Cognitive Wireless Network Dynamic Spectrum Allocation Technology Research and Implementation

Hao Wang

Changchun University of Science and Technology, Changchun 130022, China

35589435@163.com

Abstract. With the development of wireless communication technology and the people's growing demand for wireless spectrum resources, cognitive wireless network for cognitive users can include the way of capturing the user free frequency, radio is based on software radio platform of an intelligent wireless communication system, it is able to perceive the external environment, the use of understanding and the method of cumulative external environment study, in order to improve the spectrum utilization efficiency and use unique features such as flexible more and more attention, become an important development direction of wireless mobile communication network.

Keywords: Spectrum allocation. Network dynamic. Cognitive radio network.

1. Introduction

Cognitive radio is based primarily on the idea of software radio, is a new intelligent wireless communication technology with the purpose of spectrum sharing. It can perceive environmental characteristics of radio transmissions, have intelligent exchange by radio description Language and communication network, adjust the parameters of the radio system, make the wireless rules of the system meet optimal performance requirements for users. Radio is an intelligent wireless communication system built on software radio platform, it can sense the external environment, using the ways of understanding and accumulating for learning the external environment, and according to the incentives provided by external environment, allows to modify the corresponding the parameters (e.g. Transmission power, carrier frequency, modulation scheme, etc.), to achieve adaptive adjustment of the internal state. Its main purpose is to improve the reliability of wireless communication and more efficient use of radio spectrum resources.

2. Cognitive Wireless Network Dynamic Spectrum Allocation Model

Cognitive radio system network architecture is divided into centralized and distributed, sharing access methods are filled sharing and underlying sharing, the use of the spectrum are divided into exclusive and non-exclusive. In terms of the system spectrum distribution, the selection of distribution model and the design of allocation algorithm and the network architecture of system, shared access and spectrum usage are closely linked.

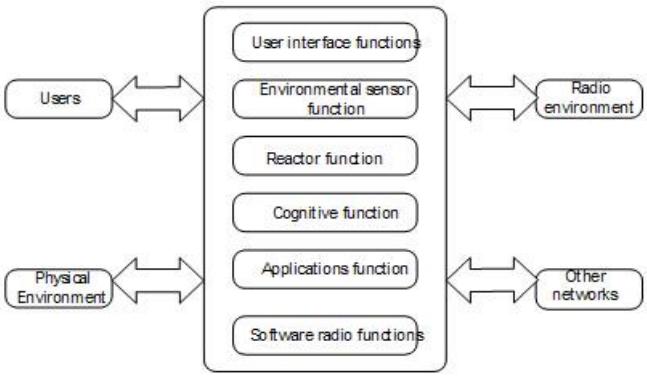

Figure 1 The function of the cognitive radio system diagram

2.1 Cognitive radio system model

The cognitive radio itself has a variety of definitions, conceptual model and network architecture. It takes into account the differences between the bottom two layers of hierarchy and common OSI (051) model. It also considered the wave sensing, spectrum sensing, network-aware, situation awareness, but not location-aware, locally available service awareness, the user needs perception, language perception. Overall, the cognitive radio is an intelligent wireless communication system, recent studies focused on the physical layer and media access control (MAC) layer.

2.2 Principles of spectrum allocation technique

Improving system performance spectrum allocation technique so as to having a reasonable distribution of the available the spectral space, to make the system performance improved or approximation to the optimal state. According to different application needs, requirements for cognitive system performance may be different.

To ensure flexibility.

Cognitive radio is able to detect the available spectrum resource, choose to borrow primary user spectrum to communicate. Therefore, the available spectrum information must be updated in real time, once the primary user to restore the use of certain spectrum space, cognitive users must exit the band in a relatively short period of time, select another band to communicate.

Reduce the signaling overhead and computation

The design of spectrum allocation algorithm undoubtedly requires a certain algorithm to transport and takes some computing time. These can be seen as overhead arising from allocation algorithm. We certainly hope to be able to spend less overhead to achieve spectrum allocation function, therefore, spectrum allocation algorithm design must take into account the complexity of control signal between users and users, users and central controller. One problem found in computation of the algorithm on users or central controller is to be considered.

2.3 Cognitive radio spectrum allocation model

1) 0-1 model

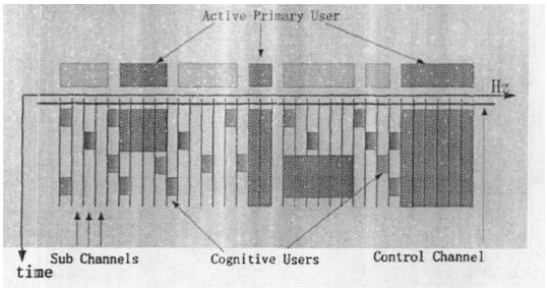

Figure 2 0-1 Spectrum allocation model

Interference temperature model

The concept of interference temperature is equivalent to the concept of noise temperature. It is a measure of the power of the interference and its corresponding bandwidth. Defined as follows:

