Towards Distributed Transmission Scheduling for Wireless Ad Hoc Networks

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Outline

Introduction

- Aim: propose distributed algorithm for channel selection in wireless ad hoc network.
- Assumptions:
- Limited number of channels (FDM, TDM, SDM)
- No Active Link protection, aim for more fairness and better performance

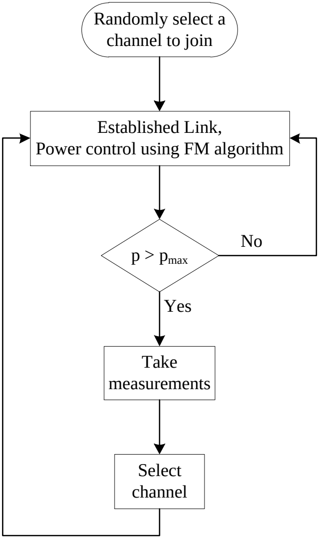
System Model

1. Network Model
    - Nodes have omnidirectional antennas
    - Links between nodes are unidirectional
2. Channel model
    - $\Gamma_i = \frac{g_{ii} p_i}{\sum\limits_{j \neq i, j \in T} g_{ji} p_j + \nu_i}$
    - Cross-node interference is major
    - No cross-channel interference

Algorithm Overview

- Basis of our algorithm:
- Foschini-Miljanic algorithm. Uses SINR of previous reception at the receiver end. Requires feedback
- Measured channel characteristics:
  1. Interference (I)
  2. Rate of change of interference. (ΔI) Probing process is used to measure reaction to a low powered transmission by node.
- Important to take measurements while channel is stable
- Calculated channel metric: $Q \triangleq I \times \Delta I$

Proposed algorithm



Adaptation of the FM algorithm

- Probing process causes temporary spikes in sensed Interference.
- Such spikes can potentially kick legitimate, stable links from the channel
- A buffer/counter is implemented to allow slower reaction of the FM algorithm.
- To efficiently take measurements, we used an aggressive configuration of the FM algorithm (proportionality gain $k = 0.9$)

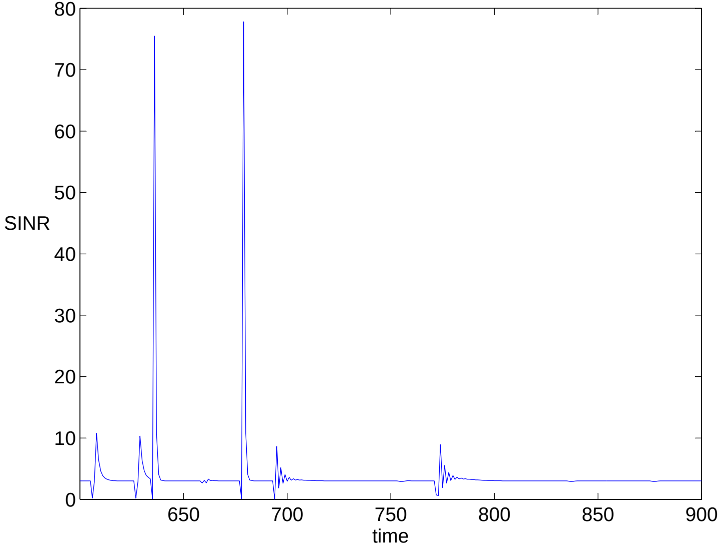
Selection of a channel

- Random selection
  - Uniformly random
  - Weighted random with I^{-1} as weight
  - Weighted random with Q^{-1} as weight
- Deterministic selection
  - Minimum(I)
  - Minimum(ΔI)
  - Minimum(Q)

