An Efficient Relay Selection and Clustering Technique for Spectrum Sharing Network

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ABSTRACT: When we consider a spectrum sharing networks it have primary user and secondary user. Spectrum share by the first user is called primary user. Primary user used the allocated spectrum without affected any interference. But in the case of secondary user used the primary user spectrum it has much interference occur, also need more emitted power. xG networks are envisioned to provide opportunistic access to the licensed spectrum using unlicensed users. This setting enables multiple systems being deployed in overlapping locations and spectrum.so primary user and secondary user speed also decreases. In our project above problem should be overcome by using proper relay selection and clustering technique. Here used distributed relay selection and clustering to improve the secondary rate and also reduced the secondary emitted power.

Keywords: spectrum sharing, relay, clustering

I. INTRODUCTION

Traditionally, use of radio spectrum has been highly regulated in order to prevent interference among users of adjacent frequencies or from neighboring geographic areas. In the past decade there have been significant innovations in the theory of spectrum management along with gradual changes in practice of spectrum management and regulation. This gradual change follows a growing consensus that past and current regulatory practices originally intended to promote the public interest have in fact delayed, [1] in some cases, the introduction and growth of a variety of beneficial technologies and services, or increased the cost of the same through an artificial scarcity[5]. In addition to these delays, the demand for spectrum has grown significantly Those reasons are making policy-makers and regulators worldwide focus on new methods of spectrum regulation with an increasing emphasis on striking the best possible balance between the certainty required to ensure stable roll-out of services and flexibility (or light-handed regulation) leading to improvements in cost, services and the use of innovative technologies[3]. In developing countries in particular, where mobile communications users now greatly outnumber those using fixed line telecommunication services, it is widely recognized that the spectrum is a highly valuable resource for future economic development. Access to the radio spectrum is based on the Table of Frequency Allocations of the International Telecommunications Union (ITU) Radio Regulations, where defined categories of radio service are allocated frequency bands in different parts of the spectrum[2][4]. The spectrum allocations can be on exclusive, shared, primary or secondary basis. Due to scarcity of the frequency spectrum, many bands are allocated for more than one radio service and are, therefore, shared. Spectrum sharing studies aim to identify technical or operational compatibilities that will enable radio services to operate in the same (or adjacent) frequency bands without causing unacceptable interference to each other[2][3]. Often, sharing becomes possible when limits are placed on certain system parameters — for example, antenna radiation patterns, transmission power etc. Decisions are made at the national levels on the purpose or purposes to which particular frequencies will be used. These decisions are reflected in the International and National Tables of Frequency Allocations.

A. BACKGROUND

Modern spectrum management policies are evolving towards more flexible and market oriented models to increase opportunities for efficient spectrum use. As the demand for spectrum increases and frequency bands become more congested, especially in densely populated urban areas, spectrum managers are following diverse approaches for sharing frequencies: using administrative methods including in band sharing [2], licensing such as leasing and spectrum trading, and the unlicensed spectrum commons combined with the use of low power radios or advanced radio technologies including ultra-wideband and multi-modal radios. Spectrum sharing typically involves more than one user sharing the same piece of spectrum for different applications or using different technologies. When a band already licensed to an operator is shared with others it is known as overlay spectrum sharing.

B. MOTIVATION OF PROCESS

- Commercial carriers have strong desire for cleared spectrum as do incumbent users.[1]
- While strong desire for more spectrum to be made available via sharing, there is a desire not to compromise the request for cleared spectrum.[4]
- This makes engaging detailed technical discussions of how to share in abstract difficult.
- Insight is that there needs to be a process to engage sharing in a more specific manner and address information challenges.
- Additionally, given the technical complexity of these systems and the wide range of uses for which they experts familiar with the systems under consideration**.**

C. SPECTRUM SHARING

Spectrum sharing is not a universal trend for all regulators nor are the approaches taken similar for all regulators. Spectrum-sharing models are fairly diverse worldwide. In its simplest form, it involves leasing of a given quantum of airwaves within a licensed service area for a mutually agreed period. The quantum [3] of airwaves taken on lease is available to other licensee for the period of lease and can be most optimally used for network design and affordable services. Spectrum sharing encompasses several techniques – some administrative, technical and market-based. Sharing can be accomplished through licensing and/or commercial arrangements involving spectrum leases and spectrum trading [4] [1]. Spectrum can also be shared in several dimensions; time, space and geography. Limiting transmit power is also a factor which can be utilized to permit sharing. Low power devices in the spectrum commons operate on the basis of that principal characteristic: [5] [6] signal propagation which takes advantage of power and interference reduction techniques. Spectrum sharing can be achieved through technical means using evolving advanced technologies such as cognitive radio.

