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# Study on Allocation Scheme for Dynamic Cognitive User based on the Spectrum Allocation of the Internet of Things

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**Abstract:** In order to improve the effective utilization of the spectrum between the network and users, this paper proposed the allocation scheme for dynamic cognitive user based on the spectrum allocation of the Internet of things. Based on the advantage of the network performance framework of spectrum of the internet of things, this paper analyzed the dynamic network user model of the spectrum, established a good resource hierarchical distributed management structure, provided support for the resource sharing and coordination between multiple heterogeneous network; then gave the spectrum of the network resource allocation algorithm of things. Finally, the simulation experiment performance comparison for the new spectrum network and traditional network model was made. The results showed that the new spectrum resource allocation scheme of things was significantly better than the traditional cooperative sensing detection performance in the right perception of cognitive network cooperation performance, which can improve perception of network nodes, with network throughput and stability.

**Keywords:** The Internet of Things; Dynamic; Weights; Dynamic Cognitive User

## 1. Introduction

The raise of the Internet of things not only expand the deployment range of terminal equipment and category of terminal equipment of users, but also expand the application scene and functional location. They connect each other through Internet, radio and television network, fixed communication network, mobile communication network and other information and communication networks and the organization form is various. This is bound to make application scene, terminal isomerism and network isomerism and others become more complex.

In order to support different network business users, the wireless communications technology evolution to form a pattern of multiple heterogeneous wireless communication network access technologies coexist. In recent years, people began to focus on the research of systematic integration to achieve different wireless spectrum network access technologies complement each other, to achieve optimal resource utilization efficiency, to provide the best service experience seamless for users and operators to bring a wealth of benefits, to achieve the integration of heterogeneous overall perspective from the end-to-end. Of which, more striking is the spectrum resource users use the Internet of things [1-3]. Cognitive wireless network using dynamic spectrum allocation technique to fully tap the spectrum holes, take the rational use of the differences in the spectrum needs of different networks at different times and spaces of resistance, thus improving spectrum efficiency, ease the contradiction spectrum resource shortages and waste. Cognitive technologies and the introduction of end-to-end reconfigurable technology makes terminal and base station can dynamically configure their operating frequencies; the device can be realized laid the foundation for dynamic spectrum allocation, so that it becomes possible application of the actual network.

The network cooperation mode of the spectrum sharing between all levels of users is also collaboration, but at an early stage. Back in the early, Zeng Yu, Yang Lan et al have been raised labeling mechanism network, which can be used to distinguish the user's level of cognitive wireless networks in 2003. The proposed of this program making part of the network has been improved [4-7]. Then He Can proposed a new algorithm for local bargaining in 2007, which obviously reduced and improved the complexity of the system [8-9]. Although these methods have made some progress, these methods are based on collaborative way to share information between neighboring frequent exchange of users; it needs a common link coordinate system, increasing the complexity of the system, increasing the network operator's consumer marketing expenses, which are not applicable for wireless sensor networks.

The core idea of cognitive radio is to achieve functional software processing of communications equipment, as implemented by software communication function communication devices, and its ultimate goal is to be able to get rid of the shackles of traditional hardware structure and function of the device is achieved through software communications, thus making the functionality of the device can not only simple and convenient way to complete the upgrade and change, and be able to complete interconnection between different systems compatible [10-11]. Cognitive radio technology will continuously cognitive various information from the external environment (such as the operating frequency of authorized user terminals and the cognitive radio terminal, modulation scheme, the noise ratio of receiver signal, the distribution of network traffic, behavior and talk of the cognitive users) to analyzed, learn and make judgment to these information. Then it can describe language radio station through knowledge, and intelligent exchanges with other cognitive radio terminals in order to select the appropriate operating frequency, modulation force a style, transmit power, and routing the media access protocol to ensure that the whole network can always provide reliable communication, which can achieve the best spectral efficiency.

