**BRIEF OF THE RESEARCH RESULTS**

Dissertation title: DESIGN AND ANALYZE THE PROTOCOLS TO ENHANCE THE PERFORMANCE OF THE TWO-WAY COOPERATION NETWORKS

Major : Electronic Engineering Major code: 9520203

PhD student : Dao Thi Thu Thuy Course: 2019-2022

Supervisor : Dr. Pham Ngoc Son

Campus : HCMC University of Technology and Education.

**Summary of theoretical and academic contribution of the dissertation**:

The dissertation studies and proposes three new models and protocols to enhance the performance of two-way cooperative networks in the conventional radio and the underlay cognitive radio environments. Additionally, the models considered under hypothetical conditions are more realistic than those in the previous works to be able to evaluate the system more comprehensively.

In the first model, the dissertation studies a two-way cooperative network consisting of two sources and a cluster of relay devices. To enhance performance, the dissertation proposes to employ a combination of the partial relay selection technique, the successive interference cancellation technique, and the digital network coding technique. Simultaneously, the model is analyzed under both ideal and real conditions of successive interference cancellation and channel state information. The results show that the system throughput is improved compared to the case where these techniques are not combined. Besides, the model achieves the maximum throughput at specific positions of the relay cluster by selecting suitable values of power coefficients for the two sources.

The next model is a two-way cooperative network in the underlay cognitive radio environment using a Reconfigurable Intelligent Surface (RIS). The model consists of two secondary sources that transmit signals to each other, operating in the full-duplex mode and under interference-limited conditions of a primary receiver cluster. The advantage of RIS compared to traditional relays is that the RIS requires almost no power when operating, no complicated hardware, so it saves energy, saves deployment and operating costs. Additionally, cognitive radio technique helps to improve spectrum efficiency. The model has been analyzed under the realistic condition that exists the residual loop-back interference in the receiving antenna of two secondary sources due to the full-duplex mode. The outage probabilities of two secondary sources are investigated and evaluated through network parameters. The results show that the system performance of the two-way network with the RIS-aided is better than the similar network with the AF relay-aided.

The third model studied is a two-way cooperative network capable of harvesting radio energy at the relay. The model considers nonlinear energy harvesting condition with the power splitting method. The research results show the existence of an optimal power allocation ratio for the system to achieve the minimum outage probability. This proposal’s contribution is to use the green energy from radio waves to improve the energy efficiency for low-cost and resource-constrained wireless networks.

In summary, three proposed models and protocols for the two-way cooperative network have enhanced the various performance criteria such as the outage probability, the throughput, the spectrum efficiency, the energy efficiency, and the cost efficiency. The performance evaluation criteria of the models and protocols are investigated through mathematical analysis and verified through Monte Carlo simulations. The mathematical expressions are expressed in exact, approximate, and asymptotic forms to help network planners and designers have an overview in the system evaluation and optimization. The proposed models of the dissertation can be used in IoT networks, heterogeneous networks, or wireless sensor networks.

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**Supervisor PhD student**