The Frequency Spectrum Resource Management Technology in the Application of Cognitive Wireless Networks

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Abstract. Cognitive radio is considered to solve the problem of low utilization rate of spectrum scarcity and most promising a key technology, has a broad application prospect and research value. This article revolves the frequency spectrum resource management technology in wireless networks "the central issue of discussion, put forward the two dimensional spectrum allocation algorithm, the optimal transmission power control method and the new network architecture of collaborative aspects such as dynamic spectrum access, algorithms, mechanism, solves the spectrum of cognitive wireless network resource management problems of key technologies. There's a lot of work in these areas can continue to further expand.

Keywords: Multidimensional spectrum. Virtual cube. Non-cooperative game of power

1. Introduction

With these new technologies are emerging and the continuous expansion of new wireless applications, people have become increasingly demanding on daily transmission rate of wireless communications,the use of spectrum resources is also increasingly frequent,resulting in scarce spectrum resources become more and more tense, has become a bottleneck of restricting development of wireless communication. The radio spectrum is a finite, non-renewable natural resources,also a valuable strategic resource,which all countries have attached great importance to and cherish and take advantage of .After years of research and development of scientific scholars,cognitive radio technology has been recognized as one of the best ways to solve the problem of shortage of wireless spectrum.

2. Several spectrum management key technical of cognitive radio networks

2.1. Spectrum allocation of resources technology in cognitive radio network

For wireless systems, the concept of wireless resources is a very broad. It can be frequency, time and can also be a code word. No matter from which perspective, cognitive wireless networks are resource-constrained systems. However at the same time, the number of users of wireless networks is sustained growing.So how efficient and fair use of authorized to give main users radio resources to meet the growing needs of users, has become one of the key technologies of cognitive wireless network spectrum sharing.

2.1.1. Multidimensional spectrum allocation in cognitive radio networks

According to the definition of three-dimensional resource space, the author suggests the concept "virtual cube" to evaluate network performance. Based on existing network resource allocation technique,the concept of virtual cube defined cell structure, the cubic capacity, cubic, and cubic space and power and so on.Three dimensional resource space models are time, power / code word and rate.Time dimension describes the required time for transmission; Rate dimension describes the data transfer speed of network, different network capacity which has same link time but at different transmission speeds can be reflected by the dimension rate; power /code word dimension describes the required energy of information transmission, when using different modulation strategies, different encoding data to transport, the required network power is different, which can be reflected in the power / code word dimension.

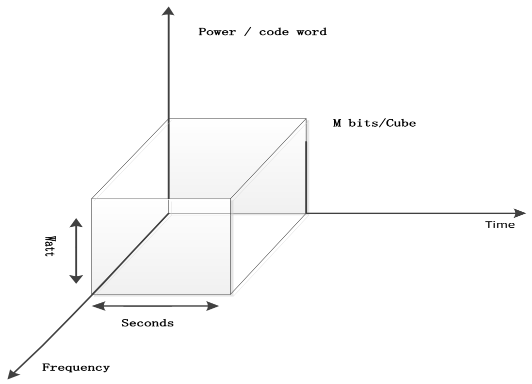

Figure 1 Multidimensional spectrum network

2.2 Transmit power control technology in cognitive wireless networks

2.2.1. Game theory and cognitive wireless network power control.

For cognitive radio network competition phenomenon, the main reason is the communicate quality of secondary users in the primary user, secondary user channel conditions, under the transmission rate requirements of secondary users and other constraints, compete for limited network resources.In this context, users will obtain and use transmit power by a variety of ways to maximize their income; meanwhile, other users will adopt a similar behavior.So from this point of speaking, users are essentially "selfish". Such competitive or confrontational behavior constitutes multi-user power game behavior in cognitive wireless network.

2.2.2. Cooperation transmit power control in cognitive wireless networks.

3. Non-cooperative game Power Control

In the non-cooperative game model, although users who participate in the game can form a final balance,and obtain a Nash equilibrium, however, due to selfishness and blindness of Game League, will lead to the solution is not only,that is there are multiple Nash equilibria. Therefore, power control can not guarantee optimal.

4. Cooperative Game Power Control

In the case of cooperation, the user to implement the transmission power control through centralized management. Thus, in this way, network users are more concerned about benefits of the entire system. the Nash bargaining approach is most representative model in cooperative game theory, Nash equilibrium solution was also called Nash bargaining solution, which is the only existing Pareto optimal solution .These advantages of Nash bargaining method has been widely used in the wireless network resource management.