II. PROPOSED ADAPTIVE COOPERATION SCHEME IN NETWORKS

A. SYSTEM MODEL

$$r_i = \sqrt{\frac{P_s}{M}}\mathbf{h}_i^t \mathbf{s} + n_i, \tag{1}$$

where Ps is the source transmit power, which must be less than a power constraint P¯s, s ∈ CM×1 is i.i.d. Gaussian signals, hti∈ C1×M is the row iof H, namely the channel vector between the relay iand the source, and niis additive noise with distribution CN(0, 1). In the second hop, a subset of the relays is selected to transmit to the destination. We define a random variable Ti to indicate whether the relay iis selected (eligible):

$$T_i = \begin{cases} 1, & \text{the relay } i \text{ is eligible} \\ 0, & \text{otherwise} \end{cases} . \tag{2}$$

No cooperation among the relays is allowed due to their distributed nature. Each relay rotates and scales riby

$$c_i = e^{j\theta_i}\sqrt{\frac{P_r}{\mathbb{E}[T_i](P_s\sigma_s^2+1)}}. \tag{3}$$

Channel matrix ˜H has entries

$$[\tilde{\mathbf{H}}]_{mq} = \sum_{i=1}^{n} T_i\, c_i\, f_{mi}\, h_{iq}, \tag{4}$$

In this paper, we focus on the effect of the number of relays on the secondary rate, i.e., the so-called scaling laws” for the relays in a spectrum-sharing system. Thus, we allow n to increase while Np remains bounded. Analysis of scaling laws has a long and established history in wireless communications among the many examples we mention a few, e.g., [14], [20], [21]. We refer to cross channels between secondary transmitters and primary receivers as *interference links*. We assume the destination knows F, D and H, and the relays only know the instantaneous channel gains to which they directly connect, i.e., hi and the column I of F. The interference (thus the channels) from the primary to the cross-channel CSI requirements in a TDD system can be met by the secondary nodes detecting packets emitted from the primary nodes. Otherwise, under the spectrum leasing model [22], the primary nodes can be expected to actively promote spectrum reuse by transmitting pilots that can be used for cross-channel gain estimation. The latter model applies to both TDD and FDD. Regarding the precision of cross-channel CSI, only the magnitude of the channel gains are needed, and the system can be made robust to imperfections in the cross channel CSI to the relays, as shown in subsequent discussions (see Remark 1).

1. Permits Communications to Work By:

- Monitoring to detect unused frequencies;
- Agreeing with similar devices on which frequencies will be used;
- Monitoring frequency use by others;

- Changing frequency bands and adjusting power as needed.

Dynamic spectrum access is often associated with, although not exclusively dependent on, technologies and concepts such as Software Defined Radio (SDR) and Cognitive Radio.

Multi-modal radios are capable of operating across multiple bands and technologies. The tri-band and world mobile phone are examples of multi-modal radios. Allotments and technical standards on a regional or global basis is not as critical.

