IEEE 802.22 is the first worldwide standard for Cognitive Radio Network (CRN) that exploits white spaces of television broadcast. It is a standard for Wireless Regional Area Networks (WRANs) which enables broadband wireless access. In order to coexist between multiple overlapped WRAN cells a single channel self-coexistence mechanism is introduced in IEEE 802.22-2011 standard. Upon the increasing demand for customer promise equipments’ (CPE) high throughput, supporting for multichannel operation is inevitable for upcoming 802.22b amendment. In this paper, we propose a novel traffic-aware self-coexistence for multichannel operation in 802.22 WRAN such that we try to reach CPEs’ satisfactions.

1. INTRODUCTION

According to FCC, cognitive radio (CR) operation in TV white spaces (TVWS) is allowed since 2008 [1]. One of the solutions to utilization of TVWS is IEEE 802.22–2011 standard. IEEE 802.22 wireless regional area network (WRAN) is the first standard using white spaces based on a cognitive radio on TV channel between 54MHz and 862MHz [2]. IEEE 802.22 WRAN base stations (BS) operate in the region of incumbent TV station to provide service to associated CPEs.

Though coexistence between incumbents has been predominantely studied in previous years, especially in spectrum sensing, tasks still remain on the issue of coexistence between secondary users, in other words, self-coexistence. When multiple WRAN cells operate in the same vicinity, neighbor BSs should use different operating channels in order to avoid interference. For the improvement of CPE’s data rate, multichannel operation is used as a solution. However, it makes self-coexistence even more difficult than existing single channel operation.

The objective of this paper is to develop a novel traffic aware self-coexistence algorithm in multi-channel IEEE 802.22 network such that we try to reach CPEs’ satisfactions.

2. BACKGROUND

2.1 Existing Self–coexistence

Figure 1 shows the existing self-coexistence specified in IEEE 802.22. The BS1 has six neighbor cells (BS 2–7). In each cell, the operating channels are in bold, the backup channels are underlined and the others are candidate channels. When channels are enough, spectrum etiquette requires overlapped WRAN cells use different operating channels.

Otherwise, some BSs have to share the same channel in on demand frame contention (ODFC).

At a certain time, as shown in (a), BS1 discovers an incumbent transmission on its operating channel, ch 1, and backup channel, ch 2. The spectrum etiquette is triggered to change both operating and backup channels. The candidate channel 7 becomes operating channels and channel 5 becomes a backup channel. BS1 sends channel set update information to the neighbor cells through coexistence beacon protocol (CBP) packets, and the other BSs start the spectrum etiquette procedure. Since updated operating channel 7 is interference-free, thus system has steady state.

Figure 1 (b) shows ODFC procedure. If another incumbent appears on channel 7 of BS1, channel 5 is promoted as the operating channel. In this case, channel 5 is used as operating channel as well by neighbor BS5. BS1 starts contention-based self-coexistence with BS5 by sending frame contention request (FC_REQ) message to BS5 specifying the number of required frames. Once the frame contention request is granted, BS1 and BS5 start to share channel 5 in contention manner.

2.2 Shortcoming of Existing Self–coexistence

Since network utilizes more operating channels compared to the single channel operation, in multichannel operation, spectrum etiquette is triggered more frequently. The problem of spectrum etiquette is
that it transits to ODFC easily. The more spectrum etiquette transits to ODFC, the bigger possibility to contend and share channels which leads to degradation on CPEs’ satisfaction.

Besides, existing ODFC also has problem. In standard, there is no specific criteria saying which channel to choose to share. Thus, rest of thesis deals with these two problems.

3. SYSTEM MODEL

We consider a distributed cooperative IEEE 802.22 WRAN, where multiple WRAN BS operates in close proximity in an overlapped region. We assume that there are \( N \) WRAN cells competing for the \( M \) available licensed channels. In this paper, we consider reaching the CPEs satisfaction, which is

\[
SC = \begin{cases} 
1, & \text{if } \frac{N_{OCH}}{N_{CPE}} \cdot C_i \geq \lambda_i \\
\frac{N_{OCH}}{N_{CPE}} \cdot C_i, & \text{otherwise}
\end{cases}
\] (1)

Where \( N_{OCH} \) and \( N_{CPE} \) are the number of operating channel and associated CPEs of cell \( j \). \( \lambda_i \) is the traffic rate of CPE \( i \) of cell \( j \).

\[ C_i = R \log(1 + SNR_i) \] (2)

\( R \) is the peak data rate per channel which is 22.69Mbps in WRAN. \( C_i \) is the transmission rate on CPE \( i \).

4. PROPOSED SCHEME

Compared to existing self-coexistance, in spectrum etiquette, neighbor’s exclusive channels are also vet to make sure there is not enough available channels left in the neighborhood. In ODFC, blocked user ratio (BUR) is used for determining which BS and channel to share the spectrum. Using that criteria, CPEs’ satisfaction will be improved compared to random selection of existing self-coexistance.

5. PERFORMANCE EVALUATION

In Figure 3, proposed scheme outperforms at all times. That is because existing spectrum etiquette is easily transit to ODFC which causes larger BUR. It is obvious that with the increase of available channels, BUR decreases. It shows even in the situation where channels are not enough, proposed scheme still has moderate performance. Smaller BUR means most of the CPEs’ satisfaction is reach by our proposed scheme.

6. CONCLUSION

In this paper, we propose a novel traffic-aware self-coexistence for multichannel operation in 802.22 WRAN such that we reach CPEs’ satisfaction. Simulation result confirmed that proposed scheme can satisfy as much as 15% more of the CPEs when 30 channels are available.

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REFERENCE

