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Intra-cell Channel Allocation scheme in IEEE 802.22 Networks

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***Abstract*—Cognitive radio based IEEE 802.22 wireless regional area networks have been proposed to harness the highly underutilized sub 900 MHz TV bands. In such networks, both base stations and the consumer premise equipments (CPEs) continuously perform spectrum sensing and transmit only on those channels which are not being used by the primary incumbents.**

In this paper, we propose a heuristic for an efficient channel allocation by a base station to the CPEs in that cell. Due to the lack of dedicated control channels, the BS and CPEs within a cell go through a process of exchanging control messages on free channels. The benefit of such sharing of their mutual spectrum usage helps the base station make informed decisions on the allocation of uplink and downlink channels to CPEs. This, in turn, guarantees no interference to and from the primary licensed incumbents. For validation of the proposed allocation scheme, we conducted simulation experiments. The results show how the proposed scheme ensures allocation to almost all the CPEs in a cell and how the nature of allocation is dependent on the total number of channels scanned, probability of getting a free channel and number of CPEs in the cell.

I. INTRODUCTION

The IEEE 802.22 standard [2] is a wireless regional area network (WRAN) technology that is targeted to harness the underutilized and unused sub-900 MHz TV bands. The core components of an IEEE 802.22 network are the base stations (BS) and the consumer premise equipments (CPE). Base stations control the spectrum allocation for their respective cells. The CPEs residing within cells are allocated both uplink and downlink channels by the base station. It is to be noted that both the base stations and the CPEs need to be cognitive radio enabled, i.e., they must continuously perform spectrum sensing, dynamically identify unused spectrum, and operate in the spectrum band when it is not used by the primary incumbents. The primary objective of the base stations and the CPEs, apart from sustaining communications among themselves, is to quickly adapt the frequency of operation when interference with a primary incumbent is detected. If a spectrum band used by a CPE is accessed by its licensed incumbent, the CPE is required to vacate that band within the ‘channel move time’ and switch to another vacant band.

Though there are some works on how the *different* BSs compete for channels, however, the problem of distributing the set of available channels to the CPEs *within* a cell still exists. This allocation needs to be efficient, quick, and fair. This intra-cell channel allocation is challenging because of several factors like absence of dedicated control channels between base station and CPEs, dynamic nature of available spectrum band at both BS and CPE, lack of knowledge of spectrum usage at the opposite ends of communication, and hidden incumbents. Moreover due to the fleeting nature of the free spectrum, the allocation needs to be updated frequently and the process of re-allocation must not disrupt the functioning of already allocated nodes. To the best of our knowledge the only work directed towards this issue in [4], which proposes a scheme for the CPEs to form a mesh network in a distributed manner. Although the proposed method shows how a mesh network of all the CPEs and BS can be formed inside a cell, the paper does not discuss problems like channel assignment to CPEs and how links are established between BS and the CPEs in the absence of any dedicated control channel.

This paper introduces a heuristic for allocating both uplink and downlink channels by a BS to the CPEs in its cell. Though channel assignment is the BS’s responsibility, more often than not, the BS has incomplete knowledge about potential interferences at or around a given CPE. We diverge from the IEEE 802.22 draft specifications by allowing a CPE to share its *spectrum usage report* with its BS in addition to parameters such as antenna pattern, height, effective isotropic radiated power (EIRP) etc. In our approach, the CPEs wanting to connect to any base station go through a process of exchange of control messages before mutually finalizing on a set of channels for uplink and downlink. Therefore, we allow the BS and CPE to share their spectrum usage report. This is achieved through a series of beacons from BS and reply messages from the CPEs before the BS allocates the CPEs a pair of channels that do not interfere with any primary incumbent signal. Although the channel allocation is done by the BS, channel sensing is done by each and every CPE in a distributed manner. The sensed information by the CPEs is a key parameter for the BS for allocation of channels. We analyzed the proposed scheme and demonstrated through simulations how a near-perfect allocation is achieved. The results show how the proposed technique ensures allocation to almost all the CPEs and how the nature of allocation is dependent on the total number of channels scanned, probability of getting a free channel, and the number of CPEs in the cell.

