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# Mobility Management in Cellular Network Based On Cognitive Radio

Kokila V M[1] , Shridhar K[2]
[1]Department of E&CE, [2] Assistant professor Dept of E&CE PDAECG kalburgi

***Abstract: Cognitive radio is emerging wireless technology which offers reallocation and reutilization of the unused spectrum. Not all the network runs with highest load at all the time. Therefore part of spectrum always remains unused. In a multi radio environment cognitive radio allows the user to request for spectrum while roaming from another service provider. In case the service provider has free spectrum, it can reallocate the spectrum to the demanding user. In this work we provide a mechanism for managing both intra cells as well as inter cell mobility management for efficient spectrum sharing technique. I proposed a pool based spectrum management where the spectrums are managed in a group called pool such that the base stations can appropriately choose the pool depending upon network load and perform spectrum switching. I use frequency domain sensing technique to effectively sense the free spectrum. Simulation result shows high accuracy in free spectrum detection and handoff.***
***Index Terms—Cognitive radio, spectrum pool, handoff, intercell resource allocation, spectrum mobility management, user mobility Management.***

## I. INTRODUCTION

WIRELESS spectrum is presently regulated by governmental agencies and is assigned to license holders or services on a long-term basis over vast geographical regions. a large portion of the assigned spectrum is used sporadically leading to underutilization and wastage of valuable frequency resources. To address the problem, the Federal Communications Commission (FCC) has recently approved the use of unlicensed devices in licensed bands. This new area of research foresees the development of cognitive radio (CR) networks to further improve spectrum efficiency. The basic idea of CR networks is that the unlicensed devices (also called CR users) share the licensed spectrum without interfering with the transmission of other licensed users (also known as primary users) . If this band is found to be occupied by a licensed user, the CR user moves to another spectrum hole to avoid interference, which is referred to as spectrum mobility. This concept has been widely investigated to solve the exponential data traffic growth in the current cellular network. The main difference between classical and CR cellular networks lies in spectrum mobility, which gives rise to a new type of handoff in CR cellular networks, that is spectrum handoff. Recent research has mainly focused on spectrum mobility, but does not consider the effect of mobile users across multiple cells. In the cellular network, mobility management, especially a handoff scheme is one of the most important functions. As a result, spectrum mobility and user mobility must be jointly considered in designing a mobility management scheme for CR cellular networks these are the following challenges: Heterogeneous mobility events, dynamic spectrum availability Spectrum availability, broad range of available spectrum. To address the challenges mentioned above, we propose a spectrum-aware mobility management scheme for CR cellular networks.

## II. PROPOSED NETWORK ARCHITECTURE

The cellular network is the most successful wireless Technology, but currently suffers from increasing data traffic. The CR technology is considered as a promising solution to this data explosion problem in the current cellular network. The CR cellular network is supposed to be deployed in several ways. First, it can be applied to the unused TV spectrum bands, the so-called TV white spaces, as the FCC recently allowed unlicensed devices to use them [5], [14].Second, while the ultra-broadband cellular technology such as 3rd Generation Partnership Project (3GPP) Long-Term Evolution-Advanced (LTE-Advanced) requires up to 100 MHz per channel [15], the amount of wideband spectrum is limited. The CR technology enables bandwidth Aggregation by sharing spectrum owned by other cellular operators, or opportunistically utilizing unused spectrum bands licensed to other services such as digital TV, and public safety [16]. Finally, in the current cellular networks, the base station (BS) has only an RF unit, and a digital unit for all communication functionalities is implemented in a separate central server [17]. As a result, the cost of BSs will be cheap enough for anybody to install anywhere. This allows a new type of a mobile virtual operator based on CR, which operates its own BSs in a local area without spectrum licenses.

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In this paper, we mainly focus on the mobility issues in CR cellular networks. The system model used in this paper is described in the following sections.

