Dynamic Channel Selection in Cognitive Radio for OFDM System

P.Perumal, Dr.M.Murugan

Abstract – In this paper, we integrate overlay cognitive radio technology into 4G cellular networks for the sharing of TV spectrum. On one hand, OFDM is a promising technique for high-speed data transmission over multipath fading channels and has been considered to be the best candidate for 4G mobile networks. On another hand, the overlay cognitive radio model makes it possible to have two concurrent transmissions in a given interference region, where conventionally only one communication takes place at a given time. We investigate different service provision scenarios and propose both time domain and frequency domain overlay cognitive radio OFDM systems for next generation cellular networks. Numerical results show our proposedschemescan achieve satisfying performance in different use cases. Thus highly reliable cognitive radio scheme for OFDM based wireless communication proposed with increasing the spectral efficiency by two concurrent transmissions in a region and thesecondary users throughput is improved.

Index Terms – Cognitive Radio,DTV,Frequency domain overlay CR, OFDM systems, Primary user,Spectrum Sharing, Time domainoverlay CR

1.INTRODUCTION

1.1Cognitive Radio

Cognitive radio (CR) technology is the key technology that enables an 4G network to use spectrum in a dynamic manner.Automatically detects available channels in wireless spectrum.. The term, cognitive radio, can formally be defined as follows

Cognitive capability

Cognitive capability refers to the ability of the radio technology to capture or sense the information from its radio environment. This capability cannot simply be realized by monitoring the power in some frequency band of interest but more sophisticated techniques are required in order to capture the temporal and spatial variations in the radio environment and avoid interference to other users. Consequently, the best spectrum and appropriate operating parameters can be selected.

Reconfigurability

The cognitive capability provides spectrum awareness whereas reconfigurability enables the radio to be dynamically programmed according to the radio environment. More specifically,the cognitive radio can be programmed to transmit and receive on a variety of frequencies and to use different transmission access technologies supported by its hardware design.

2.WORKING OF MY PROJECT

2.1 Cognitive Radio Technology

Joseph Mitola defined CR as an intelligent wireless communication system that aware and learns from its environment and adapts its internal states by makingcorresponding changes in certain operating parameters. The vital objective of the cognitive radio is to achieve the best accessible spectrum through cognitive capability and reconfigurability. In other words, CR is also defined as awareness, intelligence, learning, adaptively, reliability and efficiency. Cognitive cycle consists of three major steps as follows.

1. Sensing of RF stimuli.
   - Detection of spectrum holes.
   - Estimation of channel state information.
   - Prediction of channel capacity for use by the transmitter.
2. Cognition/spectrum management.
   - Spectrum management, which controls opportunistic spectrum access.
   - Optimal transmission rate control.
   - Traffic shaping.
   - Routing.
3. Quality of service provision.

2.2.Transmit Power Control

Asmentioned earlier, among the challenges in CR is spectrum sharing. CR allows the usage of temporally vacant spectrum, which is referred to as white space or spectrum hole. If a licensed user further uses this band, CR node need to move to another spectrum hole or stays in the same band, altering its

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transmission power level or modulation scheme to avoid interference.

Another approach is by using spectrum pooling (SP). It was first mentioned by J.Mitola and explored by T. A. Weiss and F.K. Jondral. Basically, SP technique is about merging spectral ranges from diverse spectrum holders (military, trunked radio, etc.) into a common pool. In SP, Secondary User (SU) may temporarily rent spectral resources during idle periods of PUs without any changes in the Primary User (PU) part. In the authors focus on the implementation of the SU transceiver using OFDM modulation and it is called OFDM-based SP. The basic idea is to match the bandwidth of one sub-band of the PU with an integer multiple of carrier spacing used in the SU.

2.3. Challenges In Spectrum Sensing

Spectrum sensing techniques are very vital in the implementation of CR system using dynamic spectrum resource management. To achieve CR goals, it is a fundamental requirement that the SU performs spectrum sensing to detect the presence of PU signal and also locate unoccupied spectrum segments, the spectrum holes, as quickly and accurately as possible. This type of detection is referred to as local spectrum sensing (LSS). Various approaches have been proposed for spectrum sensing such as matched filter, energy detection, cyclostationary feature detection and more recently, wavelet detection methods.