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II. INTRA-CELL CHANNEL ALLOCATION

We consider a IEEE 802.22 network that is divided into cells, each having a base station. A base station can communicate with the CPEs in its cell as well as with its neighboring base stations. The communication between a base station and a CPE is done using a pair of uplink and downlink channels. All the cells are prone to co-channel and adjacent channel interference. This is because a CPE might be in the overlapping region of two or more base stations and thus can hear the downlink signals of multiple base stations. The IEEE 802.22 draft [3] requires all the devices in the network to be installed in fixed locations and the BS be aware of the location of all the CPEs under it. The draft suggests that when a new CPE attempts to associate with a BS, the CPE sends its location coordinates along with other parameters like antenna pattern, height, effective isotropic radiated power (EIRP) to the base station. With the help of this information and the incumbent database service, the BS can determine the expected area over which the CPE could potentially interfere. Then the BS allocates channels to the CPE [5]. However, this method only gives an *estimate* of the spectrum usage at the CPE side; the actual spectrum availability at the CPE is unknown to the base station. The use of the estimated spectrum report might lead to faulty allocation and sometimes starvation of CPEs.

We consider that all base stations and CPEs continuously perform channel sensing, i.e., they scan the entire spectrum (from 54 to 862 MHz) and create their respective spectrum usage report. We assume the sensing process for both BS and CPEs is done as provisioned in the IEEE 802.22 draft [3]. However, we differ from the provisions of the draft by allowing the CPEs to share their spectrum usage with the base station by means of control messages sent in a unique manner. Based on the spectrum activity that a base station sees and in consultation with the reports obtained from the CPEs, it decides on the uplink and downlink channels that are allocated to the CPEs in that cell.

A. Channel Sets

We consider that base station BS_i of cell i contains three sets of channels: a set of free channels $F_i = \{f_k^i\} \forall 1 \leq k \leq N_i$ where N_i is the number of channels; a set of already allocated downlink channels $AD_i = \{ad_m^i\}$ where m represents the allocated CPE; and a set of already allocated uplink channels $AU_i = \{au_m^i\}$ where m represents the allocated CPE.

For the sake of convenience, we present the frequently used notations in Table I.

The set of free channels in the neighborhood of BS_i constitute the set F_i. Similarly every CPE c in cell i form the set A_i^c. Whenever a primary incumbent for a particular channel(s) is discovered by the base station BS_i, the set F_i is updated with the removal of the discovered channel(s). Similarly, when a CPE discovers primary incumbent signal(s), A_i^c is updated. With the channel sets defined, the base station can initiate the channel allocation process to new CPEs or the CPEs whose allocated channel(s) need to be freed because of the presence of primary incumbent at either BS or the CPE.

BS_i	Base station of a IEEE 802.22 cell i
F_i	Set of free/ available channels of BS_i
N_i	Total number of free channels of BS_i
AU_i	Set of allocated uplink channels by BS_i
AD_i	Set of allocated downlink channels by BS_i
A_i^c	Set of available channels scanned by CPE c in cell i
f_l^i	One of the free channels l in cell i of BS_i
au_m^i	An allocated uplink channel to CPE m in cell i
ad_m^i	An allocated downlink channel to CPE m in cell i
a_i^c	One of the available channels in cell i for CPE c
P_{ws}^b	Probability of getting white space at base station
P_{ws}^c	Probability of getting white space at CPE

TABLE I
COMMONLY USED NOTATIONS

B. BS/CPE Handshaking

For a CPE to get connected to a BS, even in the absence of a control channel, it is important that the BS take the initiative to let the CPEs know about the channels that are free for them to potentially use. This is achieved through the process of beacon broadcast by the base station. The base station BS_i periodically sends beacons with connection establishment requests in each of the free channels f_k^i of the set F_i. The beacons can be heard by any CPE in cell i. It is to be noted that the beacons do not suffer any interference from the CPEs that have already been allocated channels because they are only sent on unallocated channels.

For a CPE, c, that wants to establish a connection (i.e., acquire downlink and uplinks channels), it consults the set $A_i^c = \{a_j^c\} \forall 1 \leq j \leq R$ of free channels which it can potentially use for its uplink and downlink communication with base station BS_i. Of course, this set of free channels is obtained by the CPE via the process of spectrum scanning. On the other hand, the base station might have a set of free channels i.e., some spare channels to allocate (set F_i) to new CPEs. This scenario is technically not very different from the initial network boot-up, except in that the sets AD_i and AU_i are empty sets.