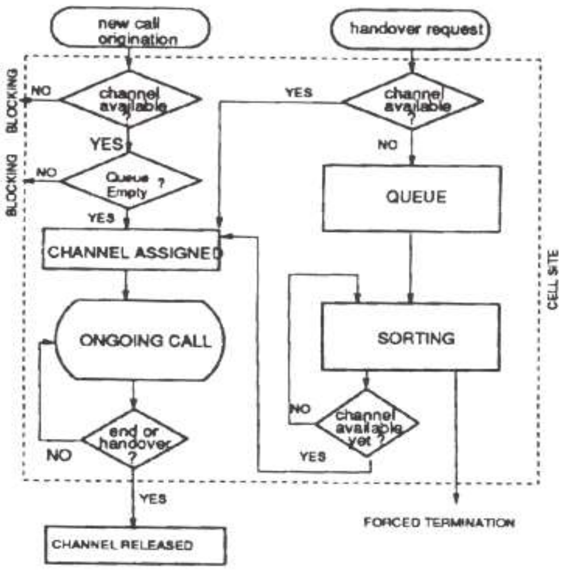

Fig 2: Channel allocation

III. SYSTEM ANALYSIS

A. PROBLEM DEFINITION:

We consider a spectrum sharing network consists of N_p primary nodes and a secondary system with an **M**-antenna source, an **M**-antenna destination and **n** single-antenna half-duplex relays, as shown in Figure 1. The average interference power caused by the secondary on each of the primary nodes must be less than **7** Let H G $C^{M x n}$ be the channel coefficient matrix from the source to the Respectively. Denote hpl G CMx1 as the channel vector from the source to the primary node I, 1 < I <Np. The source has no direct link to the destination, a widely used model appropriate for geometries where the relays are roughly located in the middle of the source and destination. A block-fading model is considered where all entries of H, F, G and hpl are zero-mean i.i.d. circular symmetric complex Gaussian (CN) with variance a2s, o\, up and respectively. The source communicates with the destination via two hops, which in general lowers the required transmit power and thus reduces the interference on the primary.

In the first hop, the source sends M independent data streams across M antennas with equal power. The relay i

$$r_i = \sqrt{\frac{P_s}{M}}\mathbf{h}_i^t \mathbf{s} + n_i, \qquad (5)$$

Receives where Ps is the source transmit power, which must be less than a power constraint Ps, s G CMx1 is i.i.d. Gaussian signals, h| G C1xM is the row i of H, namely the channel vector between the relay i and the source, and ni is additive noise with distribution CN(0,1). In the second hop, a subset of the relays is selected to transmit to the destination. We define a random variable Ti to indicate whether the relay i is selected (eligible):

$$T_i = \begin{cases} 1, & \text{the relay } i \text{ is eligible} \\ 0, & \text{otherwise} \end{cases} \qquad (6)$$

No cooperation among the relays is allowed due to their distributed nature. Each relay rotates and scales ri by

$$c_i = e^{j\theta_i}\sqrt{\frac{P_r}{\mathbb{E}[T_i](P_s\sigma_s^2 + 1)}}. \qquad (7)$$

Where Pr is the average relay power and 0i is the rotation angle, which are designed in the sequel.

After the relay forwarding, the received signal vector at the destination is

$$\mathbf{y} = \sqrt{\frac{P_s}{M}}\underbrace{\mathbf{FDHs}}_{\tilde{\mathbf{H}}} + \underbrace{\mathbf{FDn} + \mathbf{w}}_{\tilde{\mathbf{w}}}, \qquad (8)$$

B. SOLUTION:

Since each relay determines eligibility based on its own interference links, the eligible relay selection is independent across the relays. The average interference from the secondary system to the primary node ℓ is-[4]

$$\begin{aligned} \gamma_\ell &= \frac{1}{2}\mathbb{E}[(\sum_{i=1}^{n} g_{\ell i}t_i)(\sum_{i=1}^{n} g_{\ell i}^* t_i^*)] + \frac{P_s}{2M}\mathbb{E}[|\mathbf{h}_{p,\ell}|^2] \\ &= \frac{P_r}{2}\sum_{i=1}^{n}\mathbb{E}[|g_{\ell i}|^2 | T_i = 1] + \frac{\sigma_{sp}^2 P_s}{2}, \qquad (9) \end{aligned}$$

Where the factor 1/2 is due to the fact that the relays and the source only transmit during half of the time. The second equality holds since the design of θi is independent of interference links, as shown soon.

Regulation option for primary spectrum usage

Regulator control access	License control access	Application requirements
Traditional Licensing	Spectrum manager makes guarantees	Guaranteed QoS
Unlicensed band, regulator sets etiquette	Spectrum manager sets etiquette, no QoS guarantee	No QoS support coexistence, horizontal spectrum sharing
Cognitive radio, regulator sets protocols	Cognitive radio, license sets protocols	QoS support, cooperation horizontal spectrum sharing.