5. Cognitive system spectrum allocation based on two-dimensional space

Network scenarios

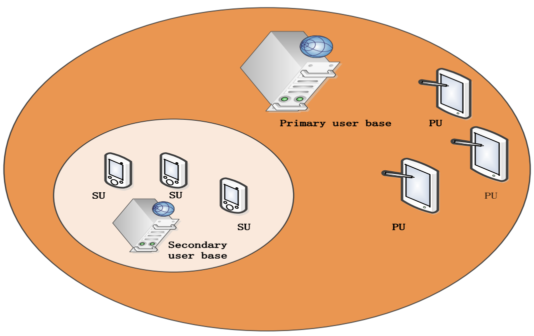

Figure 2 Centralized Cognitive OFDM network system

5.1. Flow model

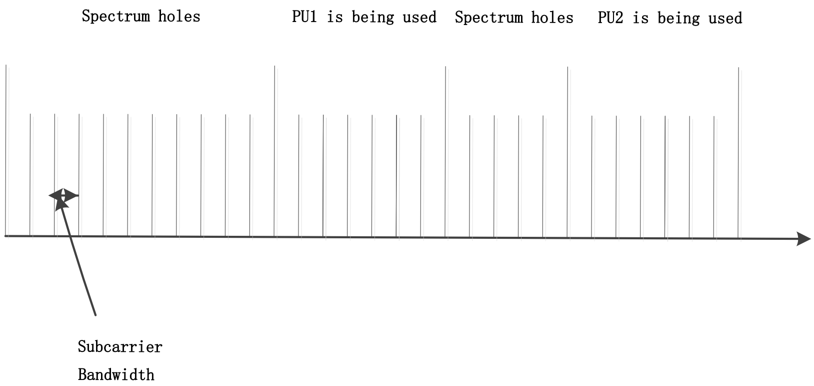

Figure 3 Occupancy of cognitive wireless networks based on OFDM subcarriers

H is defined as MxN matrix , hmn is instantaneous channel gain for secondary users m on subcarrier n . Rmn represents transfer rate that secondary users m on subcarrier n. Then the secondary user m total transfer rate Rm's calculation expression is:

$$R_m = \sum_{n=1}^{N} a_{m,n} \times r_{m,n}$$

$$= \sum_{n=1}^{N} a_{m,n} \times \Delta f \times \log_2 \left(1 + \frac{h_{m,n} p_{m,n}}{\Gamma I_{m,n}} \right)$$

5.2 Interference temperature model

Interference temperature is a quantifying and managing of interference sources model, similar to the noise temperature, Kelvin (K) as a unit,defined as the received power on the unit bandwidth. expression is:

$$IT(f_c, W) = \frac{P_1(f_c, W)}{kW}$$

To make the main users and secondary users "peaceful coexistence",should be met:

$$\frac{p_{m,n} + I_{m,n}}{k \times \Delta f} \le IT_{m,n}$$

6. Collaborative dynamic spectrum access control in cognitive wireless network

6.1. Transparent spectrum sharing

Cognitive wireless network is a special kind of heterogeneous wireless networks, cognitive radio technology can effectively improve the efficiency of spectrum use,and make secondary users dynamically use unlicensed spectrum in a dynamic spectrum access way. Provided that all acts of secondary users must be "transparent" to master user.As shown in Figure. This is because, in cognitive radio networks, users are divided into two levels, the high-level main user,has a high absolute priority for authorization spectrum ;low level for secondary users, only temporarily use of idle authorization spectrum.

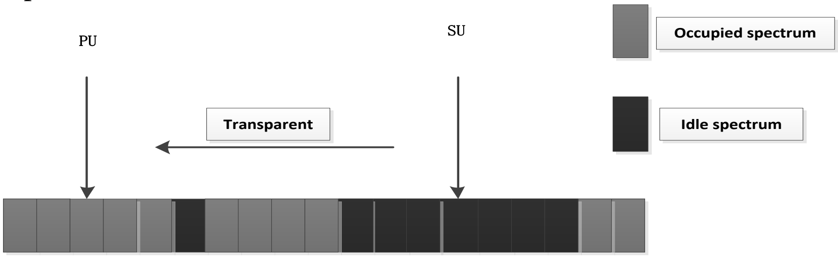

Figure 4 Authorized spectrum has the absolute high priority

6.2Cognitive wireless networks spectrum access model based on of Markov Chains

In this section,we use common Markov chain to study the existing access and switching process of primary users and secondary users in cognitive wireless networks.

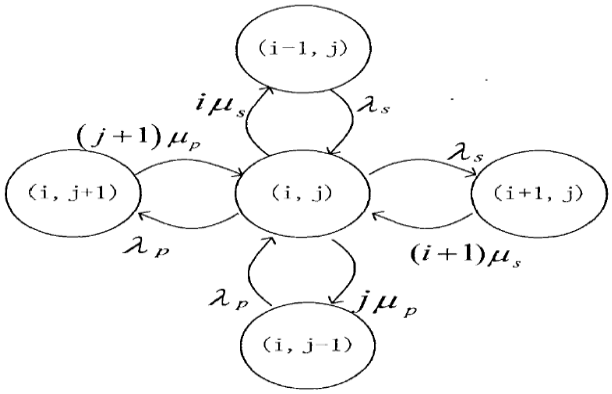

Figure 5 Markov chain

1, when a primary user arrives, the system status changes (i, j + 1);
2, when a main user leaves , the system status changes (i, j-1);
3, when a secondary user arrives , the system status changes (i + 1, j);
4, when a secondary user leaves, the system status changes (i-1, j).

7. Conclusion

Cognitive radio is considered as a key technology of the most promising to resolve wireless spectrum scarcity problem and underutilized problem, has broad application prospects and research value.This paper focuses on "spectrum resource management techniques in cognitive wireless network," the core issues discussed, proposes two-dimensional spectrum resource allocation algorithm, optimum transmission power control method, collaborative dynamic spectrum access and other aspects new network architecture, algorithms,,mechanisms,solves the existing problems of spectrum resource management key technologies in cognitive wireless network. There are a lot of work can continue to expand in depth in related fields .

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