CPE c periodically tunes itself to each of the free channels a_j^c of the set A_i^c to listen to any of the incoming beacons from the base station. CPE c can hear these beacons from BS_i only if the sets F_i and A_i^c are overlapping sets i.e., there is at-least one channel that belongs to both sets. Also the sending of beacons by BS_i and tuning of the receiver of CPE c needs to be synchronized for successful reception of beacon by CPE c. The degree of synchronization will be discussed in section IV.

Let us assume that CPE c can listen to the beacons from BS_i in any one or more channels of the set $F_i \cap A_i^c$. These beacons are intended to invite new CPEs for connection establishment. Any new CPE, such as c, after getting such a beacon sends back a connection reply to BS_i along with it's GPS coordinates. This reply is sent back in all the channels on which it has just heard the beacons– which is merely the set $F_i \cap A_i^c$. Note that if $F_i \cap A_i^c$ is an empty set, i.e., there are no common channel, then the node c cannot hear the beacons and therefore cannot be allocated to any channel.

The usefulness and provision of sending the GPS coordinates will be discussed later in Section II-D2. It is to be noted that the replies from the CPEs are sequential in nature, i.e., they arrive at the base station one after another, however small the difference between their arrival times might be. Thus, the base station always processes the reply messages on a first come first serve basis.

C. Allocation and relinquishment of channels

Upon reception of reply messages from any new CPE, BS_i first checks the number of replies it has received for that CPE. Note that one reply can be received on only one channel, therefore the number of replies indicates the number of common channels between the sets F_i and A_i^c, which in turn indicates how many options BS_i has for allocating uplink and downlink to that CPE. Note that at least two channels (one for uplink and one for downlink) are required for successful allocation. If the number of replies is more than two, then BS_i randomly chooses two among them for uplink and downlink. After the allocation, the two channels are removed from the set F_i; the uplink is added to the set AU_i and the downlink to AD_i. This ensures that those two channels are not allocated to any other CPE as long as those channels are being used. This method of channel allocation enables two neighboring cells to use some common channels as long as the CPEs allocated to those common channels do not reside in the overlapping zone of the two cells. We consider this possibility in the next subsection.

As for channel relinquishment, if CPE c wants to relinquish its uplink and downlink channels (au_c^i and ad_c^i respectively), then these channels are removed from the sets AU_i and AD_i respectively and added to the set F_i.

D. CPE hearing multiple BSs

When a CPE is switched on, it is subjected to interference from adjoining base stations. Before we discuss the various possibilities that arise due to the location of the CPEs with respect to the base stations and the consequent allocations, let us take a look at a simple, and perhaps an ideal scenario.

1) Ideal Case: Let us consider a scenario where three nodes (CPEs) p, q and r reside under two separate base stations BS_1 and BS_2 as shown in Fig. 1. Now it does not matter which channels are allocated to CPEs q and r with respect to p as the former two are under different base stations. The figure shows that q is given ch_3 and ch_4 whereas r is given ch_1 and ch_2 which are the same as that of p. However, as p and r do not reside in the overlapping region of cells 1 and 2, they do not cause any interference. But note that it is of importance what channels are allocated to CPEs q and r with respect to each other as they reside in the same cell and within their mutual interference region.

2) CPE in cell overlapped region: When a CPE lies in the overlapping region of two or more cells, then the node receives beacon signals from all the corresponding base stations. Also, a node that lies under base stations BS_i and BS_j, might hear common channel/channels in their beacons, i.e., the sets F_i and F_j have some common channels. Let us consider that the channel node CPE p can listen to be A_{ij}^p. When this kind of situation arises, the yet to be allocated CPE can only respond to any one of the base station's beacons. Let us assume that node p picks base station BS_i randomly and sends a channel allocation request. Channel allocation to node p by BS_i takes place in the same technique discussed previously in subsection II-C; however, what happens after the allocation is of interest. Let the uplink and downlink channels assigned to p by BS_i be au_p^i and ad_p^i respectively. Obviously both au_p^i and ad_p^i belonged to the intersection of sets F_i and A_{ij}^p before their allocation. Fig. 2 describes the steps taken by base station BS_1 and CPE p residing in the overlapping region of cells 1 and 2. Note that, the response from node p will also reach BS_2, but BS_2 will ignore that response as the response message from p carries the unique identifier of BS_1 not of BS_2. Let us now discuss the three possibilities that might arise due to the relative location of the contending CPEs.

