Network Environment

We consider a multi-hop wireless cellular network comprised of agile radios in which relay networks are dynamically formed when performance on the radio access network is degraded and each relay network can be operating in different spectrum.

Contributions

- We present a network model for a dynamic multi-radio, multi-hop wireless cellular network.
- We develop relay network formation algorithms for such a network environment. These algorithms provide
  - Two-hop diversity paths between adjacent nodes to reduce bit error rate and increase throughput.
  - Frequency assignments to establish non-interfering links between mobile nodes.

Two-hop Diversity

- Received SNR at each node
  \[ r_{ad} = \frac{1}{2} \left( \frac{1}{\Sigma r_{id}} + \frac{1}{\Sigma r_{id}} \right) \]
- Error probability (Q = Gaussian tail function)
  \[ P_e = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Q} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} \, dx \]
- Received signal at each node
  \[ Y_{id} = h_{id} b + Z_{id} \]
- End-to-end error probability
  \[ P_{2e} = 1 - \prod_{d \in D} (1 - P_{d}) \]

Dynamic Network Formation

1) SNR Measurement
- Every node joining the relay network initially broadcasts a NADV message.
- Receivers measure and store the SNR value of all received signals in their neighbor table.

2) Detecting 2-hop Diversity
- Joint nodes on the direct path receive several duplicates of the ROUREQ.
- Based on the path information in the received ROUREQs, the joint node detects a two-hop diverse path between adjacent nodes.

3) Frequency Assignment
- For a direct hop:
  - If \( f_{\text{high}}\) and \( f_{\text{low}}\) have the highest SNR of the direct hop
  - Relay nodes may act as a source node.
- In order to get improved network performance, the joint node can add diversity for the relay node.

4) Add Diversity to Relay
- Normal Diversity
- Added Diversity

Performance Evaluation

Average end-to-end error probability of each node (with diversity) (12 frequencies)
Enhanced end-to-end error probability of each node (12 frequencies)
Absolute diversity percentage on the path
Relative diversity percentage on the path
The percentage of hops with interfering links

We found that algorithms that order the path discovery starting with nodes furthest from the BS perform best.

This research is supported in part by NSF grant CNS-0508114