Regulation option for Secondary spectrum usage

Regulator control access	License control access	Application requirements
Not Possible unlicensed underlay Unlicensed with opportunistic access.	License guarantees QoS secondary market with overlay opportunistic access.	Guaranteed QoS. No QoS support, coexistence, vertical spectrum sharing
Interruptible secondary operation, regular sets cooperation protocol	Interruptible secondary operation, regular sets cooperation protocol	Interruptible secondary operation, regular sets cooperation, vertical spectrum sharing

IV. EVALUATION RESULT:

A.PERFORMANCE ANALYSIS

In this subsection, the SCP from the CRtx to the CRrx will be analyzed first. Then the SCP within multiple consecutive time slots will be further investigated. Also, the coexistence of multiple CR links with primary links will be considered.

C. SPECTRUM MULTIPLEXING AMONG CR USERS:

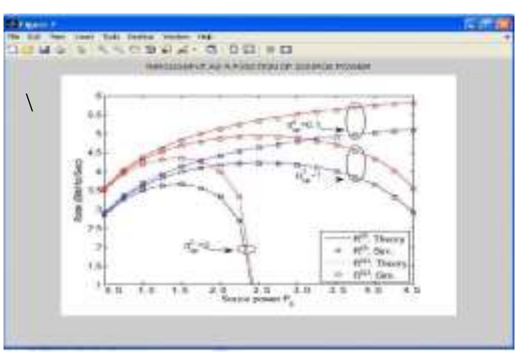

Fig 1: Secondary rate under two clustering schemes

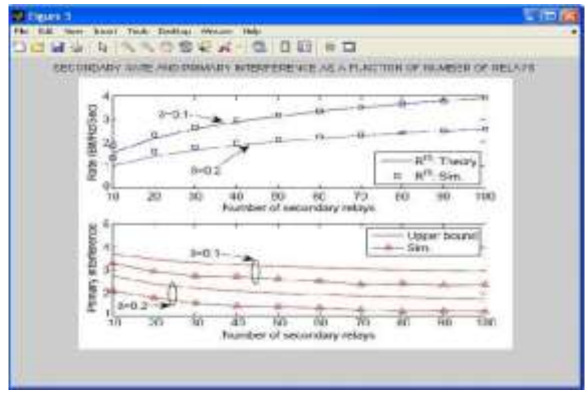

Fig 2: Secondary rate and primary interference as a function of number of relays

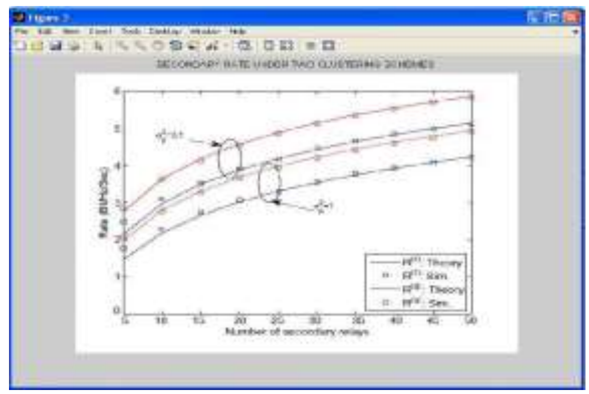

Fig. 3. Secondary rate under the alternating relaying protocol

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TABLE I
ABBREVIATION TABLE

CR	Cognitive radio
CRR	Cognitive radio relay station
CRrx	Cognitive radio receiver
CRtx	Cognitive radio transmitter
EAB	Equivalent available bandwidth
GSH	Geographic spectrum hole
NAT	Normalize achievable throughput
PU	Primary user
SCP	Successful communication probability
SH	Spectrum hole
SINR	Signal-to-interference-plus-noise-ratio
SSH	Spatial spectrum hole
TSH	Temporal spectrum hole

V. CONCLUSION

Our project investigated how increase the secondary rate and also decrease the interference level in primary user. Our project result shows the maximum secondary rate with minimum relay. Here there is no cross channel interference occur in primary and secondary user. The trade-off between the secondary rate and the interference on the primary was characterized. We have also developed a low-complexity Spectrum sharing and allocation suboptimal approach for relay selection.

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