Spectrum detection technology is one of the key technologies of cognitive radio networks, which aims to find and make use of idle spectrum, which requires various access networks have the ability to capture information for spectrum use and find empty spectrum. Spectrum detection technology requires cognitive user can take the aware and frequency analysis of a specific region that can quickly identify spectral holes suitable for wireless communication, then the specific processing techniques carried out in the existing communication system without affecting the premise. Thus, cognitive radio networks when the user perception of secondary bands in the access authorization, in order not to cause interference of the authorization system, timeliness and reliability of the spectrum detection will directly affect the spectrum of cognitive users authorized to use. So this paper proposed a framework for the dynamic allocation of cognitive user and application networking spectrum allocation based implementation to improve the operating speed of the network, with network throughput, stability, reducing the operator's cost.

## 2. The Advantage of Network Performance Structure of Spectrum of the Internet of Things

In order to achieve the efficient use of spectrum resources, the integration of heterogeneous networks and dynamic spectrum allocation in cognitive radio networks showing some different new requirements from the past traditional network, which may require in the performance of the new network spectrum the Internet of things to do better resource sharing and coordination for more heterogeneous network users, dynamic allocation of spectrum resources to the co-presence condition, which is not available in the traditional network implementations. The new type of dynamic the Internet of Things cognitive radio network framework diagram designed was shown in Figure 1. The architecture management functions include three parts: policy language, abstract behavior, develop protocols and interface features.

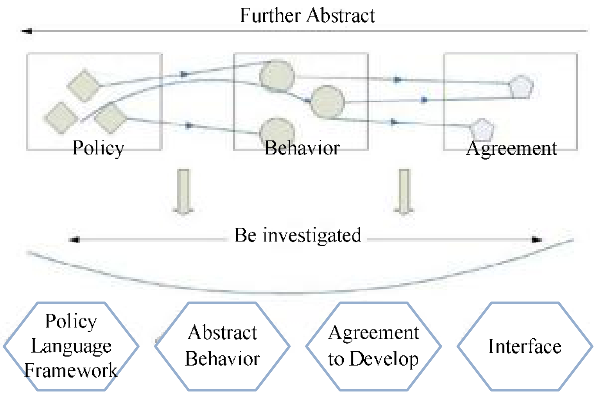


**Figure 1. Spectrum architecture of the Internet of things**

As to the architecture performance of the spectrum of the Internet of things, the authorization systems of large area coverage, such as radio and television system frequency spectrum detection, divide management domains within the authorization system coverage. The detected result of the behavior of the frequency spectrum of authorized user in each management domain in the same period is same, but the detection time for different management domains are not necessarily synchronized, once submitted to the same cycle frequency management region adjacent the latent demand for the same band, it needs a resource coordination between the management domain to avoid interference. The same applies to the case of unauthorized sharing of the spectrum band. Conversely, as to the smaller coverage area network band spectrum detection, when the division of the management domain is large enough, the detected result of the behavior of the authorized user in adjacent management domain in general is different. At this time, it does not need to coordinate between the areas to avoided inter-regional interference. As shown in Figure 2.

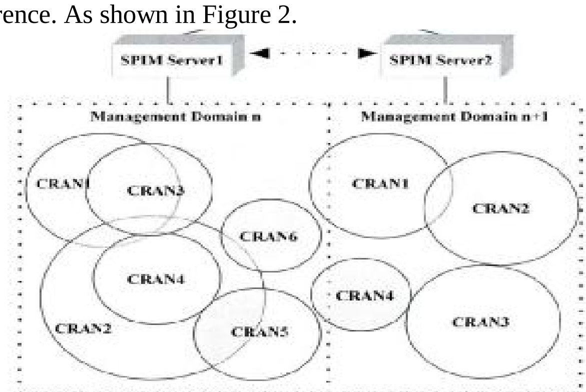

**Figure 2. Allocation scheme of spectrum space of the Internet of things**

## 3. Spectrum Allocation Model for the Internet of Things

In the functional structure of the frame in the spectrum the Internet of things, the dynamic spectrum cognitive allocation is the essential part, the network functional model spectrum cognitive users with centralized distribution was shown in Figure 3. The model can cover multiple heterogeneous structure of overlapping networks.

