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Materials Today: Proceedings 3 (2016) 1242 – 1247

International Semiconductor Science and Technology Conference 2015 (ISSTC 2015)

Power allocation in orthogonal frequency-division multiplexing (OFDM) based two-way relaying with relay selection

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Abstract

In this paper, error performance analysis of relay selection in orthogonal frequency-division multiplexing (OFDM) based amplify-and-forward (AF) relaying two-way cooperative communication system is examined over frequency selective Nakagami-*m* fading channels with power allocation at source, relay and destination nodes. Furthermore, we allocated the power to the sub-channels at three terminals. Power allocation is done under the total power constraints based on scaling factor obtained by available channel knowledge of links between the nodes. It is shown that as relay selection can achieve full diversity and improves bit error rate (BER) performance, the power allocation can further improve the performance. Results show that BER performance of proposed system increases with the power allocation and it improves through higher value of fading parameter *m*.

Keywords: Amplify and Forward; Relaying; Relay Selection, Power allocation, OFDM; Two-Way

1. Introduction

One of the great achievements in wireless communication system is the use of multi antennas on transceivers which is known as Multi-Input Multi-Output (MIMO). The greatness of MIMO comes from the fact that it provides higher BER performance without extra power cost [1], however, MIMO cannot be applied to small devices. This inspired the development of a new system known as cooperative system (CS).

In cooperative system (CS), small devices act in cooperation to benefit one another [2]. In CS, communication between two terminals, source (S) and destination (D), is supported by another terminal-relay (R). The relay link is used to provide diversity in different time slots, hence the quality of service is improved. This type of CS is known as one-way (OW) relaying since any given time one terminal stays in silent. In Fig.1, a model for two-way (TW)

doi:10.1016/j.matpr.2016.03.066

cooperative system is provided with more than one relay. In TW, there are two phases as multiple access (MAC, 1st time slot) and broadcast phase (BC, 2nd time slot). In MAC, both U1 and U2 send their signals to relays. The selected relay, assuming relay selection is used, processes the signal and sends it back to the users. In TW, physical-layer network coding (PNC) [3] is used to overcome spectral loss due to half duplexing. Thanks to PNC, TW can provide full-duplex communication and each user can extract the transmitted message.

The types of signal processing in relay terminal are various and each one creates different protocol. The most common protocols are amplify-forward (AF) and decode-forward (DF). In DF based CS, the signal is decoded, re-encoded and sent to the destination. In AF, the relay amplifies the signal and retransmits. AF uses channels knowledge to calculate the best amplification factor. Depending on the condition, either AF or DF can be advantageous. This allows the designer to design a system which intelligently changes to the advantageous one which is named as adaptive relaying.

In TW or OW, there can be more than one relay. The studies show that as more relays are used, better performance is obtained [4]. But using the more relay can also be considered as a waste of resources when it is possible to achieve it by less relay. The introduction of relay selection (RS) realizes it. In RS, the best relay is selected instantly and used for relaying. The studies show that diversity order can be achieved by relay selection.

A great multiplexing technique in communication is orthogonal frequency division multiplexing (OFDM) [5]. In OFDM, provided channel is divided into many to create sub-channels. Due to narrowness of the sub-channels, the fading becomes flat. Furthermore, carriers are orthogonally located to the sub-channels; hence, the bandwidth is used more efficiently. The up-conversion or down-conversion to the sub-carriers can be achieved by the help of FFT (Fast Fourier Transform), thus, great complexity is reduced.

The allocation of resources has become very important field of study in the wireless communication. One of the resources is power. The power should be used effectively and it should be used at the right amount at the right place, known as power allocation (PA). The expected result of PA is to improve overall performance of the system. The studies show that, under the limited power constraint, the performance of the system can be optimally improved by distributing the total power [6] which tries to maximize the achievable sum-rate.

In this study, the power allocation is done for two-way communication based on OFDM. The total power is first allocated to three terminals (U1, U2, R) and then each terminal allocates the power to sub-channels optimally. Furthermore, we used Nakagami-*m* channel so that the system performance can be simulated under various fading environments.

The rest of the paper is organized as follows; section II gives the details of the system, section III has the simulation results and section IV is conclusion.

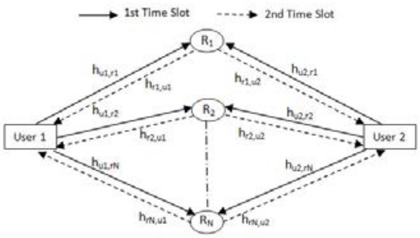

Fig.1 The system model

2. System model

Figure 1 depicts the two way relaying where two users intended to communicate. The communication is achieved through relay nodes since no direct link is available. It is assumed that all users or nodes have OFDM transceivers.