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A Proactive Spectrum Approach for Cognitive Radio Ad-Hoc Networks

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ABSTRACT - The rapid growth of wireless devices has led to a dramatic increase in the need of spectrum access from wireless services. Cognitive Radio (CR) technology is a promising solution to enhance the spectrum utilization by enabling unlicensed users to exploit the licensed spectrum in an opportunistic manner. A Proactive CR technique is a distributed channel selection scheme to eliminate collisions among unlicensed users in a multiuser spectrum handoff. Simulation results show that our proactive spectrum handoff outperforms the reactive spectrum handoff approach in terms of higher throughput and fewer collisions to licensed users. By using CR technology higher packet delivery rate is achieved.

Key Words- Cognitive Radio, Proactive spectrum, Handoff and ad-hoc networks

1. INTRODUCTION

Cognitive Radio (CR) technology is to enhance the spectrum utilization by enabling unlicensed users to exploit the spectrum in an opportunistic manner. Cognitive Radio is a transceiver which automatically detects the available channels in wireless spectrum. It is a key technology to realize Dynamic Spectrum Access that enables an unlicensed user to adaptively adjust its operating parameters and exploit the spectrum which is unused by licensed users in an opportunistic manner. Optimize the utilization of radio resources, by switching channel to the most suitable transport channel based on traffic volume (throughput), radio resources availability, radio conditions and mobility. A cognitive network is an opportunistic network. Spectrum opportunity deals with the usage of an available (free) channel that is a part of the spectrum which is not currently used by primary users.

A cognitive radio is a transceiver which automatically detects available channels in wireless spectrum and accordingly changes its transmission or reception parameters so more wireless communications may run concurrently in a given spectrum band at a place. This process is also known as dynamic spectrum management. It is a software defined radio with a cognitive engine brain. Cognitive radio is considered as a goal towards which a software-defined radio platform should evolve: a fully reconfigurable wireless transceiver which automatically adapts its communication parameters to network and user demands. Cellular network bands are overloaded in most parts of the world, but other frequency bands (such as military, amateur radio and paging frequencies) are insufficiently utilized. Moreover, fixed spectrum allocation prevents rarely used frequencies (those assigned to specific services) from being used, even when any unlicensed users would not cause noticeable interference to the assigned service. Thus it allows unlicensed users in licensed bands if unlicensed users would not cause any interference to licensed users. These initiatives

have focused cognitive radio research on dynamic spectrum access.

The main function of cognitive radio is spectrum sensing. The spectrum sensing detects unused spectrum and sharing it, without harmful interference to other users; an important requirement the cognitive-radio network to sense empty spectrum. Detecting primary users is the most efficient way to detect empty spectrum.

2. LITERATURE SURVEY

2.1 SPECTRUM HANDOFF IN CR NETWORKS

Spectrum handoff is an inherent operation in cognitive radio networks to support resilient and continuous communications. The spectrum handoff procedure is characterized. Its short-term performance and long-term behavior are thoroughly investigated with respect to four metrics: link maintenance probability, the number of spectrum handoff, switching delay and non-completion probability. Results show that the opportunistic and negotiated spectrum access strategies can lead to significantly different performance. The techniques as well as the results are very helpful for optimizing cognitive radio networks.

Spectrum is a scarce and precious resource in wireless communications. The scarcity challenge is largely caused by the current fixed frequency assignment policy. This policy partitions the whole spectrum into a large number of different ranges. Cognitive Radio (CR) has been proposed to effectively utilize the spectrum. CR refers to the potentiality that wireless systems are context-aware and capable of reconfiguration based on the surrounding environments and their own properties. In the same frequency range, there are two co-existing systems: primary system and secondary system.

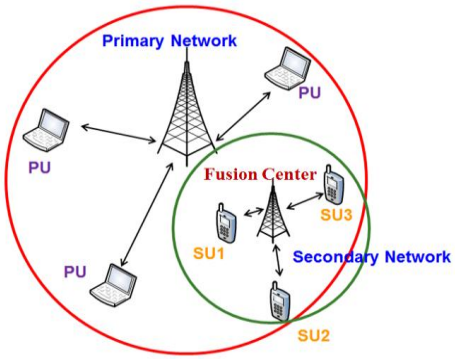

Fig 2.1: CR Technology

2.2 ANALYSIS FOR PROACTIVE SPECTRUM

Cognitive can improves spectrum efficiency through intelligent spectrum management technologies by allowing secondary users to temporarily access primary users. Spectrum handoff occurs when the high priority primary users appear at its licensed band occupied by secondary users. Spectrum handoff procedure aim to help the secondary users to vacate the occupied licensed spectrum and find suitable target channel to resume the unfinished transmissions.

