Dynamic Frequency Selection method applying Mobile Security concept

JOOSEOK KIM, KYUNGSEOK KIM
School Electrical and Computer Eng.
Chungbuk National Univ.
12 Gaeshin-dong Heungduk-gu Chongju Chungbuk 361-763
KOREA

Abstract: - As a wireless technique advances, the frequency tapping danger grows bigger and the frequency security is required more. Dynamic frequency selection(DFS) technique has the strength in frequency security because it uses variable frequency. In this paper, we investigate DFS technique in IEEE 802.22 WRAN environment of Cognitive radio(CR) foundation for the security. To use frequency more efficiently, we propose some DFS techniques for variable bandwidth, limitation of candidate set and verify these through the result of the simulations.

Key-Words: - Mobile security, Cognitive radio, Dynamic frequency selection

1 Introduction

A wireless communication technique can communicate conveniently by frequency in anywhere and anytime, but the frequency tapping danger grows bigger and the frequency security is required more. DFS(dynamic frequency selection) is one of the techniques which is belonging to CR(cognitive radio). This CR can make a reliable communication by recognizing around environment in anywhere and anytime and is to use effectively a spectrum. FCC(Federal Communications Commission) proposed the CR technique that comes into notice recently to solve a shortage problem of the frequency [1]~[3].

IEEE 802.22 Standardization Group is made to develop a wireless communication system standard and fulfill actively standardization [4].

In addition, DFS has the strength at the security. The communication using a channel can be exposed. However, DFS doesn't have probability of exposure because of changing channels frequently. It is because frequency is changed again in spite of being tapped at any moment.

This paper proposes the efficient DFS algorithm which allocates bandwidth variably, for IEEE 802.22 WRAN environment applied the Mobile Security concept, and applies a method limiting candidate set. The proposed method is also analyzed at CR mobile environment with mobility. These simulations measured DFS algorithm performance as changed the possession rate of the primary user which have the priority about frequency.

2 Mobile Security environments

We investigate DFS technique which uses frequency to be changed at any time, to prevent the tapping in IEEE 802.22 environments. A merit of DFS technique is the strength at the security as well to use frequency efficiently. In this chapter, we introduce IEEE 802.22 WRAN environments for applying a frequency allocation method and DFS technique for the Mobile Security concept.

2.1 IEEE 802.22 WRAN environments

The target of applying IEEE 802.22 is the outer cities of the USA and Canada or developing nations and provides wireless communication service through using the Cognitive Radio system in the TV band.

IEEE 802.22 has many merits. One of the merits is a lower cost than established cellular wireless communication system. But, there are some considerable items to materialize base station (BS) for cognitive radio: a additional complexity, a size problem of a receiving antenna in case of using VHF band and Quality of Service (QoS) by using common frequency.

In physical layer requirement of IEEE 802.22 WRAN, a service covers 33~100Km and a frequency band uses in VHF/UHF band, previous TV band [5]. TV band is different in each country. (ex. 6,7,8 MHz) I decided 6MHz in this paper.

2.2 Dynamic frequency selection for Mobile Security concept

CR is a technology which detects empty frequency and doesn't interfere existing users in the frequency and can use with a next generation wireless mobile communication technology which have been studied currently.

CR technique has spectrum sensing, dynamic frequency selection and power control, but we assume that spectrum sensing and power control are perfect and studied DFS in algorithm in this paper.
DFS provides users with empty frequency band detected continuously. It allocate frequency band providing QoS(Quality of Service) basing on a factor which is user's electric wave reception sensitivity situation and data requirement amount. We marked the example about DFS at the Fig. 1. Frequency allocated by DFS at changes any time according to an existence yes or no of a primary user, but has been provided constantly to a time prize. In addition, although frequency of the one any bandwidth is becoming the tapping, the leakage of the information is extremely small because of Frequency to be changed at any time.

Fig. 1 Dynamic Frequency Selection

A primary target of DFS is to provide users with frequency constantly and to make best frequency use efficiency. So it has to divide and manage to the condition of the best.
In this paper, two kind subjects in DFS algorithm of CR foundation to be proposed will be studied: Variable Bandwidth, which accommodates more users; The limit of a channel candidate set number, which can make processing time of system fast.

3 Efficient DFS algorithm for Mobile Security concept

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3.1 Variable Bandwidth application

Variable Bandwidth is method that is using frequency of more than user in limited frequency space. A modern wireless communication mobile receives various services on same bandwidth. For example, when it provides a communication or receives a multimedia service by a cellular phone, it uses the previous same bandwidth. But the bandwidth is much bigger than that of the normal communication since it has to replay the multimedia. So, if it applies DSA, the rest space can empty the frequency for other CR mobiles. I assume the bandwidth size is decided at own mobile since a cellular user chooses a kind of the service.

