INFORMATION OF THE DOCTORAL THESIS

Thesis title: Cognitive Underlay Cooperative Communications: Performance Analysis and Performance improvement for secondary networks
Specialty: Telecommunications
Code: 62.52.02.08
PhD. Candidate: Nguyen Van Chinh
Scientific supervisors:
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THESIS CONTRIBUTION

This thesis studies the combination of cognitive radio and cooperative communications to confirm that the combination is necessary to improve the spectrum efficiency as well as the network quality of service (QoS). The thesis proposes cognitive cooperative protocols as basic model to develop more complex practical models. The thesis has shown that cooperative communication for cognitive networks can improve network performance in terms of low interference at primary receivers, better performance at primary networks, better spectral efficiency, and lower network complexity for secondary/primary networks. In particular, the thesis contributions are as follows:

Contribution #1: we proposed underlay cognitive AF relaying networks over Rayleigh fading channels. We have derived the network performance and shown that (1) the underlay networks with multiple relays will provide better performance than the direct communication network and the networks using MRC outperforms the networks using SC or non-combination networks. The simulation results shown that the proposed networks obtain full spatial diversity, i.e., the diversity order equals to the number of cooperative relays. As a result, the proposed network is a potential candidate for next generation networks as well as to reduce the communication cost in practice.

Contribution #2: we proposed cognitive underlay DF multihop relaying networks. In this contribution, we focus on solving the optimal problem of relay positions. The obtained results are valid for both low and high SNRs and confirm the advantage of the relay optimization location as compared with the randomized location method and the uniformly distance location method in the constraints of the given maximum allowable interference level and the maximum transmit power.

Contribution #3 we proposed space time block code Alamouti for cognitive underlay networks with one hop and multi hop. We, for the first time, proposed a new derivation approach to derive the system outage probability and system Shannon Capacity over Rayleigh fading. The numerical results have shown that Alamouti scheme for one and multi hop can significantly improve the performance of the cognitive underlay networks as compared with single input single output direct transmission for the same channel settings.

Contribution #4: we proposed adaptive modulation for cognitive underlay network and solved the optimal problem of the system spectral efficiency. The novel point of the problem is on the approach to derive the closed-form expression for the system outage probability, average bit error probability, spectral efficiency and probability of transmit modes. It is noted that the proposed approach is generalized, i.e., applicable for other fading channels such as Rician or Nakagami-m.

APPLICATIONS, PRACTICAL APPLICABILITY AND FURTHER STUDIES

The obtained results of the thesis have much scientific significance and application capabilities listed as follows:

- confirm that relaying is an enable technique to improve the system performance and the network coverage. The relay locations have significant impact on the performance optimization of secondary networks.
- to improve the secondary network performance, space time block code and adaptive modulation are effective techniques.

The obtained results and conclusions have great scientific significance and can be applied in proposed standards of cognitive radio networks for 5G wireless generation networks and beyond

Below are some further works:

- Study the performance of cognitive underlay AF networks over Rician and Nakagami-m fading channels. The optimal number of underlay relays should be investigated. Another direction is to examine the effect of multhop relaying on the network.
- Investigate the performance of cognitive underlay DF multihop relaying networks with the assumption that all relay nodes are not located randomly, not located on a line.
- Propose a derivation approach to obtain the closed form expression for outage probability of cognitive underlay networks with space time block code employing multi antennas at receiver side. The imperfect CSI of interference links on the secondary network performance should also be studied over fading channels such as Nakagami-m and Rician.
- Propose adaptive modulation for cognitive underlay cooperative MIMO system.

On the behalf of the scientific advisors **PhD. Candidate**

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