*A. Basic System Model*

Consider infrastructure-based CR networks consisting of multiple cells. Each cell has a single BS and its CR users. In this architecture, CR users observe their radio environments and report the results to the BS. Accordingly, the BS determines proper actions in support of an upper-level control node, such as the mobility management entity (MME) in 3GPP LTE [15]. CR users have a single wideband RF transceiver that can sense multiple contiguous spectrum bands at the same time without RF reconfiguration. Each CR user m needs Km channels to satisfy its QoS requirement. All spectrum bands are assumed to be licensed to different primary networks. Furthermore, each spectrum can have multiple primary networks that are operated independently in the different region, called PU activity region. For example, the cell coverage of each BS is considered as the PU activity region. Since most of primary networks such as cellular networks or TV broadcasting networks have a fixed service coverage, the PU activity region is generally assumed to be fixed . Generally, each PU activity region in the licensed band has ON and OFF states where ON (Busy) state represents the period used by primary users and an OFF (Idle) state represents the unused period.

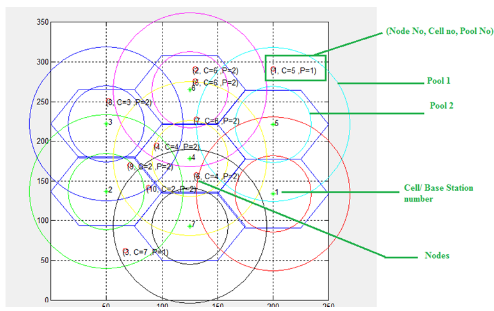


Fig. 1. Spectrum pool-based CR network architecture.

*B. Spectrum Pool Structure*

In this section, we present the proposed spectrum pool and cell architectures and a corresponding capacity model.

*1) Spectrum Pool Architecture For Spectrum Mobility:* To solve the problem in spectrum mobility,  modify a conventional spectrum pooling concept, known as the most suitable structure to adapt to the dynamic radio environment in CR networks , for handling both spectrum and user mobility's in a multicell environment. The main components of the spectrum pool are defined as follows (Fig. 1):
Spectrum pool: A set of contiguous licensed spectrum bands, each of which consists of multiple channels.
Spectrum band: A basic bandwidth unit for operating a certain wireless access technology such as 5 MHz WCDMA band operating at 2.1 GHz.
Channel: A minimum logical unit of wireless resource that mobile users can access through multiple access schemes. Each channel has the identical capacity.

*2) Cell Architecture For User Mobility:* In the proposed architecture, spectrum pools are assigned to each cell exclusively with its neighbor cells with a predetermined frequency reuse factor, f, as shown in Fig. 1. Although this architecture supports a seamless transition between spectrum bands within the pool, still has difficulty in providing seamless communication to CR users moving across different cells. To address this problem, we introduce two different types of cell coverage as depicted in Fig. 1:
Basic area (BA): A basic coverage not overlapped with that of neighbor cells.
Extended area (EA): A larger coverage overlapped with the basic areas of neighbor cells.
Based on this architecture, each cell has multiple basic spectrum bands accessible only within BA and at least one extended spectrum band supporting both BA and EA

*3)  Handoff Types:* Mobility management in classical cellular networks is closely related to user mobility. However, CR networks have another unique mobility event, the so-called spectrum mobility. By taking into account both mobility events based on the proposed network architecture, we define four different types of handoff schemes.

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Intracellular/intrapool handoff. The CR user moves to a spectrum band in the same spectrum pool without switching a serving BS. Intercell/intrapool handoff. The CR user switches its serving BS to a neighbor BS without changing the spectrum pool. Intercell/interpool handoff. The CR user switches its serving BS to a neighbor BS, which has a different spectrum pool. Intracell/interpool handoff. The CR user changes its spectrum bands from one spectrum pool to another within the current cell.

Each handoff type is related to different mobility event, and its performance is mainly dependent on both network and user conditions, such as resource availability, network capacity, user location, etc. Thus, CR networks require a unified mobility management scheme to exploit different handoff types adaptively to the dynamic nature of underlying spectrum bands

## III. METHODOLOGY

Simulate the system using Matlab. The basic simulation issues are as bellow:

In this architecture, CR users observe their radio environments and report the results to the BS. Accordingly, the BS determines proper actions in support of a upper-level control node, such as the mobility management entity (MME).