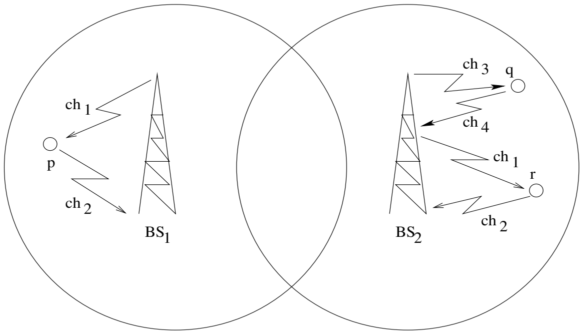
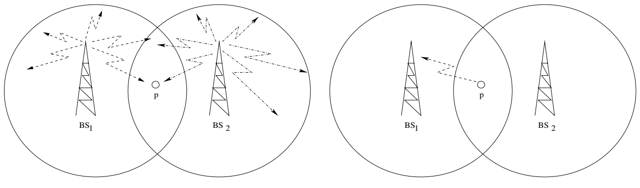
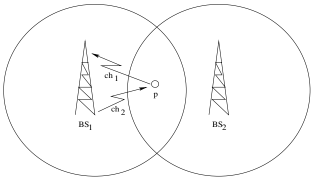


Fig. 1. Channels allocated to p and q are (ch_1, ch_2), and (ch_3, ch_4) respectively. CPE r under $BS-2$ at a considerable distance apart from p is allocated the same channels as p.



(a) Node p receives beacons from both base stations.

(b) Node p responds to BS_1



(c) BS_1 allocates uplink and downlink to node p

Fig. 2. A case where p resides in the overlapping region of cell i and j

Case I: There is a possibility that the uplink channel allocated by BS_i to p i.e., au_p^i also belongs to the set F_j. However, this possibility is not going to hinder the communication between the CPE p and its base station BS_i. This is because no CPE of cell j in the vicinity of p will be allocated this channel by BS_j as that CPE will find this channel au_p^i busy and this channel will not feature in the set of free channels for that CPE. However, this channel can be allocated by BS_j to any other CPE in the cell j as an uplink or downlink channel which is sufficiently distant from p to cause mutual interference. Fig. 3 shows the scenario where base station BS_2 allocates node q channel ch_1 as downlink which is also an uplink to CPE p residing in the overlapping region.

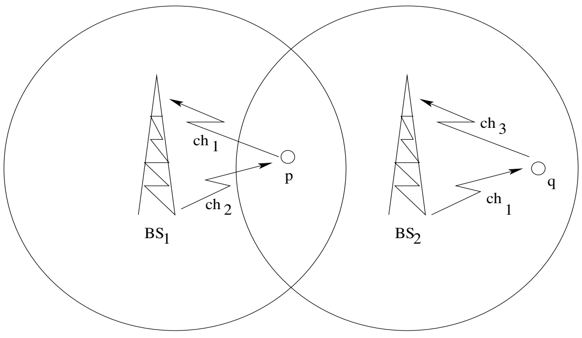
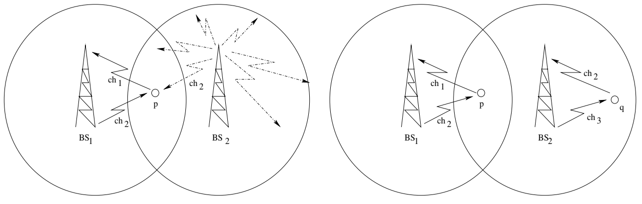


Fig. 3. Uplink ch_1 of node p is allocated as a downlink to node q by BS_2.

