Adaptive and Occupancy-based Channel Selection for Unreliable Cognitive Radio Networks (CRNs)

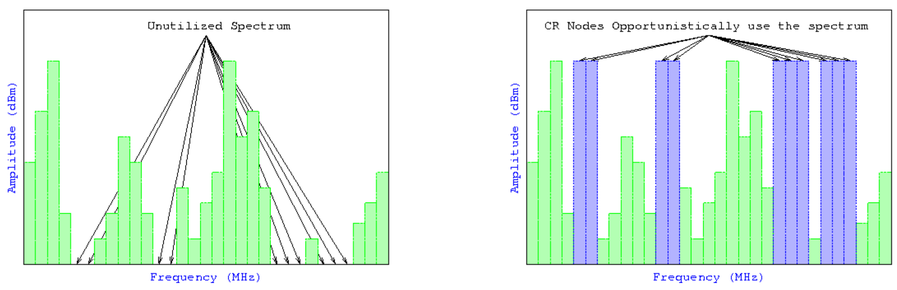
Mubashir Husain Rehmani, Aline Carneiro Viana, Hicham Khalife, and Serge Fdida

Algotel 2009 Poster Session

Cognitive Radio Networks (CRNs)

Motivation

- Limited available spectrum in today's wireless networks
- Fixed spectrum assignment policy
- Geographical and temporal utilization of spectrum varies from 15%-85% (FCC) [1]
- Results in the:
  - ✓ Inefficiency in spectrum usage
  - ✓ Creation of spectrum holes



Cognitive Radio Nodes

In CRNs, Cognitive Radio (CR) nodes:

- Utilize free parts of unlicensed spectrum
- Opportunistically exploit licensed band

Operating Constraints

- CR transmissions should not degrade the reception quality of PR nodes
- CR node should immediately interrupt its transmission whenever a neighboring PR activity is detected [2]

Challenges

- Frequency agility
  - ✓ CR nodes rapidly changes the channels
- Multiple channels
  - ✓ CR nodes can access to a range of channels
- Intermittent connectivity
  - ✓ Due to PR activity, links are not consistent
- Unreliability
  - ✓ Difficulty for CR nodes to select a particular channel

Traffic Pattern and Activity of PR Nodes

- Traffic pattern of PR nodes are of key importance
  - ✓ Highly used channel by PR nodes in terms of agility and time ⇒ Less availability of that channel to CR node
- Occupancy is time-variant and hardly predictable

Adaptive and occupancy-based Channel Selection

Our Goal

- Select channel that is less occupied by PR nodes as well as increase the number of CR receivers
- To understand the behavior of the mechanism before start with multi-hop scenario

How?

By exploiting PR Occupancy and Overhearing

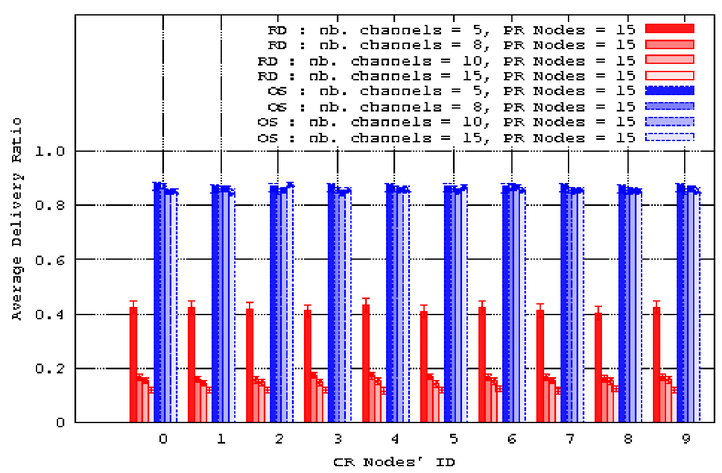
Our Solution

- Each CR node sense channels
- Classify sensed channels in the decreasing order of availability for transmission and/or overhearing
  - ✓ Based upon PR and CR Occupancy
- Approaches are present [3] that provides PR Occupancy
- Assign weights to channels based upon PR Occupancy and CR Occupancy.
- PR Occupancy ⇒ Ratio of the PR nodes utilizing the channels over total number of PR nodes on that channel.
  - ✓ Based on PR nodes that are in activity and is based on PR nodes' state (i.e. if they are active – ON – or not – OFF)
- CR Occupancy ⇒ Number of active CR nodes competing for the channel
  - ✓ CR Occupancy = 1 – PROccupancy
- Channels' weight is calculated based on formula:

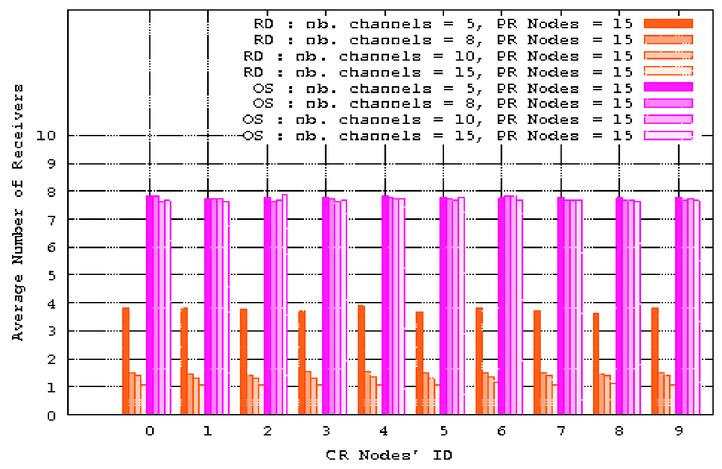
$$P_{channel} = e^{-PROccupancy} \times CROccupancy$$

Simulation Results

- Comparison: Our Strategy (OS) and Random (RD), Single-Hop Scenario, network of 10 CR and 15 PR nodes



- OS guarantees the delivery of 80-85% messages, contrarily to less than 45-40% for the RD.



- OS also guarantees from 38-40% more nodes reception than with the RD

Advantages

- Increased throughput
- Reliable communication
  - ✓ High number of CR nodes overhears the channel
- Nodes make local decision
- Decrease disconnectivity of CR nodes
  - ✓ By using channels with less PR nodes
- Empowers CR nodes with the ability to infer, based on information regarding PR Occupancy, the less occupied channels to use

Future Work

Multi-hop scenarios, opportunistically forwarding mechanisms, and comparison with related approaches

References

[1] I. F. Akyildiz, W. -Y. Lee, M. C. Vuran, and S. Mohanty, "Next Generation/ dynamic spectrum access/ cognitive radio wireless networks: a survey", Computer Networks: The International Journal of Computer and Telecommunications Networking, Vol. 50, Issue 13, pp. 2127-2159, 2006

[2] H. Khalife, S. Ahuja, N. Malouch, and M. Krunz, Probabilistic path selection in opportunistic cognitive radio networks", in Proceeding of the IEEE GlobeCom Conference, 30 Nov-4 Dec 2008, pp. 1-5

[3] T. Yucek and H. Arslan, "A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications", IEEE Communications Surveys and Tutorials, Vol. 11, No. 1, First Quarter 2009

M. H. Rehmani : Mubashir.Rehmani@lip6.fr
(ASAP/INRIA and LIP6/UPMC)
A. C. Viana : Aline.Viana@inria.fr
(ASAP/INRIA)

H. Khalife : Hicham.Khalife@lip6.fr
(LIP6/UPMC)
S. Fdida: Serge.Fdida@lip6.fr
(LIP6/UPMC)