Relay-Aided Failover in Wireless Networks using Adaptive Unicast Scheduling

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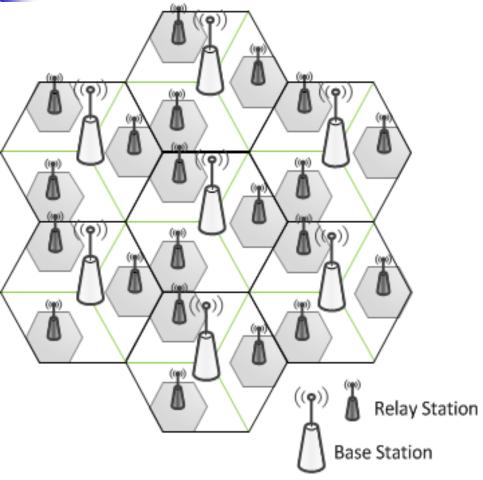UCLA

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Objectives and Motivations

- Cell outage management is functionality that aims to automatically detect and mitigate outages that occur in wireless cellular networks due to unexpected failures.

- Develop scheduling algorithms with power and rate adaptation to compensate for coverage and performance degradations during network failure events.

- Fixed relays are deployed as part of the infrastructure to relay messages between base stations and mobile stations.

Relay-Aided Cellular Network Configuration
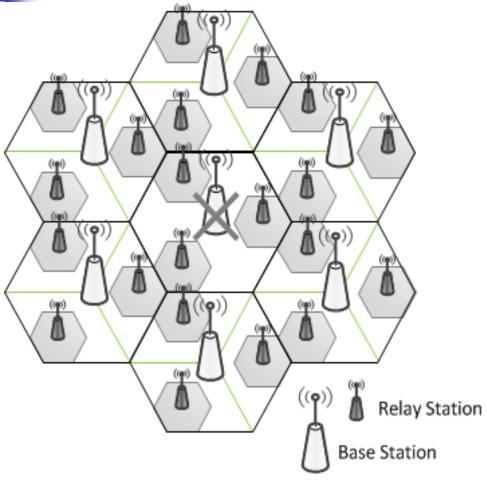

Relay Station

Base Station

- Base Stations (BSs) coordinate scheduling operations

- Base Stations use tri-sectored antennas

- Adaptive rate/power unicast transmissions

- Fixed relay stations may be employed to aid operation under base station failure

Relay-Aided Cellular Network Configuration

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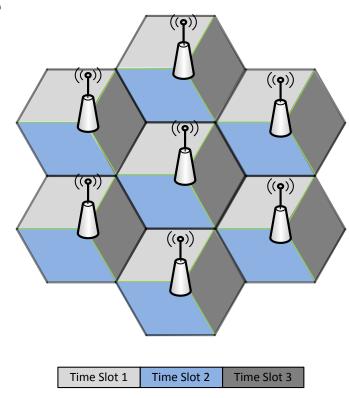- Fixed relay stations may be employed to aid operation under base station failure

Static Coloring Algorithm

The static coloring algorithms are used as a baseline comparison to our adaptive algorithms.

- Coloring Algorithm Without Relays

  - Static 3-color algorithm, all simultaneous transmissions have same directionality.

  - Base station downlink transmission rates are adapted to the SINR monitored at receiving mobile stations.

| Time Slot 1 | Time Slot 2 | Time Slot 3 |

Static 3-Color Scheduling

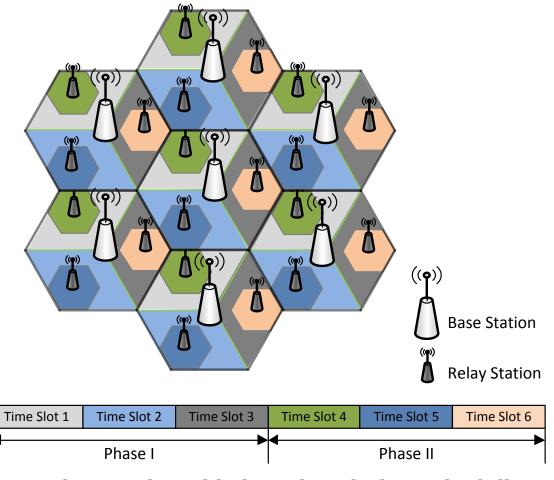# Relay-Aided Static Coloring Algorithm

- Two-Phase Relay-Aided Coloring Algorithm
  - Determine whether a mobile station should receive the packet directly from the BS, or through relay stations.

  - **First Phase:** base stations transmit to the relay stations and the selected set of mobile stations that are close to it.

  - **Second Phase:** relay stations transmit to mobile stations using omni-directional antennas.