Case II: It might so happen that the channel ad_p^i i.e., downlink channel allocated to CPE p belongs to the set of free or available channels of BS_j i.e., F_j. In such a situation, the newly allocated CPE p can still listen to the beacons from BS_j even after channel allocation by BS_i. Therefore, whenever a CPE which is already allocated a channel by one base station can hear the beacons from another one, it identifies that the downlink channel assigned to it also belongs to the set of free channels of the base station whose beacons it can hear. To resolve this, the CPE sends an error message to the interfering base station along with its GPS location indicating that it is being interfered in that particular channel and the base station should not allocate that channel to any CPE in its vicinity. It is to be noted that the IEEE 802.22 draft [3] has a provision that all CPEs must be GPS enabled because a base station should know the geographic location of all the CPEs within its cell. We take advantage of the GPS data that is sent by the CPE to the interfering base station. When a base station receives such an error message along with GPS location, it sets a timer. Now within that stipulated time any other CPE which is distantly apart from the overlapping zone i.e., from the CPE which is having interference, can request for channel allocation in the same channel in dispute. In such a case the base station allocates that particular channel apriori to the CPE only as an uplink because downlink will still cause interference. If the timer expires, the base station drops the channel from its pool of free channels and marks it as a blacklisted channels which it cannot use. For example, let us assume that base station BS_j receives an error message from CPE p along with the GPS coordinates in channel ad_p^i. BS_j sets a timer and during this stipulated time another CPE q responds to the beacons of BS_j though a set of channels which include the channel ad_p^i. BS_j in this case will check the GPS coordinates of q; if q is sufficiently apart from p to cause interference then q is allocated ad_p^i apriori.

This is illustrated in Fig. 4 where we show the steps taken by BS_2 to ensure that its allocation does not cause interference to CPE p in its downlink channel ch_2.



(a) (b)

Fig. 4. (a) CPE p can hear the beacons from BS_2 even after channel allocation by BS_1. (b) Solution:BS_2 allocates ch_2 as uplink to CPE q which is at a non-interfering range from p.

It is to be noted that Case I and Case II reiterate how our scheme allows different adjacent cells to reuse the same set of channels without causing interference.

Case III: This is the ideal scenario where none of the uplinks and downlinks allocated to CPE p by BS_i belongs to the set of free channels of base station BS_j. In this case, no action is needed as no interference is caused to the transmission of CPE p by elements of cell j.

III. ANALYTICAL MODEL

To gain some insights on the key parameters, we analyze the system both from base station and CPEs' perspective. Let us first consider the base station. Let the spectrum range be S which can be thought of being the number of channels that the cognitive radio scans. Let P_{ws}^b be the probability of finding a free channel (white space). Therefore the expected number of free channels at base station is:

$$\mathbf{E}[Number\ of\ free\ channels] \quad = \quad SP_{ws}^b \tag{1}$$

Let A be the number of allocated channels by the base station at any given time; therefore the number of channels on which beacons are sent is $(SP_{ws}^b - A)$. Now suppose, the time taken by the base station to send a beacon through a particular channel and then listen to that channel for a possible reply from CPE be T_b. Therefore the probability that the base station will send a beacon on a particular channel among the free channels is:

$$P_B \quad = \quad \frac{T_b}{(SP_{ws}^b - A)T_b} = \frac{1}{(SP_{ws}^b - A)} \tag{2}$$

Now consider that for any CPE c, the probability of getting a free channel (white space) be P_{ws}^c. Also, assume that the time taken to listen to a particular channel and send a reply to the base station be T_c. Then, similar to the base station, the probability that the CPE will listen to a base station's beacon on a particular channel and send a reply back is:

$$P_C \quad = \quad \frac{T_c}{SP_{ws}^c T_c} = \frac{1}{SP_{ws}^c} \tag{3}$$

It is important that a CPE while scanning the entire spectrum range, hears a beacon on a channel that the base station is transmitting on at the same time. That is, the CPE scans the very channel that the base station has selected for transmission. Since there is no co-ordination between the two, the synchronization is purely a probabilistic event. The probability of synchronization between a base station and a particular CPE is conditioned on the fact that the CPE listens on a channel that the base station already selected. Thus, using conditional probability, we find that the probability of synchronization is given by:

$$P(CPE\ listens|BS\ sends\ beacon) = \frac{P_C P_B}{P_B} = \frac{1}{SP^c_{ws}} \quad (4)$$

This probability of synchronization, which we call success, is for the first time slot. Recall, the CPE is constantly scanning for beacons, and if unsuccessful at the first slot, the probability of success in the second slot is:

$$P_{success\ at\ second\ slot} = (1 - \frac{1}{SP^c_{ws}})\frac{1}{SP^c_{ws}} + \frac{1}{SP^c_{ws}}$$

Extrapolating, the probability of success in the Nth slot is[1]:

$$P_{success\ at\ Nth\ slot} = \frac{1}{SP^c_{ws}} \sum_{k=0}^{N-1} (1 - \frac{1}{SP^c_{ws}})^k \quad (5)$$

