A Thesis for the Degree of Ph.D. in Engineering

A Study on Hopping Based Control Channel Establishment for Dynamic Spectrum Access

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Thesis Abstract

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Thesis Title

A Study on Hopping Based Control Channel Establishment for Dynamic Spectrum Access

Thesis Summary

This dissertation provides a study on hopping based control channel establishment (CCE) for dynamic spectrum access (DSA). DSA technique was proposed to improve spectrum efficiency, where unlicensed secondary users (SUs) can utilize licensed spectrum without interfering licensed primary users (PUs) opportunistically. A pair of SUs wishing to communicate with each other needs to exchange control information using control links firstly in DSA networks. The procedure of CCE is referred to as a rendezvous process, plays a critical role in configuring a DSA network. CCE in a DSA network is a challenging problem. To cope with the problems of control channel saturation and channel blocking by PUs, channel hopping (CH) based rendezvous algorithms are commonly used for CCE in DSA networks. In CH based rendezvous algorithms, each SU generates its own CH sequence (CHS) according to the CH algorithms, and then accesses available channels according to the generated CHS sequentially. Control channels between SUs can be established on the channels that they access simultaneously.

The main contributions of this dissertation are summarized as follows. Firstly, a heterogeneous radios based rendezvous (HRR) algorithm is proposed to guarantee rendezvous within upper bounded time for the SUs in heterogeneous DSA networks. Then, a modified enhanced HRR (MEHRR) algorithm is proposed to achieve full rendezvous diversity for avoiding blocking PUs for a long time while increasing the successful probability of CCE. Finally, the performance in terms of rendezvous channel quality, channel loading, and optimal radio allocation manner is evaluated for the proposed algorithms.

Chapter 1 introduces the concept of DSA and the importance of the CCE for DSA firstly. Then, the advantages of the CH based CCE compared with other techniques and methods are described. Moreover, the scope and contributions of this dissertation are summarized while presenting the disadvantages of the conventional CH based algorithms.

Chapter 2 reviews some representative CH rendezvous algorithms firstly. Then, the pros and cons of the conventional CH based algorithms as well as the motivation of our proposed algorithms are presented.

Chapter 3 proposes the HRR algorithm. The HRR algorithm consists of the multi-radio based rendezvous (MRR) algorithm and the single radio based rendezvous (SRR) algorithm. The MRR algorithm and the SRR algorithm are utilized to generate CHSs for the SUs with multiple radios and the SUs with single radio, respectively. Theoretical analysis and simulation results verify that CCE can be

guaranteed among the SUs in heterogeneous DSA networks within upper bounded time using the HRR algorithm.

Chapter 4 proposes the MEHRR algorithm to achieve full rendezvous diversity for the SUs in heterogeneous DSA networks. Theoretical analysis and simulation results verify that CCE with full rendezvous diversity can be guaranteed among the SUs in heterogeneous DSA networks within upper bounded time using the MEHRR algorithm.

Chapter 5 evaluates the performance in terms of the rendezvous channel quality, the channel loading, and the optimal radio allocation manner for the proposed HRR algorithm and the MEHRR algorithm.

Finally, Chapter 6 concludes this dissertation while discussing the future work.