Relay-Aided Static Coloring Algorithm (2)

Base Station

Relay Station

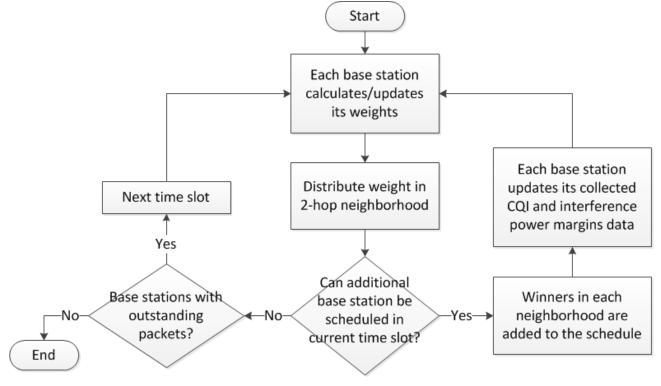| Time Slot 1	Time Slot 2	Time Slot 3	Time Slot 4	Time Slot 5	Time Slot 6
		Phase I		Phase II	

Two-Phase Relay-Aided Static Coloring Scheduling

Adaptive Scheduling Algorithm

■ Our adaptive algorithm is based on the iterative scheduling of base stations that realize the highest throughput in their two-hop base station neighborhood.
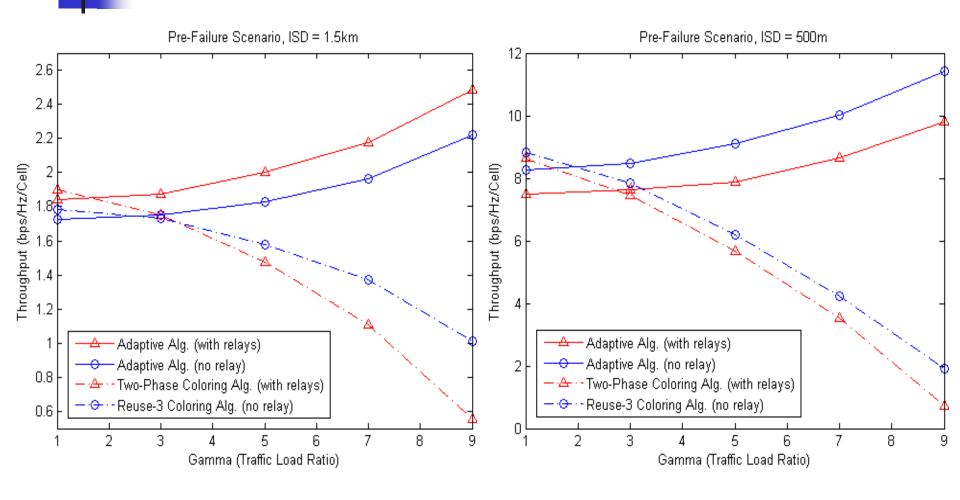
Simulation Setup

- Network Layout
    - 35 macro base station cells with tri-sectored antenna
    - Each cell contains 3 relay stations (one for each sector)
- Transmit power levels
    - Macro base stations [0-40W] with tri-sectored antenna
    - Relay stations [0-10W] with omni-directional antenna
- Number of mobile stations: 1400
    - Uniformly distributed in cell areas
- Cost-Hata propagation model
- Transmission bandwidth: 5 MHz
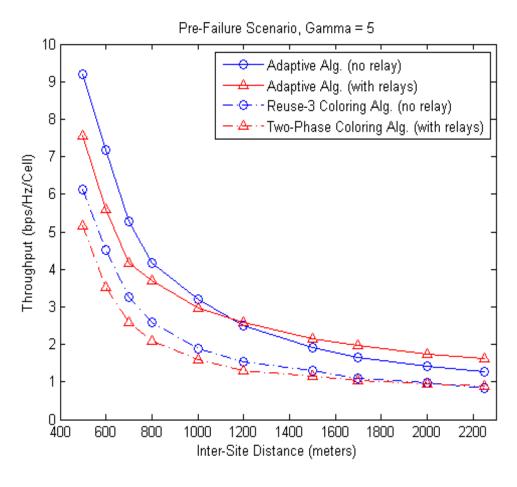- Gamma represents the heterogeneity in traffic loading levels for each cell
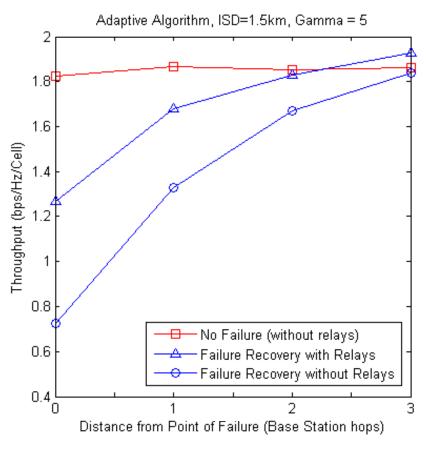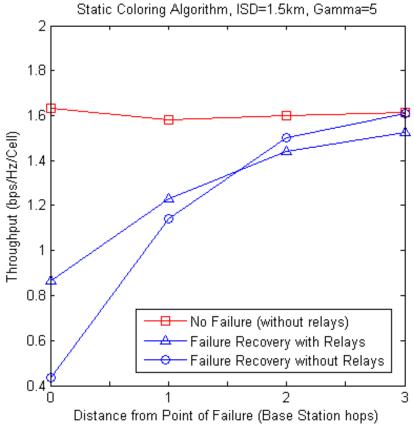
Pre-Failure Simulation Results

Pre-Failure Simulation Results (2)

Post-Failure Simulation Results

Conclusions

- We study failover schemes, with and without relay stations, for adaptive unicasting in wireless cellular networks.

- Following the failure of a base station, our failover schemes lead to the dynamic selections of transmit power and rate levels, in scheduling unicast transmissions by neighboring base stations and relay stations.

- Our adaptive algorithm is scalable with the increase in traffic heterogeneity levels, and outperforms the static coloring algorithm.

- We observe that relay stations are effective under the scenario when ISD is large.

- Our latest development results with adaptable coloring schemes provide good performance in heterogeneous traffic loading environment.

Q & A