Scheduling Model for Cognitive Radio Based Priority Queue

Spectrum scheduling should consider user priority in claiming the spectrum. Traditional priority queue model divides CR system users into PU and SU. The PU seizes the spectrum according to their stochastic characteristic, whereas the SU leases the spectrum vacancy at the absence of PU. Such leasing policy is aimed to make best efficient utilization of the precious spectrum resources. The author in proposed an improvement to the queue method on CR system.

In the work, mathematical M/G/1 priority queue model was built, classical queue parameters were discussed andCR improvement was computed on a real system implementation. Different SUs differ from each other in arriving process, serving process, QoS requirement, etc. Hence, classifying all of them into just one kind is not precise enough. To achieve a more precise model, proposed further priority level partition among SUs. Moreover, suppose SUs have been further partitioned already, not only PU can preempt, but also higher priority SU can preempt lower ones.

The preemption process causes spectrum switch and the accompanying switch overhead is time cost and unelectable in a real system. Large amount of preemption will results in an inefficient system. To reduce switch overhead, hybrid priority should be introduced, which indicates PU's preemptive priority and SU's non-preemptive priority.

2.4.Spectrum Scheduling

In a cooperative cognitive radio networking (CCRN), the Secondary user-transmitter (SU-Tx) communicates with the Secondary receiver(SR) through the help of one or several SPs in which both the SU-Tx and SR have to adapt their transmit power to satisfy the constraint of the PUs communication in their vicinity. Here, a simple CCRN is presented where the SU-Tx communicates with the SU-Rx through the help of a single SR. The SR and SU-Rx are subject to the interference from the Primary user-transmitter(PU-Tx), while the SU-Tx and SR must control their transmit power to keep the interference at the Primary User-receiver(PU-Rx) at an acceptable level.

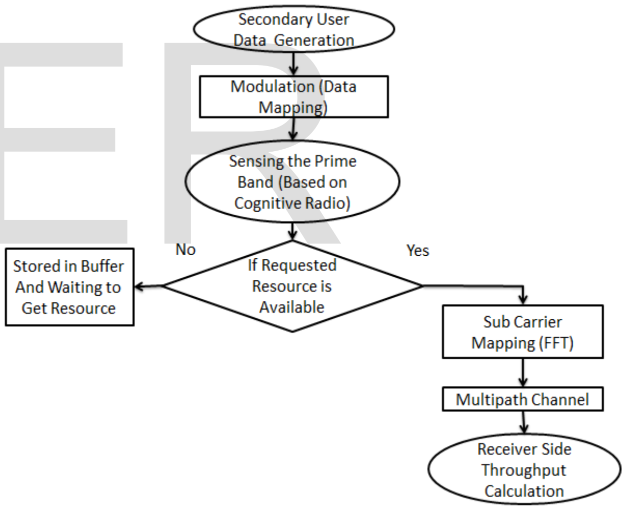

Fig.1. Receiver architecture

2.5.Spectrum Holes

A spectrum hole is originally defined as a band of frequencies which are readily assigned to a PU, however, it may not be always used by the PU at a specific time or a geographic area. Depending on the communication environment, the spectrum holes can be identified following frequency and time(see Fig.2), or space as:

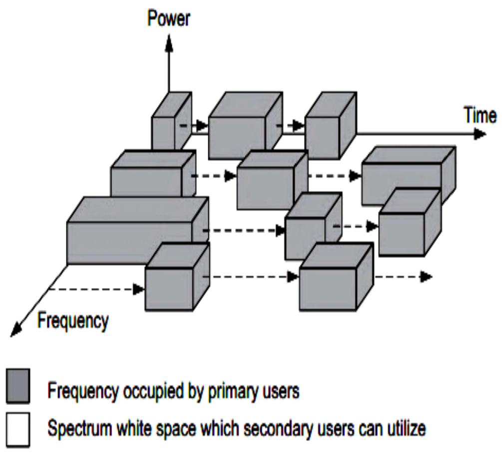

Fig.2. Example of a spectrum allocation graph

• Frequency spectrum hole is a contiguous frequency band in which activities of the SU do not cause any harmful interference to the PUs.
• Temporal spectrum hole is a frequency band that is not occupied by a PU for a period of time. By using advanced spectrum sensing techniques, an SU can detect spectrum holes and opportunistically access it without degrading any quality of service (QoS) of the PU.

