Dynamic Spectrum Access in Cognitive Radio Networks

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Abstract

The frequency spectrum is an essential resource of wireless communication. Special sections of the spectrum are used for military purposes, governments sell some frequency bands to broadcasting and mobile communication companies for commercial use, and others such ISM (Industrial, Science and Medical) bands are available for the public free of charge. The rapid development of wireless business leads to the spectrum scarcity which restricts the development of wireless communication technology in future. So, there has not been shortage of spectrum resources in the true sense, the phenomenon of resources shortage and low utilization exist at the same time.

The new Cognitive Radio (CR) approach comes with the feasible solution to spectrum scarcity. Secondary utilization of a licensed spectrum band can enhance the spectrum usage and introduce a reliable solution to its insufficiency. In such a cognitive radio network, secondary users can access the spectrum under the constraint that a minimum quality of service is ensured for the licensed primary users. As long as taking effective management manners and technical measures, those cognitive users are made to access the spectrum when they do not affect the main users, the tension phase of spectrum resources can be alleviated largely. Due to the static frequency allocation model lack of flexibility, it does not meet the need of electromagnetic spectrum management in the future. Hence, new technologies of frequency reuse must be developed in the time and space domain. Cognitive radio is put forward in this case as a spectrum resource sharing technology, its core function is to sense the electromagnetic environment, find the spectrum holes, and allocate the available frequencies to cognitive users dynamically without interfering with the premise users, which improves spectrum utilization effectively.

Moreover, a Dynamic Spectrum Access (DSA) is presented, which is the enabling technology for increasing the spectral efficiency of wireless communications. Based on that, Cognitive Radio (CR) can be developed as an enabling technology for supporting the DSA, which means that the wireless users are provided with enhanced capability for sensing the operating radio environment and for exploiting the network side information obtained from this sensing.

The illustration of the two types of Markov Chain which are discrete-time Markov chain (DTMC) and continuous time Markov chain (CTMC). Moreover, explanation the transition matrix, transition diagram and find the state probability distribution for each type. Additionally, definition of Markov chain is demonstrated and its applications which are very important in cognitive radio networks. The usage of Markov in Queuing model of dynamic spectrum allocation and the importance comes from providing better coverage and efficiency handover technique.

This thesis proposes a distributed channel selection algorithm for cognitive radio networks (CRN). The algorithm is dependent on reservation channels and does not require a common control channel. Both the dynamic states of the channels and the effects of insufficient spectrum sensing are considered in this algorithm.By deriving the optimal number of reservation channels, a good balance between the success probability of channel selection and minimal average channel switching times can be achieved. Simulation results show that the algorithm is highly adjustable and flexible to dynamic channels.

Furthermore, the other model is characterized by adding idle state, external reserved channel Q, primary node and three secondary nodes in the network, so one of the secondary nodes could occupy this external reserved channel. The mathematical analysis and simulation are shown for optimal number of reserved channels and the average number of channel switching in the two cases related to the distance away from the primary node.

The main purpose of channel reservation of dynamic spectrum access (DSA) is to access these idle channels intelligently which are specialized for primary users (PUS) to be used by unlicensed users temporarily, which are called secondary users (SUS) without causing critical interference to the licensed user`s activity. In this thesis, continuous-time Markov chain paradigm is improved via channel reservation to show the best usage of the radio spectrum bands, and the transition matrix are deduced for the proposed model. Moreover, the probability state vector is proved by performing steady state analysis.

The improvement of this model is caused by the external reserved channel in the network. The secondary user could occupy this channel and complete its demanded service when the primary user arrives suddenly. Therefore, the blocking and forced termination probabilities will be reduced for secondary users due to the existence of reserved channel. In addition, this insertion will increase the transmission quality of service for secondary users as it prevents interruption of service and makes them complete the demanded tasks.