A pre-emptive resume priority (PRP) M/G/1 queuing network model is proposed to characterize the spectrum usage interactions between primary and secondary users with multiple spectrum handoffs. A suboptimal greedy target channel selection scheme is proposed to reduce the complexity for finding optimal target channels. The optimal sequences for target channels can be determined by exhaustive search for all possible permutations of target channels, but this method is obviously too complicated. The low-complexity greedy target channel selection scheme can reduce the

total service time compared to the randomly selection scheme.

2.3 ANALYSIS FOR PROACTIVE SPECTRUM

The channel frequencies are not wasted. The frequencies that are in use are utilized to the maximum extent without the need for bothering about the effects of interference. It automatically detects and exploiting unused spectrum and thereby improving the performance of the existing network.

Spectrum sharing is to perform channel selection, power allocation, Resource allocation& Medium access protocols for spectrum access.

Spectrum sensing is to monitor the unused spectrum bands.

Spectrum decision to select the most appropriate band according to the quality of service (QoS)

Spectrum mobility is process by which a cognitive-radio user changes its frequency of operation. Cognitive-radio networks aim to use the spectrum in a dynamic manner by allowing radio terminals to operate in the best available frequency band, maintaining seamless communication requirements during transitions to better spectrum.

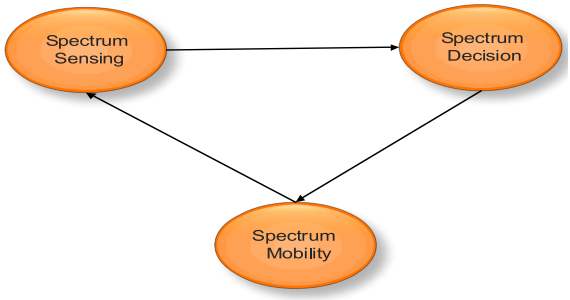

Fig 2.2: Spectrum management

3. EXISTING SYSTEM

Cognitive radio (CR) is an emerging technique to promote spectrum efficiency. The low-priority secondary users can search the unused licensed spectrum of the high-priority primary users to transmit data. However, the secondary users must vacate the occupied channel when the primary user appears because the primary users have the pre-emptive priority to access channels. In order to return the occupied channel to the primary users, the spectrum handoff procedures are initiated for the interrupted secondary user. The interrupted secondary user must perform spectrum sensing to search the idle channels for spectrum handoff, and then resume the unfinished transmission at one of the idle channels. A secondary user's connection link may experience multiple interruptions from the primary users during its transmission period. These interruptions result in a series of spectrum handoffs because spectrum handoff procedures are performed whenever an interruption event occurs. Then, a series of target channels will be selected sequentially for multiple handoffs through spectrum sensing. Clearly, these handoffs will increase the secondary connections extended data delivery time, which is defined as the duration from the instant of starting transmitting data until the instant of finishing the whole transmission. According to the decision timing for selecting target channels, spectrum handoff mechanisms can be categorized as either the proactive-decision spectrum handoff or the reactive-decision spectrum handoff. In the reactive-decision spectrum handoff, the target channel is searched by instantaneous spectrum sensing after the spectrum handoff request is made. Then, the interrupted secondary user can

resume the unfinished transmission on one of the idle channels.

3.1 SPECTRUM HANDOFF IN CR NETWORKS

A secondary user's connection may experience multiple interruption requests from the primary users during its transmission period. Because these interruptions result in multiple handoffs, a series of target channels needs to be selected, called the target channel sequence in this paper.

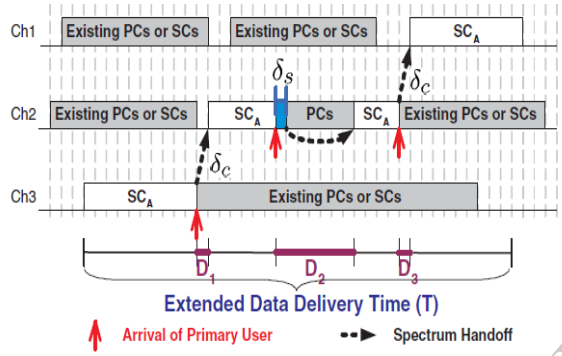

Fig 3.1: Transmission process for secondary connection

Fig. 3.1 shows an example that three times of spectrum handoffs occur during the transmission period of the secondary connection SCA. We assume that the transmitter of SCA wants to establish a connection flow with 30 slots to the corresponding receiver. The extended data delivery time of SCA is denoted by T.