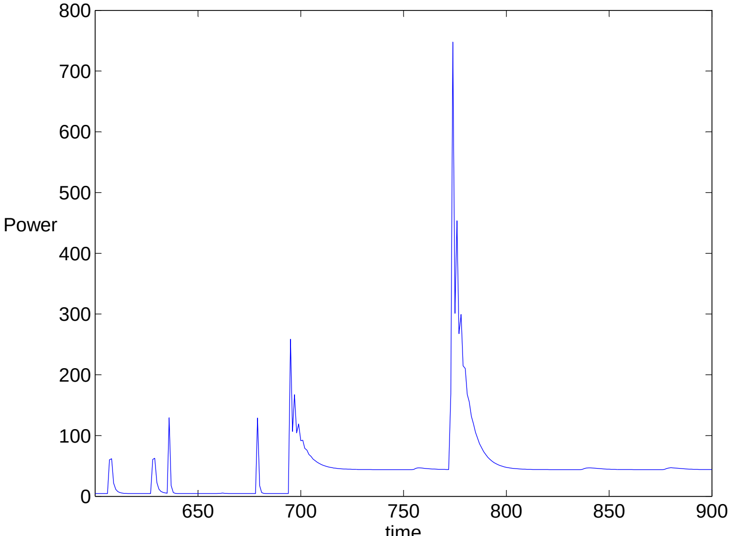
Performance measures

- Simulation using MATLAB
- Best estimate of algorithm performance is the number of nodes that reached their desired SINR level γ_i
- In the optimal solution, the nodes in a network would all reach their desired SINR in the optimal number of channels
- Simulations for number of channels: optimal, optimal+1, optimal+2

Example of a communication pair reaching its desired SINR



Example of the previous communication pair's power in reaction to events



Example of another communication pair reaching its desired SINR

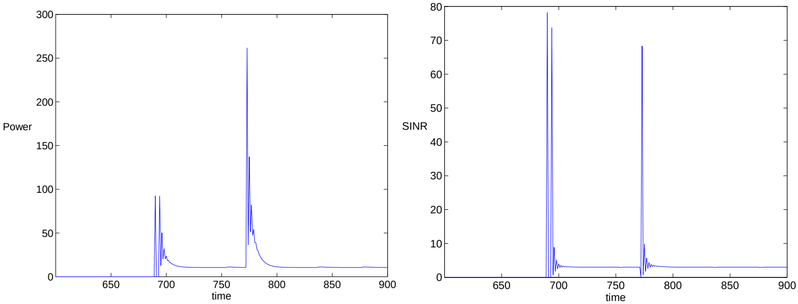
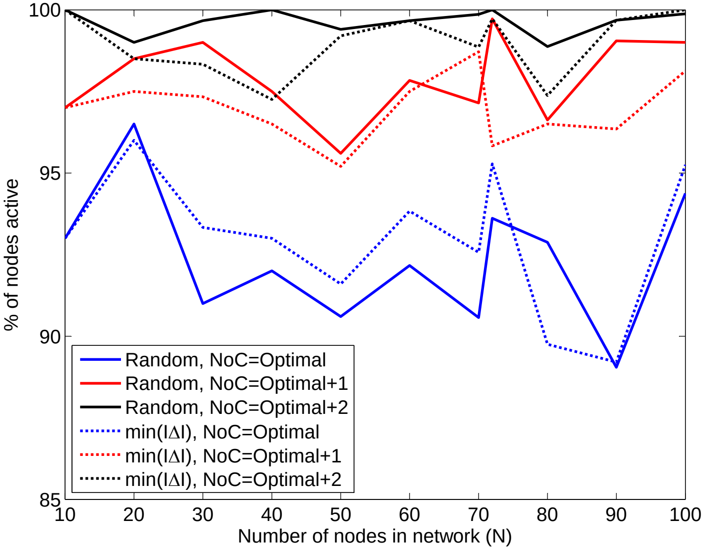


Figure: The transmitter's power and SINR levels for node 39, for a simulated time period.

Comparison of selection schemes



Conclusions and future work

- Deterministic approaches work, but so do random schemes
- Trade-off between transmitter complexity and negligible performance improvement
- Use of relay nodes could further improve performance

Questions?