3.2 The limit of a channel candidate set number

A candidate set is an empty channel which CR devices or primary users don't use. DFS have to manage candidate sets efficiently.
If CR devices demand frequency, DFS assigns suitable frequency of candidate sets to CR devices. In conventional algorithm, DFS searches all of empty frequency. At this situation, frequency change can take long.
In this paper's algorithm, DFS limits the number of the candidate set and shortens a change frequency time. Frequency not to be used for a while has the priority rank.

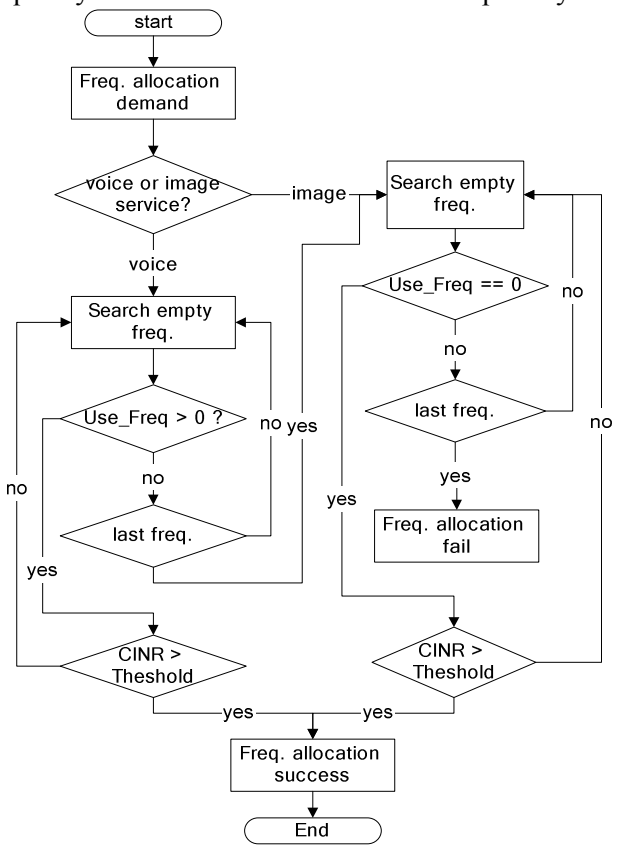

Fig. 2 flow chart of DFS algorithm proposed

The flow chart of DFS algorithm proposed is Fig. 2. If a frequency allocation demand is a voice service, DFS searches empty frequency and checks whether Use_Freq is 0 or not. Use_Freq is a variable which stores a number of 1MHz frequency bandwidth used per 6MHz frequency bandwidth. If Use_Freq is 0, the frequency is empty and if Use_Freq is 6, all of the frequency are using. So DFS searches frequency which is lesser than 5.
If a frequency allocation demand is a image service, DFS searches frequency which is 6.
Finally, this algorithm measures CNIR(Carrier to Noise and Interference Ratio) when the Ues_Freq condition is suitable. The expression to rescue generally the CNIR is as follows[6]:

$$CNIR = \frac{Carrier\ Power}{Noise + \sum Interference\ Power} \quad (1)$$

This algorithm applies Pass Loss – Hata model[7].

$$L_P = -K_1 - K_2 \log(f) + 13.82\log(h_b) + a(h_m) - [44.9 - 6.55\log(h_b)]\log(d) - K_0 \quad (2)$$

This utility object of IEEE 802.22 is the outside of the city of America or Canada, so the fading influence is not relatively sufficient. We skipped consequently a fading environment.
This algorithm checks afterwards the mobility and primary user. If the position of CR devices is more than cell coverage or primary users occur, CR devices have to request frequency again.

4 Simulations

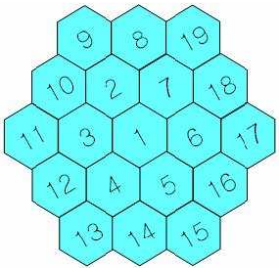

Fig. 3 Multi-cell to support the IEEE 802.22 environment

The DFS algorithm to be proposed arranged the cells of 19 totals like the Fig. 3 and set one cell radius to the 33km. This algorithm used the frequency range from 54 to 354 MHz in Requirements of IEEE 802.22 WRAN PHY. It assigned 1MHz to voice service and 2MHz to movie service for Variable Bandwidth method to be proposed. It applied random speed between minimum 0 km/h(fixing) and maximum 120 km/h.
Limit number of candidate set is 20. This value does not appear greatly with the conventional method in the performance difference and this method's processing speed is faster than conventional method.