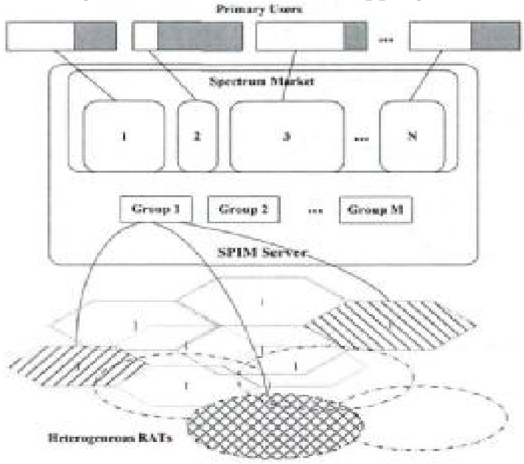


**Figure 3. Schematic of spectrum network model**

From Figure 3, we can see that the spectrum of the network used in the stock market, in such a market, the model assumes that there is x spectrum of products with differences, their bandwidth was $l_{x,y}$ respectively, the price is $q^d_{i.allowed}$. Secondary buyer composed of M buying groups, where $i = 1......x$ and $m = 1......xm$. The number of individual buyer of each group was denoted $q_m$. It can fully reflect that the shared network distribution of the spectrum of the Internet of things is superior to the traditional network model.

## 4. Network Algorithm of Spectrum Perception based on the Cooperation of the Internet of Things

In the spectrum of network-aware the Internet of things cooperation, the primary user and the main base constitute the main user network, sub-station as a fusion center constitute the cognitive user network with the cognitive users, which requires the spectrum of network-aware system must met with two conditions. One is the information sharing between the K sub-station, base station can achieve that by wired high-speed transmission, which does not take the radio resources; Second u base stations take some spectral analysis of the network together. This can obtain the following N sample data matrix composed of a $u \times m$ base station, as represented by the formula (1):

$$U = \begin{bmatrix} u_{10} & u_{11} & \cdots & u_{1n} \\ u_{20} & u_{21} & \cdots & u_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ u_{m1} & u_{m2} & \cdots & u_{mn} \end{bmatrix} \quad (1)$$

The cognitive cooperation of spectrum network method above was in a multi-user environment. While the network algorithm of perception of the spectrum, through the use of asymptotic random matrix maximum spectral distribution characteristics under small sample values and convergence features to improve the performance of their perception, the steps are:

(1) The spectrum cognitive signal of the Internet of things was sampled to obtain a matrix y and calculate:

$$y = \sum_{k=1}^{N} b_k y_k \quad (2)$$

(2) Calculate the R (N) of the maximum and minimum feature $\sum_{k=1}^{N} b_k$ and $y = \{y_k\}_{k=1}^{N}$;

(3) Calculate judging threshold $o$ according to the following formula

$$o = \sqrt{\sum_{i=0}^{n-1} i^1.b_i / \sum_{i=0}^{n-1} b_i} \quad (3)$$

(4) Make the judgment based on the following rules:

$$u^e_{x,y} = \begin{cases} 1, & t^e_{x,y} \neq 0 \\ r\dfrac{e_{x,y}}{\sum_{x=1} u_{x,y}}, & t^e_{x,y} = 0 \end{cases} \quad (4)$$

$$l^{e'}_{x,l} = \begin{cases} 0, & (random\_num \mathbf{f}\ b) \cap (l^{e'}_{x,l}) \times (h_{x,y}) = \max\limits_{e \in q^d_{i,allowed}} \{(l^{e'}_{x,l}) \times (h_{x,y})\} \\ 1, & (random\_num \mathbf{f}\ b) \cap (l^{e'}_{x,l}) \times (h_{x,y}) = \max\limits_{e \in q^d_{i,allowed}} \{(l^{e'}_{x,l}) \times (h_{x,y})\} \end{cases}$$

(5)

The algorithm changed the shortcomings of the traditional algorithm that can only work in a large sample which cannot change noise information. It achieved detect of the spectrum without noise information based on small samples. The performance is better than similar traditional detection algorithm, and reduces the threat of malicious tampering sensing data by feature calculated for a single node, which can stay with network security.

## 5. Simulation

Taking the number of network users N = 3, take a different node by 3 cognitive user SNR values. The performance simulation tests carried out for single-node user on the perception average cooperative network sharing scheme.