$$T_1(f_c, B) = \frac{p_1(f_c, B)}{kB}$$

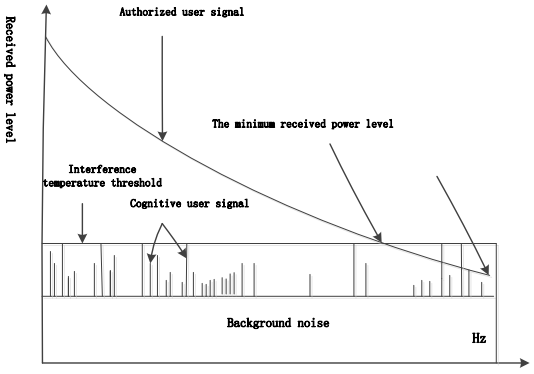

Figure 3 Interference temperature model

3. Cognitive wireless network dynamic spectrum allocation algorithm

3.1 Dynamic channel allocation algorithm based on the center

Literature uses a distributed network architecture, proposes a distributed greedy algorithm based on graph coloring model. Model network spectrum allocation into an infinite map G = {V, C, L}, spectrum allocation matrix is A, the definition of V, C, L,A is same to section 3.2.2. The objective of the model allocation of resources is to maximize the entire system bandwidth (spectrum) utility. The objective function is expressed as:

$$\max_{A\in\wedge N,M}\sum_{n=0}^{N-1}\sum_{m=0}^{M-1}a_{n,m}$$

$$S.T:a_{n,m}\le l_{n,m},0\le n,k\le N-1,0\le m\le M-1$$

$$a_{n,m}*a_{k,m}*c_{n,k}=0$$

3.2 Coordinated to maximize total system bandwidth (CMSB) algorithm

Literature proposes a coordinated to maximize the total bandwidth (CMSB) algorithm. The algorithm based on different sub-channels effectiveness as well as the interference of neighbors SU', maximize the coordinated total bandwidth. The objective function is:

$$\max_{A\in N,M}\sum_{n=0}^{N-1}\sum_{m=0}^{M-1}a_{n,m}*b_{n,m}$$

3.3 The dynamic channel allocation algorithm design based on potential game theory

Literature suggests spectrum allocation algorithm based on potential game theory, uses a function uZ as its own utility function. Among them, the calculation value of the interference needs related data. Interference information exchanged depends more on the respective common control channel. This section will make specific description on the background of the proposed algorithm and assumptions. UZ specifically expressed as follows:

$$U2_i(s_i,s_{-i})=-\sum_{j\neq i,\,j=1}^{N}p_jG_{ij}f(s_j,s_i)-\sum_{j\neq i,\,j=1}^{N}p_jG_{ij}f(s_i,s_j),\forall i=1,2,3...N$$

4. Dynamic spectrum allocation model and algorithm based on licensed spectrum utilization

4.1 Channel characteristics

In this paper, a channel is based on spectrum sharing strategy, combing spectrum which are sensed by each cognitive node into a common spectrum pool, dividing spectrum pool into several sub-channel, considering a sub-channel as the basic unit of spectrum allocation. Here spectrum is equivalent to channel.

4.2 Node features

(l), each node i has a unique identifier UID.A node corresponds to a secondary user.

, every node knows all authorized spectrum utilization time, p={p1,p2…pM },M is known. p1 is determined by the statistics, reflect busy degree of a spectrum in a certain day .

4.3 Model construction

When the model structure, on the one hand considering the spectrum time utilization, controlling primary user seizure for spectrum while secondary users are communicating, and achieving diverse bandwidth spectrum decisions. On the other hand, considering the effect of the size of the minimum coverage set to delay. Delay here, includes broadcast delay, switching delay and the same frequency back off delay. In the modeling process, SDUTR algorithm controls and predict the monthly main user activity by introducing parameters, so as to avoid spectral switch. The lower the licensed spectrum time utilization, the more associated neighbor nodes, the higher the spectrum availability for cognitive users. The higher the licensed spectrum time utilization, the less associated neighbor nodes, the lower the spectrum availability for cognitive users.

5. Conclusion

With the development of wireless communication technology and people's growing demand for radio spectrum resources, cognitive wireless network can access the primary user's idle band through choosing because cognitive user, to improve the spectrum utilization efficiency and the unique flexible using characteristics, and get more attention. It will become an important direction of development of wireless mobile communication network.

References

[1] Chad English,Adam Deslauriers,Iain Christie.The complementary nature of triangulation and ladar technologies. Proceedings of SPIE.Laser Radar Technology and Applications X, 2005, 5791: 27-41.

[2] Chad English,Adam Deslauriers,Iain Christie.The complementary nature of triangulation and ladar technologies. Proceedings of SPIE. Laser Radar Technology and Applications X, 2005, 5791: 27-41.

[3] KOTA K, CAVALLARO J R. Numerical accuracy and hardware tradeoffs for CORDIC arithmetic forspecial-purpose processors. IEEE Transactions on Computers, 1993, 42(7): 769-779.