Furthermore, Di is the handoff delay of the ith interruption. Here, the handoff delay is defined as the duration from the instant that transmission is terminated until the instant that the unfinished transmission is resumed. Moreover, SCA's initial (default) channel2 is Ch3.

4. PROPOSED SYSTEM

Cognitive radio (CR) can improve spectrum efficiency through intelligent spectrum management technologies by allowing secondary users to temporarily access primary users' unutilized licensed spectrum. In order to enhance spectrum management, CR systems require many capabilities such as spectrum mobility (or called spectrum handoff). Spectrum handoff occurs when the high-priority primary users appear at its licensed band occupied by the secondary users. Spectrum handoff procedures aim to help the secondary users to vacate the occupied licensed spectrum and find suitable target channel to resume the unfinished transmission .In general, according to the target channel decision methods, spectrum handoff mechanisms can be categorized into (1) proactive-decision spectrum handoff: make the target channels for spectrum handoff ready before data transmission according to the long-term observation outcomes, and (2) reactive decision spectrum handoff: determine the target channel according to the results from on-demand wideband sensing. Compared to the reactive-decision spectrum handoff, the proactive-decision spectrum handoff may be able to reduce handoff delay because the time-consuming wideband sensing is not required. Furthermore, it is easier to let both transmitter and receiver have a consensus on their target channel for the proactive-decision spectrum handoff than for the reactive decision spectrum sensing. Nevertheless, when the spectrum handoff process is initiated, the proactive-decision spectrum handoff needs to resolve the issue that the pre-selected target channel may no longer be available. Hence, one challenge for the proactive-decision handoff is to

determine the optimal target channels sequences to minimize total service time.

4.1 CHANNEL SELECTION IN CR NETWORKS

Even though the channel allocation issue has been well studied in traditional wireless networks (e.g., cellular networks and wireless local area networks (WLANs)), channel allocation in CR networks, especially in a spectrum handoff scenario, and still lacks sufficient research. When SUs perform spectrum handoffs, a well-designed channel selection method is required to provide fairness for all SUs as well as to avoid multiple SUs to select the same channel at the same time. Currently, the channel selection issue in a multi-user CR network is investigated mainly using game theoretic approaches, while properties of interest during spectrum handoffs, such as SU handoff delay and SU service time, are not studied. Furthermore, most of the prior work on channel allocation in spectrum handoffs only considers a two-secondary-user scenario, where a SU greedily selects the channel which either results in the minimum service time or has the highest probability of being idle. However, if multiple SUs perform spectrum handoffs at the same time, these channel selection methods will cause definite collisions among SUs. Hence, the channel selection method aiming to prevent collisions among SUs in a multi secondary - user spectrum handoff scenario is ignored in the prior work.

4.2 DISTRIBUTED CHANNEL SELECTION

To investigate the performance of the proposed channel selection scheme, we compare it with the following three different channel selection methods under the proposed proactive spectrum handoff scenario using the single rendezvous coordination scheme:

Random channel selection: A SU randomly chooses a channel from its predicted available channels.

Greedy channel selection: In this method, only one pair of SUs is considered in the network. The SUs can obtain all the channel usage information and predict the service time on each channel. Thus, when a spectrum handoff occurs, a SU selects a pre-determined channel that leads
to the minimum service time.

Local bargaining: In this method, SUs form a local group to achieve a collision free channel assignment. To make an agreement among SUs, a four-way handshake is needed between the neighbours (i.e., request, acknowledgment, action, acknowledgment). Since one of the SUs is the initiating node which serves as a group header, the total number of control messages exchanged is 2NLB, where NLB is the number of SUs need to perform spectrum handoffs. Since for channel selection schemes, reducing the number of collisions among SUs is the primary goal, we consider the SU throughput, average SU service time, collisions among SUs, and average spectrum handoff delay as the performance metrics.

4.3 ADVANTAGES

1. A distributed channel selection scheme to eliminate collisions among unlicensed users in a multiuser spectrum handoff so there is no interference or collisions.

