SHORT NOTES ON THE DISSERTATION

Title: **PERFORMANCE ANALYSIS OF COGNITIVE SPECTRUM-SHARING MULTI-HOP NETWORKS**

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Abstract:

The aim of the thesis is to develop a performance analysis for underlay based multi-hop CR networks. In particular:

- Reduce the secondary user's interference affection on the primary receiver,
- Improve the performance of the secondary system,
- Improve the secondary system's spectral efficiency .

The research's objectives:

1). The study focuses on the physical layer with performance parameters: Outage Probability (OP), Bit Error Probability (BEP), Ergodic Capacity (C) under different assumptions for fading channels: Rayleigh or Nakagami-m in both probabilistic models and Matlab simulation.

2). Performance analysis in changing of the number of hops, the relay and the primary receiver's positions. For a pre-determined position of a primary receiver, the problem of relay position

optimization is also considered and solved by using numerical approach.

3). Compare the proposed schemes with the direct one.

4). Study and apply the adaptive modulation in the secondary system.

Results and contributions of the dissertation:

The dissertation has achieved the research objectives under four proposed schemes:

1) Model 1: We deploy a performance analysis and study the optimal relay placement for cognitive spectrum-sharing dual-hop DF network over Nakagami-m channels. The closed-form expressions for the exact and approximated OP are derived showing that the system diversity is determined by the fading severity of secondary links. A solution for optimal relay placement is obtained, which significantly improves secondary network performance while adhering to the spectrum-sharing constraints.
2) Model 2: We have investigated the performance of cognitive regenerative multi-hop relay networks using the underlay approach. We have derived the closed-form expressions for the outage probability, BER, and ergodic capacity over i.n.d. Rayleigh fading channels. High SNR analysis for outage probability and bit error rate has been done to provide insights into system behaviors. The numerical results show that under the interference constraints inflicted by primary network, the multi-hop transmission still offers a considerable gain as compared to direct transmission and thus makes it an attractive proposition for cognitive networks. Besides, the optimal problem is also considered in terms of minimized OP or BER.
3) Model 3: We apply the adaptive modulation technique into the secondary dual-hop RPCN system in order to increase the achievable spectral efficiency. To reduce the hardware complexity, the AF is suggested to be used instead of DF. Under Rayleigh fading channels, we are able to derive the closed-form expression of the occurrence

probability, outage probability, bit error probability and achievable spectral efficiency of the system. Numerous simulations are performed to verify the analytic results showing that by applying adaptive modulation, the achievable spectral efficiency of the system is much improved.

4) Model 4: In all three previous models, the feedback channels are assumed to be perfect with no errors or delay. This last proposed model investigates the effect of imperfect feedback information to the primary user by using the interference probability. Besides, the performance of the cognitive DF relay networks is invested by the outage probability in the general Nakagami-m fading scenarios.

Practical applications and further developments:

Both the cognitive radio and the multi-hop technique play a crucial role in the 5G standard. The Ministry of Information and Communications of the Socialist Republic of Vietnam announced the route for digitalized television services and released some spectrum domains for 4G and the 802.22 standard's preservation. Besides, the BRAC is authorized for the 802.22 testing program. Therefore, the work of this dissertation is not antiquated. The dissertation with the achieved results shows much potential for further developments in actual applications as follows,

1). Study the application's MIMO technique in oder to improve the diversity and the performance of the secondary system.

2). Study different modulation techniques such as *M*-PSK or *M*-PAM instead of the *M*-QAM proposed in the dissertation.

3). Study the transmit power constraints limited by hardware.

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