• Spatial spectrum hole is a frequency band in a specific geographic area where the PU transmission is being occupied. The SU can utilize this band if it is outside this area.

Spectrum Sensing Techniques

Spectrum sensing is one of the most important functions in a CRN, and it is also a must-have component in the interweave approach. This does not only help the SU to be aware of the surrounding radio environment, but also provides information for communication decisions such that the system performance is enhanced. In this section, well-known sensing techniques along with their advantage and disadvantage are introduced.
• Direct signal detection from the PU

As the primary transmitter (PU-Tx) communicates with the primary receiver (PU-Rx), it uses a certain power level to transmit signals in a specific spectrum band. Thus, if the SU wants to know whether the PU is active or not, it needs to observe the radio signal in the spectrum band. Accordingly, the received signal y(t) at the SU can be given by

$$\boldsymbol{y}(\boldsymbol{t}) = \begin{cases} c(t)x(t) + n(t), & H_1 \\ n(t), & H_0 \end{cases} \quad \ldots \quad (1)$$

Energy detection

Energy detection is a low-complexity spectrum sensing technique which is applicable for wide-band spectrum sensing. As the name suggests, the energy detector observes the average energy within M samples of the received signal, given by

$$Y = \frac{1}{M}\sum_{t=1}^{M}|\boldsymbol{y}(\boldsymbol{t})|^2 \quad \ldots. \quad (2)$$

2.6. Cooperative Communications In Underlay Networks

In traditional wireless technologies, point-to-point or point-to-multipoint communications have been widely used. In contrast to point-to-point communication. Thanks to cooperative communication techniques, limitations in underlay CRNs such as low transmission rate and short range communication can be overcome.

In a CCRN, the SU-Tx communicates with the SU-Rx through the help of one or several SRs in which both the SU-Tx and SRs have to adapt their transmit power to satisfy the constraint of the PUs communication in their vicinity. Here, a simple CCRN is presented where the SU-Tx communicates with the SU-Rx through the help of a single SR. The SR and SU-Rx are subject to the interference from the PU-Tx, while the SU-Tx and SR must control their transmit power to keep the interference at the PU-Rx at an acceptable level.

3.Results and Discussion

In Cognitive radio, Digital video broadcast terrestrial (video frame) is given as the primary user and , OFDM is a promising technique for high-speed data transmission over multipath fading channels and has been considered to be secondary user which is used for 4G mobile networks to transmit over the prime band.

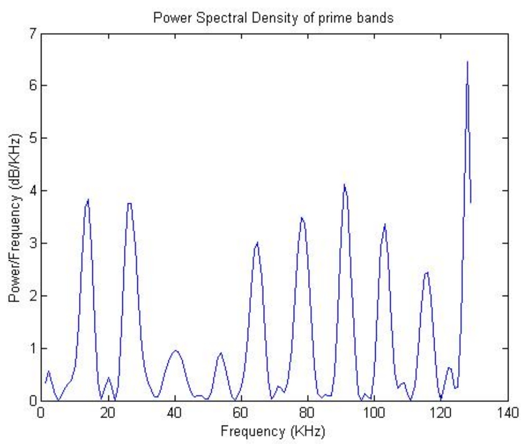

Fig.3.Holes in 2nd band

From fig.3 The spectrum holes are unused spectrum are in third and fourth prime band if it is non cognitive system the unused spectrum are not effectively utilized where as in cognitive system the unused spectrum are effectively used by the secondary user

