Sense in Order: Channel Selection for Sensing in Cognitive Radio Networks

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- Before data transmission happens, each node (secondary user) needs to find one available channel.
- If the channel is unavailable, it needs to adjust its parameters and switch to sense another channel.

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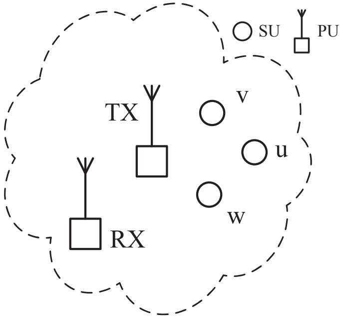

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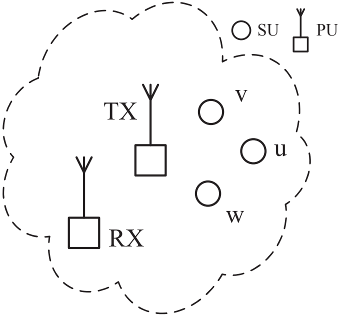

Q: How to increase the efficiency for spectrum sensing?

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- This is practical with the help of nodes nearby.
  - For example, in previous figure, node u is likely to know which channels are more likely to be available by overhearing some information provided by v and w.

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- Each looks up the list and selects a channel for sensing.

  ◦ Each node knows the order to sense, which results in a reduction of switches among channels during spectrum sensing.

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- We define the cost C_v of each node v during the spectrum sensing as the number of switches among channels that are needed until an available one is found.
- **Objective:** Provide an order of channels for sensing so that the cost during the spectrum sensing phase is minimized: Min $\sum_{v \in N} C_v$.

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- If the node finds an available channel, it will access that channel.
- The node will also broadcast when it accesses and when it quits that channel.

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- PO_m: channel m is occupied by primary users;
- SO_m: channel m is free from primary users, but is occupied by the secondary user who sent this signal;
- SF_m: Secondary user finishes transmission and quit from channel m.

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- We use $< S_i, m >$ to indicate that channel m is in state S_i:

  ◦ $< S_1, m >$: m is occupied by primary users;

  ◦ $< S_2, m >$: m is not occupied by primary users, but is occupied by the secondary user;

  ◦ $< S_3, m >$: the secondary user previously using m has finished transmission and quit from m;

  ◦ $< S_4, m >$: no signal is received about m.

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- For $< S_3, m >$, node v should assign higher probabilities for selecting m to sense.
- For $< S_4, m >$, v is not sure about the availability of m either.

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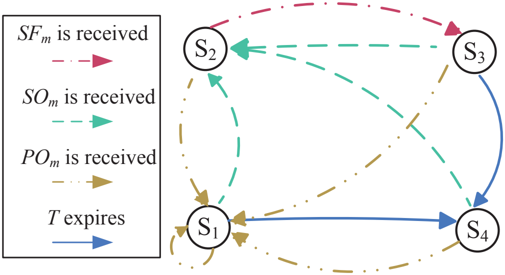

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  ∘ For node v, the whole channel set M is divided into four subsets $M_v(S_i)$, $1 \leq i \leq 4$.

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- The probability of each channel to be chosen for sensing is:

$$p_v^m = \begin{cases} \frac{t_m}{\sum_{m_0 \in M_v(S_1)} t_{m_0}} \times P_v(S_1) & m \in M_v(S_1) \\ 0 & m \in M_v(S_2) \\ \frac{T - t_m}{\sum_{m_0 \in M_v(S_3)} (T - t_{m_0})} \times P_v(S_3) & m \in M_v(S_3) \\ \frac{P_v(S_4)}{|M_v(S_4)|} & m \in M_v(S_4) \end{cases}.$$

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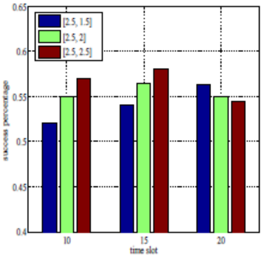
The overall structure of our algorithm for a node v is:

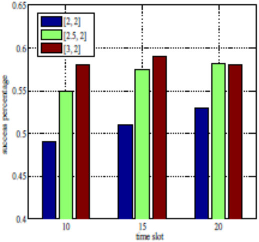
- v updates the state of each channel based on the received signal;
- When v needs to transmit data, it calculates the probability of each channel to be chosen and selects one channel to sense until it finds an available one;
- v shares its sensing results with others and sends out the corresponding signal when it accesses and quits that channel.

Simulation Results

We evaluate our algorithm performance by varying different parameters, including both network parameters and algorithm parameters.



(a) change W_4/W_1



(b) change W_3/W_4

Conclusion

- We consider the pre-phase of spectrum sensing, which focus on how to choose a channel for sensing for each node in cognitive radio networks (CRNs).
- We propose an SIO model, which constructs a state transition diagram and a corresponding algorithm for each node to calculate the probability of each channel being chosen for sensing.
- Extensive simulation results testify the efficiency of our model.

Thank you!