Performance of a Cooperative Network using Rate Adaptation and Cooperative Combining

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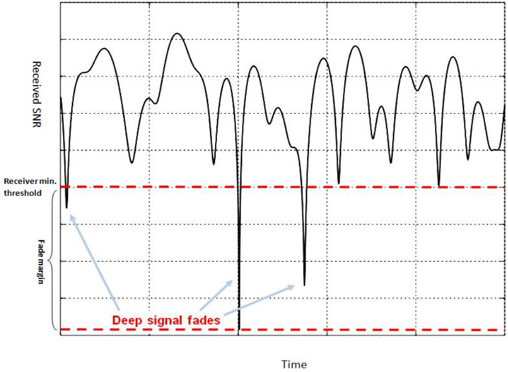
Introduction

Cooperative Diversity

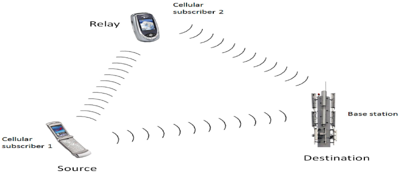
What is Diversity?



- multipath, shadowing
  - Reduced performance
- Independent signal paths
  - Better performance under fading
- Diversity
  - frequency, time, and space

Cooperative Diversity

What is Cooperative Communication?



Cooperative Diversity

Cooperative Networks

Cooperation schemes

Decode-and-forward (DF) or regenerative

Amplify-and-forward (AF) or non–regenerative

Adaptive Transmission

Why adapt?

- Conventional
  - Increase Tx power to account fade margin
- Adapt Tx parameters
  - Better average performance under fading

Adaptive transmission in Cooperative Networks

- Both techniques enhance performance.
  - Cooperation combats fading.
  - Adaption increases overall performance.
- How integration of two techniques improves system performance.

System and Channel model

Figure: System model.

- Nakagami-*m* fading
- Decode and forward
- C-MRC policy is used to combine signals
- Ideal feedback link aids adaptation at source

Adaptive M-QAM

Performance metrics

- Mode selection probability
- Outage probability
- Average throughput
- Average bit error rate

Rate Adaptation with Cooperative MRC

Cooperative combining & decoding

- Decoding errors at relays
  - error propagation
  - can't get full diversity
- Relay information - better results
  - CSI at relays
  - BER at relays

Cooperative combining & decoding ctd.

Weighted combiner

- MRC gives very low performance
- Decoding errors
  - different symbols

Cooperative MRC (T. Wang et. al. 2005)

- Why C-MRC ?
  - near ML performance
  - simplicity
  - full diversity is achieved

Cooperative MRC ctd.

Figure: Average BER of a two relay Network using BPSK with i.i.d. Nakagami-m fading $(m = 2)$ channels.

Cooperative MRC ctd.

Figure: Average BER of a two relay Network using BPSK with i.i.d. Nakagami-m fading ($m = 2$) channels.

Cooperative MRC ctd.

Figure: Average BER of a two relay Network using BPSK with i.i.d. Nakagami-m fading ($m = 2$) channels.

What is the received SNR?

- What is the total received SNR after C-MRC ?
- Resort of simpler heuristic approximation of SNR
  - equivalent SNR
  - based BER simulation results
  - reasonable accuracy
  - easier to use

Rate adaptive *M*-QAM with C-MRC

Heuristic approximation for received SNR

- SNR is approximated as

$$\gamma_{ap} = \gamma_{s,d} + \sum_{i} 0.5 \min(\gamma_{s,r_i}, \gamma_{r_i,d}) \quad (1)$$

Fitness of Approximation

Figure: Average BER for cooperative network with 2 relays and i.i.d. Nakagami-m fading ($m = 2$) channels.

Fitness of Approximation

Figure: Average BER for cooperative network with 2 relays and i.i.d. Nakagami-m fading ($m = 2$) channels.

Rate adaptive *M*-QAM with C-MRC

- Approximation is used to find the SNR at receiver - select mode at Tx
- Expressions for performance metrics are derived from PDF of SNR

Results

Average spectral efficiency

Figure: Average spectral efficiency for i.i.d. Nakagami-m fading ($m = 2$) for a two relay network.

Results

Average bit error rate

Figure: Average bit error rate for i.i.d. Nakagami-m fading ($m = 2$) for a two relay network.

Conclusions and Summary

- Proposed a heuristic approximation for the SNR of CMRC method.
- Analysed the performance of a Relay network with adaptive transmission using CMRC.
- Due to decoding errors at relay nodes the performance degrades.

Thank You