed thereby enabling efficient use of the spectrum.

REFERENCES

1. Zhaoxi Fang, Tianlong Song, and Tongtong Li, Senior Member, IEEE, "Energy Harvesting for Two-Way OFDM Communications under Hostile Jamming", IEEE Signal Processing Letters, vol. 22, no. 4, April 2015
2. Ding. Z, Perlaza. S. M, Esnaola. I and Poor. H. V,"Power Allocation Strategies in Energy Harvesting Wireless Cooperative Networks", IEEE Trans. Wireless Commun., Vol. 13, no. 2, pp. 846-860, Feb. 2014.

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3. Ding. Z, Poor .H. V ,"Cooperative Energy Harvesting Networks with Spatially Random Users", IEEE Signal Processing etters, Vol. 20, n0. 12, pp. 1211-1214, 2014.
4. Zhou. X, Zhang. R and Ho.C ,"Wireless Information and Power Transfer: Architecture Design and Rate-Energy Tradeoff" , Proc. IEEE GlobeCOM, pp. 3982-3987,2012.
5. Abdelhakim. M ,Ren. J, Li.T , "Reliable OFDM System Design under Hostile Multi-Tone Jamming", Proc. Globecom, pp. 4290-4295,2012.
6. Harjula. I, Pinola. J, Prokkola. J ,"Performance of IEEE 802.11 Based WLAN Devices under Various Jamming Signals", Proc. MILCOM, pp. 2129-2135, Nov. 2011.
7. Huang. K and Larsson. E. G, "Simultaneous Information and Power Transfer for Broadband Wireless Systems", IEEE Trans. Signal Process. , Vol. 61, no. 23, pp. 5972-5986, 2013.
8. Krikidis. I, Sasaki. S, Timotheou. S and Ding. Z, " A Low Complexity Antenna Switching for Joint Wireless Information and Energy Transfer in MIMO Relay Channels", IEEE Trans. Commun., Vol. 62, no. 5, pp.1577-1587, May 2014.
9. Ng. D. W.K, Lo. E. S and Schober. R ,"Energy-Efficient Resource Allocation in Multiuser OFDM Systems with Wireless Information and Power Transfer", Proc. IEEE ICC, pp. 4125-4130, 2013.
10. Shahriar. C, McGwier. R and Clancy. T. C,"Performance Impact of Pilot Tone Randomization to Mitigate OFDM Jamming Attacks", Proc. CCNC, Jan. 2013.