2. Due to no collisions the proactive spectrum can achieve high throughput value and higher packet delivery.
3. Due the spectrum handoff packet loss is greatly reduced.
4. Compare to reactive spectrum the quality of service is improved.

5. IMPLEMENTATION & SIMULATION RESULT

The current simulation is carried out in the network simulator (Ns-2). This is very helpful in the networking concepts. By using this, the parameters like throughput, delay, collision rate, packet drop can be measured.

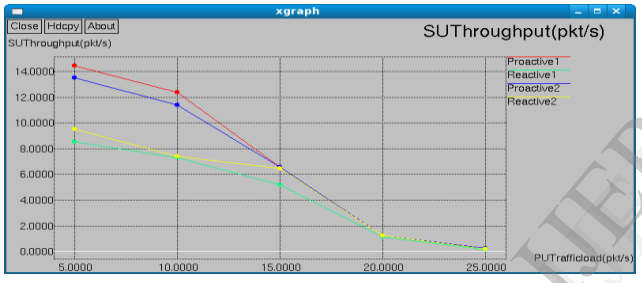

Fig 5.1 Comparison of proactive Vs Reactive

From the graph, the throughput offered in the proactive will be better than the reactive spectrum is shown in fig 5.1. It is clearly shows that 30% increase in throughput in proactive when compared with the reactive spectrum. The collision rate in proactive is less than the reactive spectrum is shown in fig 5.2. From graph, it is shown that 27% of the collision rate gets decreased in proactive spectrum.

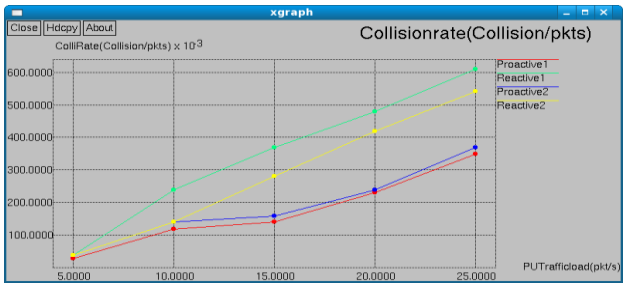

Fig 5.2: Collision Rate Vs Load

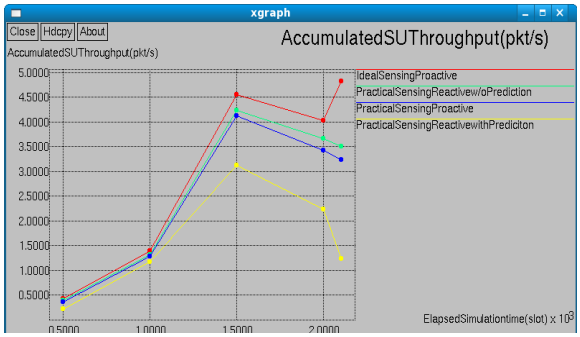

Fig 5.3: Accumulated throughput Vs Elapsed time

From the graph, it is clearly shows that the ideal sensing proactive gets higher throughput than practical sensing throughput is shown in fig 5.3. The average delay on the channel is also maintaining the initial delay on greedy channel selection on comparing with the secondary user channel which is shown in fig 5.4.

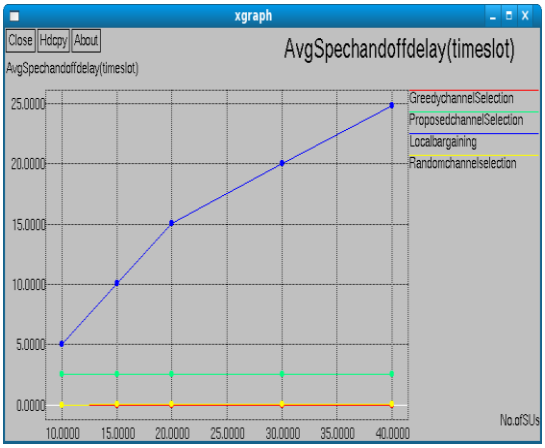

Fig 5.4: Average delay Vs Secondary user

6. CONCLUSION & FUTURE WORK

In this paper, by using proactive cognitive radio technology interference and collision avoidance is explained. The Spectrum utilization is done through proactive spectrum handoff. The proactive spectrum handoff

protocol triggers the unlicensed users to vacate the channel before the licensed user utilizes it. Cognitive radio can achieve higher packet delivery and maximum throughput.

In future, Channel sensing in Cognitive Radio can be carried out by using waveform based sensing.

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