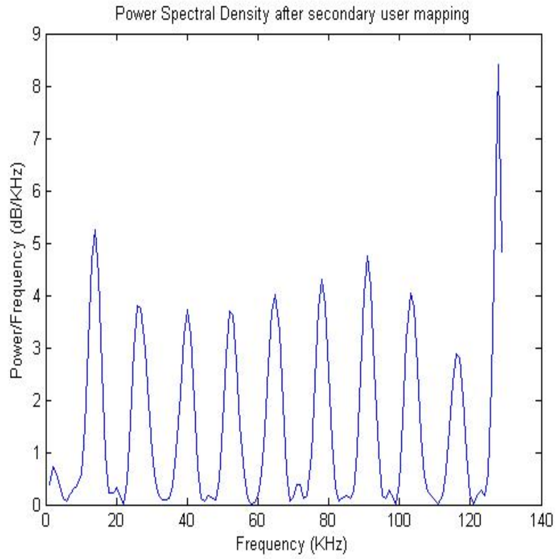

Fig.4. After Spectrum mapping

From fig.4 the cognitive radio sense the unused spectrum or spectrum holes after Spectrum mapping the secondary user mapped into the spectrum holes or unused spectrum.

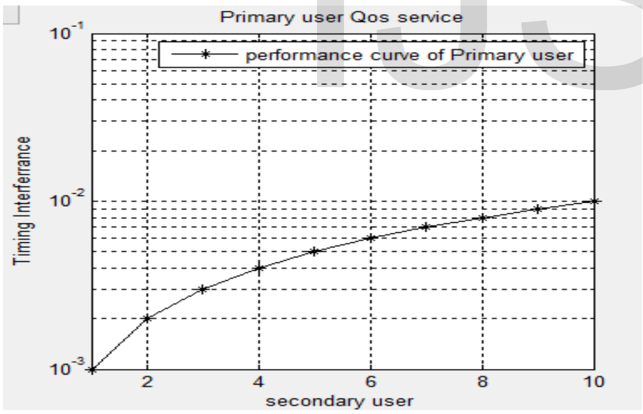

Fig.5.Primary user interference analyzes

From fig.5 Interference rate in prime bands will be increased when we increase the number of secondary users.It will be a linear interferences caused by concurrent transmission. As interference rate is linearly increased transmission of secondary user acceptable.

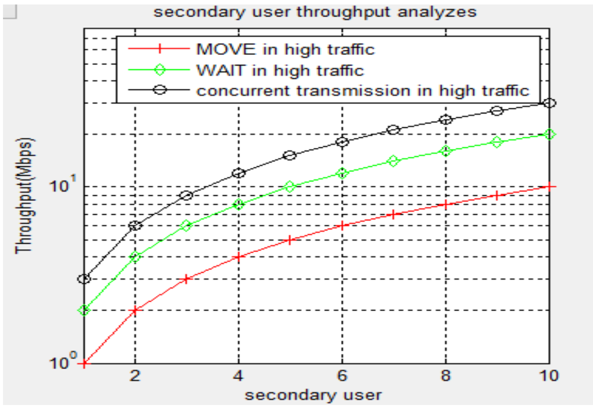

Fig.6. Secondary user throughput analyzes

From Fig.6 Primary user (Video frame) a transmitted over the channel in a given spectrum . Based on the availability of the holes the secondary user can transmit. Here in spectrum we consider totally ten prime bands.Two prime bands are allocated for the single primary user. First consider without hole in the prime band therefore only primary user can transmit over the channel. Then hole is consider in the second prime band, after mapping secondary user can transmit in second prime band. Minimize the Interference level for primary user and throughput for secondary user can be achieved as.

- In case of MOVE secondary users will move from one prime band to another based on holes availability.
- But in WAIT secondary users has to wait to get holes in their unique prime bands.
- Compare with these two methods concurrent transmission will give better throughput rate.

4.Conclusion

In this paper we describe spectrum wastages as a hole and it was originally defined as a band of frequencies which are readily assigned to a Primary Users. Here we successfully sensed those unused bands it was used by the secondary users at a specific time. Depending on the communication environment,we analyzes two methodologies in which spectrum holes are allocated to secondary user and finally robustness of proposed system was analyzed by measuring BER of PU's and throughput of SU's.

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