Let us now calculate the probability of getting a channel allocation reply from the CPEs by the base station. This is a measure of how frequently the base station is going to receive replies from CPEs for channel allocation. To find this, we must use the equations (2) and (3). The probability of the base station receiving a reply from a particular CPE can be calculated in the same way as before:

$$\begin{aligned} P(BS\ receiving\ reply|CPE\ sending\ reply) &= \frac{P_B P_C}{P_C} \\ &= \frac{1}{(SP^c_{ws} - A)} \quad (6) \end{aligned}$$

Now equations (4) and (6) represent the probabilities considering only one CPE. When there are N CPEs in the system, out of which A have been allocated channels, then let the corresponding probabilities of CPE receiving a beacon and BS receiving a reply are:

$$P_{CPE\ receives\ beacons} = \frac{N - A}{SP^c_{ws}} \quad (7)$$

$$P_{BS\ receives\ reply} = \frac{N - A}{(SP^b_{ws} - A)} \quad (8)$$

Therefore, from equations (7) and (8), the probability of the base station receiving a channel allocation reply on a particular channel after sending the beacon on the same channel from any one of the non-allocated nodes in the cell in any one of the slots/rounds is given by:

$$P(Recv.\ channel\ alloc.\ reply) = \frac{(N - A)^2}{SP^c_{ws}(SP^c_{ws} - A)} \quad (9)$$

If we take typical values of the parameters with no CPE currently allocated any channels, then the value of this probability is around 0.40. This means that when there are 255 (maximum number of CPEs in a cell [3]) unallocated CPEs in a cell and all are trying to be allocated a pair of channels then the base station receives 40 channel allocation reply messages from the CPEs for every 100 beacons sent per slot. This is reasonably high keeping in mind that the time duration of each slot is small.

IV. SIMULATION RESULTS

We conducted simulation experiments to evaluate the performance of our proposed channel allocation scheme. The simulator was written in C on a Linux environment. We assumed an IEEE 802.22 cell with a single base station and variable number of CPEs. However, the maximum number of CPEs was fixed at 255 as per the IEEE 802.22 draft [3]. The base station and the CPEs are randomly instantiated with a certain number of free channels that are found after scanning the spectrum range. The exact number of free channels found depends on the probability of finding white space. The number of non-allocated CPEs is varied. The value of the spectrum range is taken as 808 MHz as the TV spectrum band ranges from 54-862 MHz, each of the channels are taken of 1MHz.

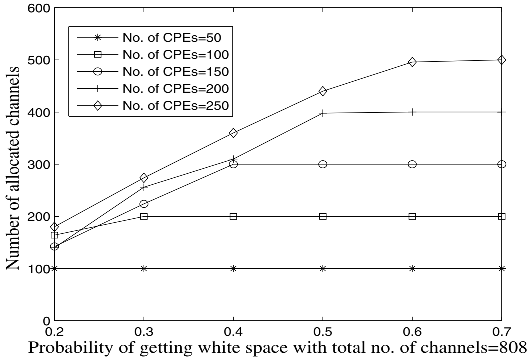


Fig. 5. Probability of getting white space vs. number of allocated channels

Fig. 5 shows the total number of allocated channels with the probability of getting white space for different values of number of unallocated CPEs in the network. Here the probability of getting white space is kept the same for base station and CPEs. The number of CPEs are varied from 50 to 250 (255 being the maximum number). The plot shows that as the probability of getting white space increases, a near perfect allocation is achieved i.e., every CPE gets a pair of channels for any number of unallocated nodes. This is quite obvious as the increase in probability of getting white space results in more free channels and this means more and more CPEs can be allocated with a pair of channels.

In Fig. 6(a) we show how our proposed scheme manages to allocate channels to CPEs as the probability of getting free channels varies. In this plot, a straight line of slope $45\ degrees$ is ideal implying complete allocation. The plot shows that with

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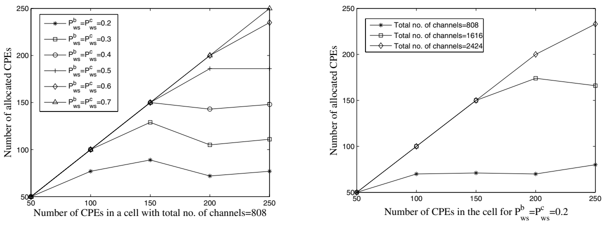
[1] Later, in Section IV, we show a characteristic of this cumulative distribution function.