Table 1 Parameter

Item	Value
The total number of cells	19
A range of a cell	33km
Frequency range	54 ~ 354 MHz (VHF/UHF TV Bands)
User number per a cell	100
Allocation bandwidth	1 (voice), 6 (image)MHz
Limit number of candidate set	20

This algorithm uses as table 2 for measuring CNIR of empty frequency and verifies the performance of various environment in the simulation because required SNR is different according to the modulation type and code rate[8].

Table 2 Modulation Coding Set

Modulation	Code rate	bps/Hz	Required SNR (dB)
QPSK	1/2	1	6
QPSK	3/4	1.5	10.5
16QAM	1/2	2	13.2
16QAM	3/4	3	19

4.1 The result according to Variable Bandwidth

The first results Fig. 4 are the graphs of the time which the bandwidth is the variable or fixed. The voice service rate of the variable bandwidth is 50%. The horizontal axis is the simulation time and the vertical axis is the frequency allocation fail rate. In the graphs, we can know that the performance of using the variable bandwidth is better than fixed bandwidth. The reason is that the maximum number of CR devices assigned is six one by one MHz per one channel when the bandwidth is allocated variably.
The four directions are a result measuring as change the modulation type and code rate. The performance of QPSK is better than 16QAM and code rate 1/2 is better than 3/4, because required SNR of QPSK and code rate 1/2 is lower. CR devices can use more frequency when required SNR is low.

4.2 The result according to limit of candidate set number

Fig. 5 is the result according to mobility and limit of candidate set number and measured as change the code rate when the modulation type is QPSK.

