Cooperative Sensing Protocol for Cognitive Radio

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I. Introduction

In recent years, the cognitive radio (CR) has been receiving a great attention to overcome spectrum scarcity [1]. The key to this new technology is spectrum sensing that is aware of the environments and informs vacant bands [2]. The main problem in spectrum sensing is the degradation of detection performance when a CR node is exposed to fading from both shadowing and multipath. This motivates the development of cooperative sensing. Some authors have analyzed potential benefits of cooperative sensing [3] and proposed data fusion rules to combine sensing information efficiently [4]. In this paper, we focus on the protocol design to exchange of sensing information when CR nodes collaborate with each other. Our proposed protocol operates dynamically in accordance with prior informed notifications. We demonstrate its superiority by Monte Carlo simulation.

II. Cooperative Sensing Protocol

We consider the centralized cooperative scenario in this paper. Therefore, we assume that an access point (AP) gathers sensing information (there are M radio channels to be sensed) of all nodes (there are N nodes in a CR network) and it is performed using synchronized TDMA on a single dedicated channel which is not affected by any licensed user (LU). Fig. 1 shows our network topology. The fame structure of our protocol which is depicted in Fig. 2 mainly consists of two phases which are sensing phase and notification phase. Herein, we provide an overview of features relevant to proposed protocol.

In sensing phase, every node stops the data transmission to sense the channel state. Predefined K nodes transmit these results to AP one by one in initial notifying phase. Fussing these notifications (we consider OR operation), AP broadcasts the channel state to nodes. If there are remaining nodes which have LU information not containing in a previous broadcast packet, they try to access AP with uniform random number in random access of round phase. Again, AP gathers these information and broadcasts the updated channel state to nodes. The round phase repeats until there is no contender in random access phase. Lastly, after the round phase, AP announces final channel states to all nodes.

The noticeable feature that discriminates our protocol from others is that it is designed to avoid overlapped information by inserting broadcast phases. Hence, it makes possible to dynamically coordinate sensing period in CR network.

III. Performance Results and Discussion

The performance of proposed protocol depends on the number of initial notifying nodes(K), LUs(L), radio channels(M), CR nodes(N), and random access slots(R). We simply set L and M to 5 and 10 respectively and try to find the most suitable parameters of K and R for various N by Monte Carlo simulations. Fig. 3 shows the number of average required packets during a sensing period for $N = 50$ and Fig. 4 compares that of proposed protocol and general protocol in which all CR nodes notify the sensing information to AP sequentially. As shown in figures, the number of average required packets of proposed protocol are not directly proportional to the number of CR nodes

References

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[3] A. Ghasemi, and E. S. Sousa, "Collaborative Spectrum Sensing for Opportunistic Access in Fading Environments," *IEEE DySPAN*, pp. 131-136, Nov. 2005.

[4] T. Weiss and F. K. Jondral, "Spectrum Pooling: An Innovative Strategy for the enhancement of Spectrum Efficiency," *IEEE Communications Magazine*, Vol. 42, pp. S8-S14, Mar. 2004.

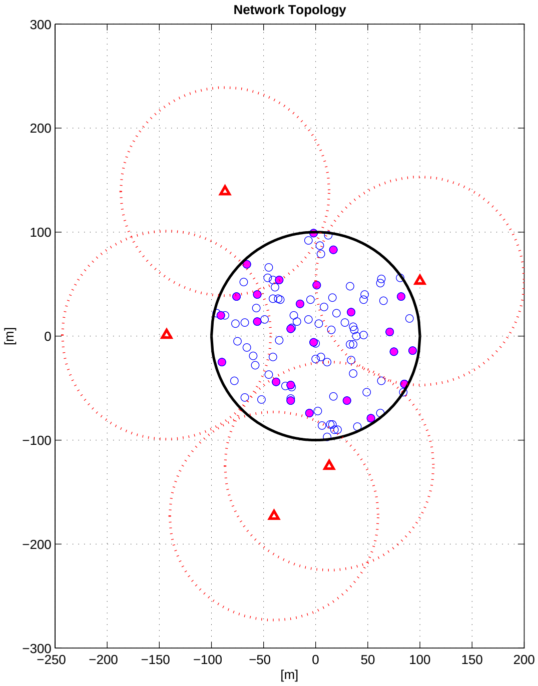

Fig. 1. An example of the node position and network topology; Circles - CR nodes, Colored Circles - Initial notifying CR nodes, Triangles - LU, Black Solid Line - CR network service coverage, Red Dotted Lines - LU service coverage

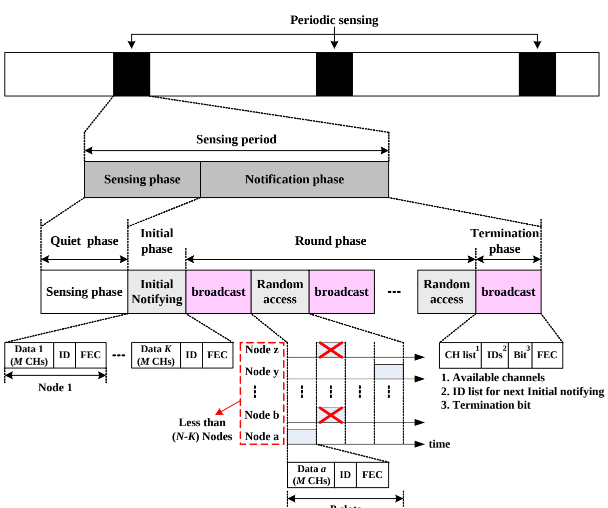

Fig. 2. Frame structure of proposed protocol

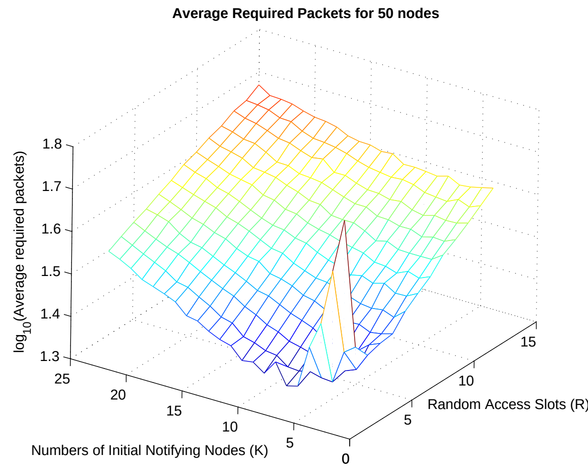

Fig. 3. The number of average required packets for 50 CR nodes. We assume that the length of all packets in a sensing period is same.

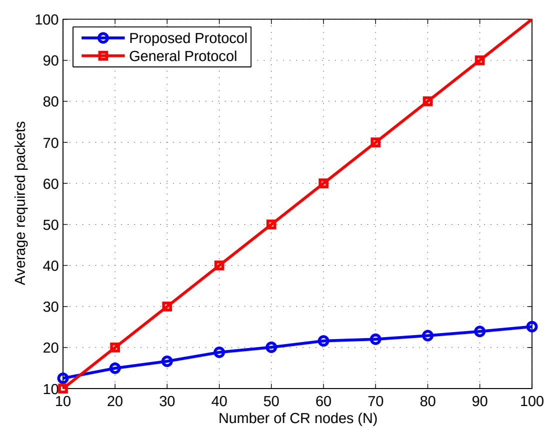

Fig. 4. Comparison of the number of average required packets for various numbers of CR nodes