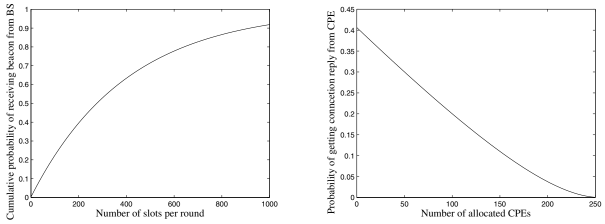


(a) (b)

Fig. 6. (a) Number of unallocated CPEs in a cell vs. number of allocated CPEs for different values of probability of white space; (b) Number of CPEs in a cell vs. number of allocated CPEs for different values of total available spectrum

the probability of getting white space of 0.7 we can achieve complete allocation to any number of CPEs present in the network. However, for probability of 0.6, we can almost have a complete allocation except at a very high value of unallocated nodes (240 and above); this situation only happens at the time of initiation of the network when all the CPEs are being allocated for the first time. For any other point of time such a high number of unallocated CPEs is rare.

The nature of the number of allocated CPEs with total number of CPEs in a cell for different values of total number of channels scanned by both CPE and BS is shown in Fig. 6(b). Here the probability of getting white space for both BS and CPE i.e., P_{ws}^b and P_{ws}^c are kept at a very low level of 0.2. It is interesting to see that even at a very low probability of getting free channels in the spectrum, if we increase the size of total spectrum i.e., by decreasing the size of each channel from 1 MHz to 500 KHz or even 250 KHz, we can achieve near perfect allocation for any number of CPEs present in the cell. However all will depend on the efficiency of modulation techniques and the level of carrier to signal interference ratio to ensure that even with channel bandwidth of 500 KHz or 250 KHz whether the promised minimum peak throughput (1.5 Mbps for downstream and 384 kbps for upstream) for a IEEE 802.22 network [3] can be achieved.



(a) (b)

Fig. 7. (a)Number of slots in a CPE round vs. cumulative probability of receiving beacon from base station; (b) Number of allocated CPEs in a cell vs. probability for the base station to receive connection reply from any of the CPEs

The characteristic of the cumulative distribution function from equation (5) is shown in Fig 7(a). From the figure it can be seen that the probability of receiving a beacon from the BS in any of the free channels by a CPE reaches more than 90% at around 1000 slots/rounds of the CPE. Although this is high, in reality the actual time before exact synchronization takes place between the base station and any one of the CPEs depends on the time of each slot/round. The smaller the time slots are, the quicker it takes for the CPE to receive a beacon from the base station after starting the channel sensing process. For small time slots not only does the time to receive a beacon from base station increase but also a near perfect (almost 100%) probability of receiving beacons for a particular CPE is achieved in a small period of time.

Fig. 7(b) depicts the characteristic of the probability of getting a reply from any CPE by the BS with different values of number of CPEs already allocated from equation 9. From the figure it is evident that the value of the probability of getting a reply from the CPEs decreases almost linearly with the number of already allocated nodes. One should keep in mind that this probability is for receiving a reply in the first slot/round of the BS; therefore it is a pdf unlike the one in Fig. 7. which is a cdf. Although the probability is low when the cell has very few unallocated CPEs, this is only the probability of getting a reply in the first round; as the number of rounds increase the probability goes up to a reasonable level which in fact gives us the cdf.

V. CONCLUSIONS

In this paper, we proposed an adaptive, robust and dynamic scheme for channel assignment in IEEE 802.22 networks. The algorithm allows the BS and CPE to share their spectrum usage report through a series of beacons from BS and reply messages from the CPEs. Based on these reports the BS allocates the CPEs a pair of channels such that there is no interference to primary incumbents. Although the allocation of channels is done centrally by the BS, the sensing is done in a distributed manner. The scheme is robust in the sense that it guarantees no interference to primary incumbent signals and the reallocation process does not disrupt the already allocated CPEs. We conducted simulation experiments to check how efficiently the algorithm is able to allocate channels; results show how allocation is dependent on parameters like probability of getting white space, total spectrum range and synchronization between CPE spectrum sensing and base station beacon broadcast. The results also verify that a near perfect allocation can be achieved even with a low probability of getting white space, no matter what the number of unallocated CPEs is.

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