Figure 4 showed each network user's perception toward the detection performance network solutions in a non-fading environment. From three different curves toward in Figure 4, it is easy to see that the curve a indicates the perception of weights based on cooperation, curve b represents the single node perception, curve c represents the common perception of cooperation. As can be seen from Figure 4, the perception of traditional cooperation is often less than the accuracy of a single node in the perception of high SNR conditions when the signal of noise ratio is not the same for each user. While perceived accuracy is greatly improved by using the cooperative sensing method of weighted spectral with the Internet of things.

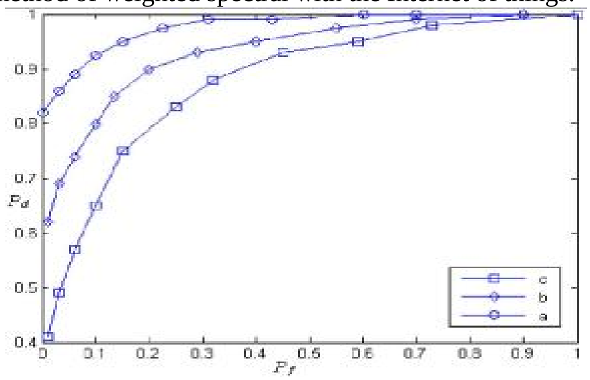


**Figure 4. The Perceptual Comparison based on the Weights of the Internet of Things**

In Figure 4, curve a and b represent the weight of the co-sensing detector under the cases that number of cognitive users N = 0.8, N = 0.6, the curve c, and d denote the general perception of the average co-testing that the cases that the number of cognitive users N = 0.8, N under = 0.6. Statistical results show that spectrum detection performance is superior to the ordinary average cooperation detection under the same number of cognitive users. As to the weighted cooperative sensing methods, the cognitive performance will be increased with the increase of users.

In Figure 5, curves a and b denote the cooperative spectrum sensing based on power detection value under the cases that number of cognitive users N = 0.8, N = 0.4. The curves c and d denote that the general perception of the average detection was similar with non-fading environment under the cases that the number of users of cognitive N = 0.8, N = 0.4. Under the same number of cognitive users, the cognitive cooperation accuracy of spectrum of the Internet of things based on weights is better than ordinary perception overall. As to the value of cognitive cooperation of the spectrum network based on the weights, the accuracy rate will be perceived as the number of users of cognitive increases.

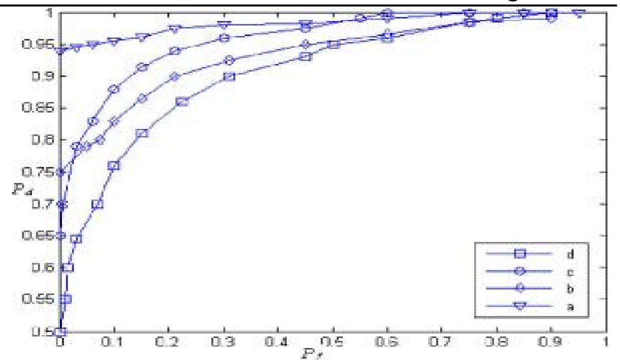


**Figure 4. Performance compares of two networks**

Through the above two sets of experimental data in Figure 4 Figure 5, we can see that, in the non-fading channel fading environment, cognitive testing network performance of the new spectrum of the Internet of things was obviously superior to the traditional perception of cognitive networks of cooperation for weighted cooperative sensing detection. Also detection performance will improved with the cognitive user's data increase. It changed the results that traditional perceptions of a single-node network performance vulnerable to environmental fading, which can achieve the rate of cognitive users of network spectrum with stable accuracy, reduce the cost of operating characteristics.

## 6. Conclusion

Due to the data tampering, easy to be attacked and other defects of cognitive data security of traditional network user, this paper proposed a dynamic cognitive user model of the spectrum of the Internet of things. Through the design of framework of network spectrum and analysis of advantages of modeling algorithm, it provided the spectrum algorithm for the spectrum network model. Finally, simulation experiment was carried out for cognitive testing of the network spectrum. The results showed that the model can improve perceived performance under the environmental with decline of the signal to noise than the traditional Internet users cognitive testing. It was less susceptible to tampering spectrum attacks about network-aware data. The perceived performance was significantly better than the traditional one. For how to reduce the attacker perceived data network performance by tampering should be the further study and solve.

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