### *A. Mobility Management Framework*

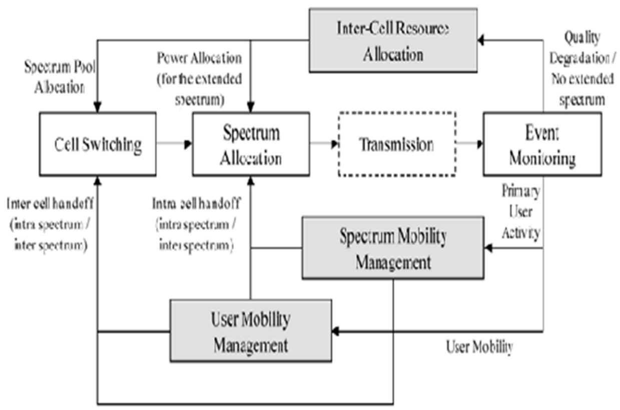


Fig 2. The proposed mobility management framework

Compared to the classical cellular network, the CR network requires more complicated mobility management functionalities due to the dynamic spectrum environment and heterogeneous handoff types, as shown in Fig. 3.

These functionalities are initiated by three different events:

user mobility, spectrum mobility, and quality degradation.

Here, user mobility is defined as the event that a mobile CR user transfers an ongoing connection from one BS to another as it approaches the cell boundary.

## IV. RESULTS AND ANALYSIS

System Model

Following parameters are considered for implementation of above methods in MATLAB.

Table 1: Parameters Used In Matlab Program

| Sl no | Parameters | Description |
|---|---|---|
| 1 | no. of primary users | 05 |
| 2 | Value of Fc in kHz | 500,1000,1100,1900,2000 |
| 3 | Sampling Frequency Fs | 5000 |
| 4 | Transmitted signal X(t) | A*sin (2 Π* f* t) |
| 5 | Received Signal Y(t) | Y(t)=X1+X2+X3+X4+X5 |
| 6 | Noise Signal | AWGN |
| 7 | SNR | 20 |
| 8 | DFT | 5000 point |

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Generation of Sine Wave:

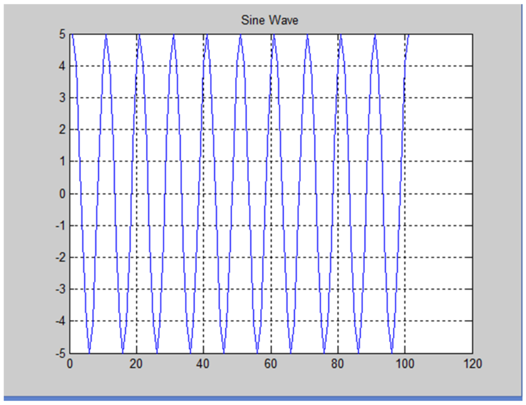


Fig 3: Generation of Sine WaveFrequency Domain Channel Of Sine Wave:

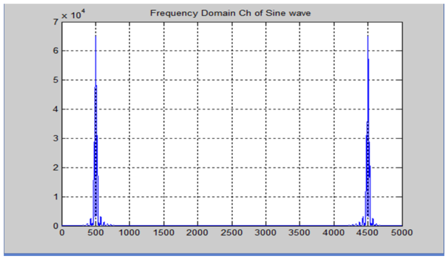


Fig 4: Frequency Domain Channel Of Sine Wave.