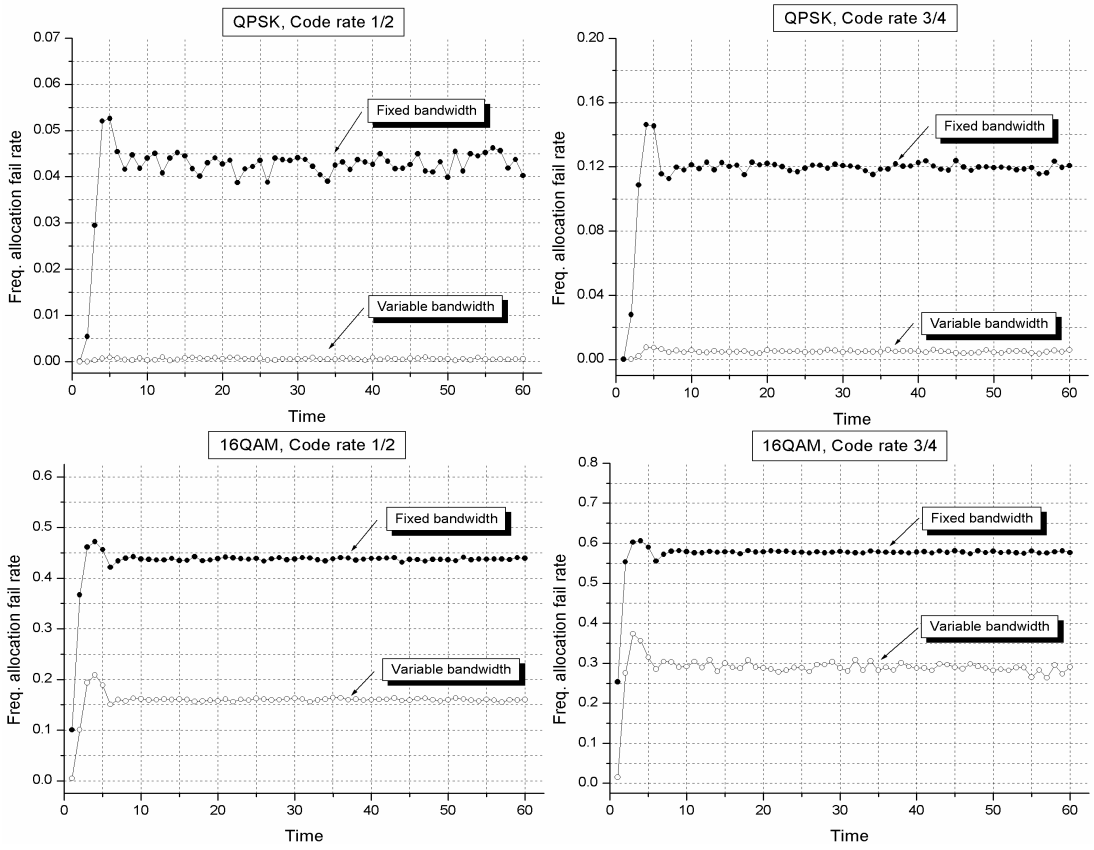

Figure 4. The result according to Variable Bandwidth

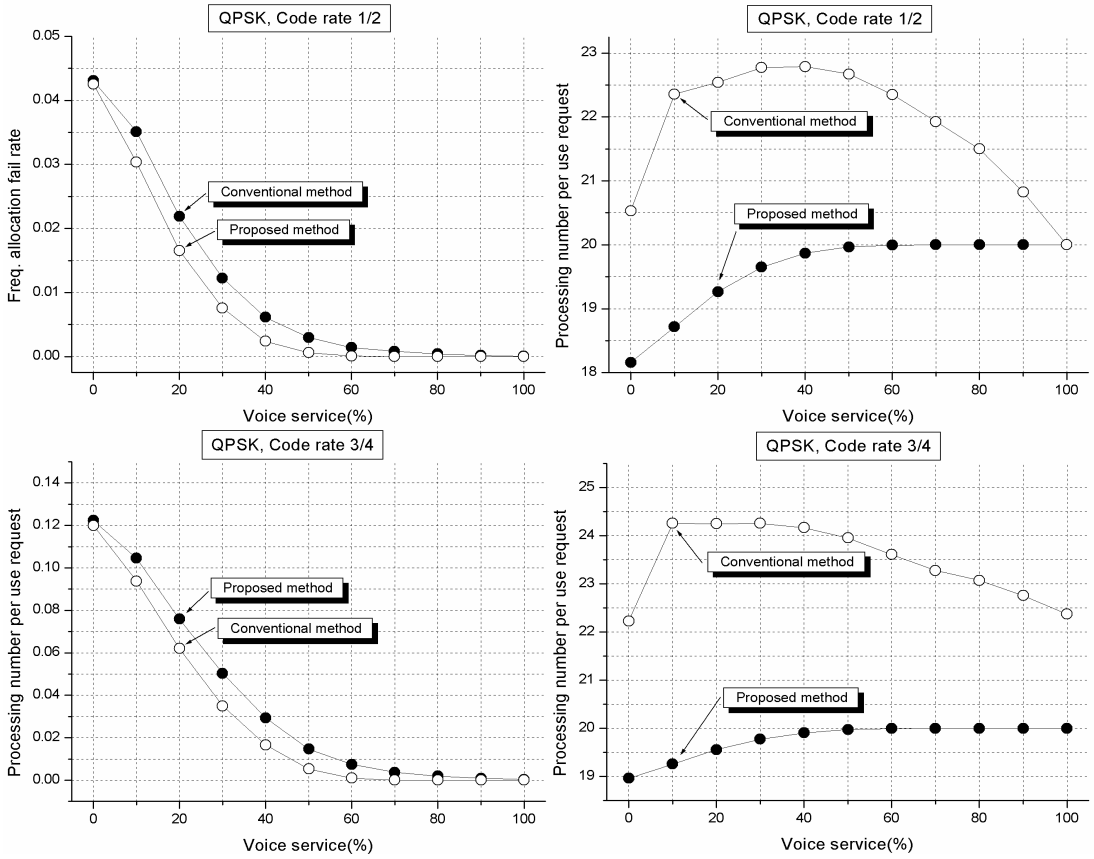

Figure 5. The result according to the rate of voice service in QPSK

The vertical axis of the left graph is frequency allocation fail rate and the right graph is processing number per use request of a CR device. The horizontal axis of both is the rate of voice service. If the rate of voice service is 0%, the system doesn't apply the variable bandwidth. it is fixed bandwidth. In this result, frequency fail rate lowers when the rate of voice service increases. The reason is that the bandwidth of voice service(1MHz) is smaller than image service(6MHz). The frequency allocation fail rate is almost close to zero when the rate of voice service is more than 80%.

This algorithm applies limit method of candidate set number. The conventional method is limit method of candidate set number, and proposed method is limitless method. In the right graph, processing number of conventional method is less than 20, but proposed method is almost more than 20. In other words, processing time of the proposed method is shorter. In the left graph, the performance of proposed method is not almost different from conventional method.

5 Conclusions

This paper investigates the proposed efficient DFS technique for Mobile Security concept in IEEE 802.22 WRAN. The performance applying a variable bandwidth method is good when the rate of voice service of big. It showed all same patterns though there was the performance difference as the required SNR different.

The performance difference doesn't appear a conventional method greatly with the method not to limit candidate set. At the same time, the proposed method reduces the processing time.

In the result, the performance will be fine if it applies the method of variable bandwidth. The limit method of candidate set does not have an influence greatly on performance degradation and reduces the processing time.

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