Original Signal Passed Through the AWGN Channel:

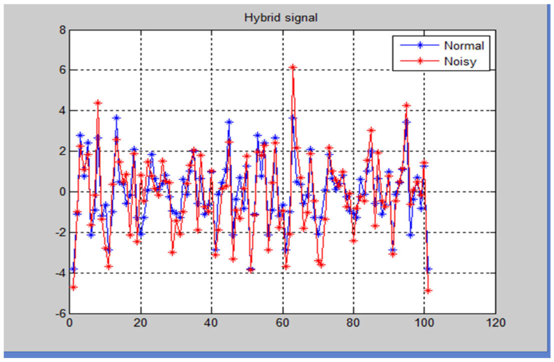


Fig: 5 Original Signal Passed Through the AWGN Channel

Frequency Domain Channel Of Mixed Wave:

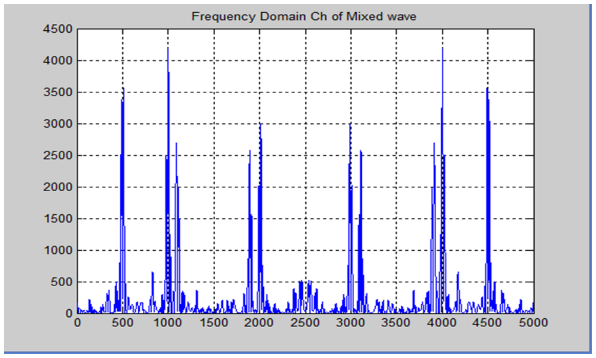


Fig 6: Frequency Domain Channel of Mixed Wave

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Detected Frequencies:

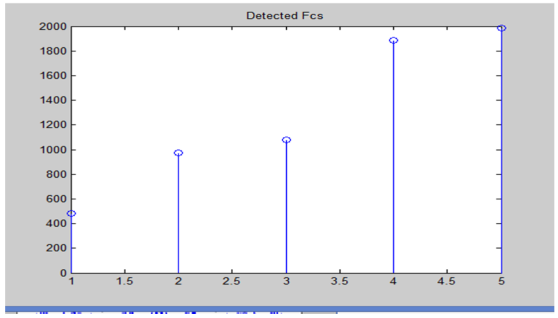


Fig 7: Detected Frequencies

GUI showing handoff operations:

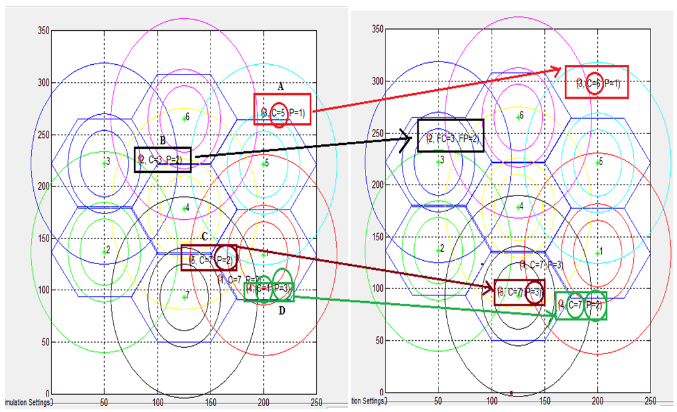


Fig 8 A) Intercell Intrapool B) Failed Handoff C) Intracell Interpool D) Intercell-Interpool Intracell Intrapool is not graphically demonstratable.

## V. CONCLUSION AND FUTURE WORK

Mobility based spectrum sensing, allocation and reallocation is an important issue in Cognitive radio. By basic definition, it supports the case of such mobility management in intercell environment by base stations exchanging user information among themselves. This limits the capability of the cognitive radio as the primary users within a cell does not get the advantage of such spectrum management. We have proposed a unique system here that overcomes this limitation of the cognitive radio by averaging four different handoffs. We have also shown that frequency domain spectrum sensing is an efficient technique that can correctly detect void users in range and reallocate that spectrum in case any user is missing. Simulation result shows that number of successful handoff is far higher than failed handoff even under more load and users. The system is also noise resilient. Different types of spectrum sensing techniques with different multi user access can be used as a future work. Future researchers can also leverage the framework being designed here to adopt and perform simulation under different types of channels like Rayleigh fading or Racian channel.

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