Superposition Coding for Wireless Mesh Networks

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MAC Scheduling with Superposition Coding
- Treat existing scheduler as black box
- Always transmit head-of-line packet
- Maximize throughput given current channel conditions

Algorithm Sketch

Precede(pkt_{ad}, d) - On receiving packet pkt_{ad} with next hop d, from basic scheduler
0. for each rate r_{ij} and direction d != d_{ij} do
1. if r_{ij} not supported by d then
2. continue
3. for each rate r_{ij} do
4. r_{ij} = max rate supported by d in second layer
5. if scheduling transmission serially has better throughput then
6. continue
7. Select N_{ij} = \lfloor \frac{r_{ij}}{r_{ij}} \rfloor packets to d from queue
8. Effective throughput is r_{ij} (1 + N_{ij})
9. endfor
10. Select neighbor d' and rate r_{ij} combination with best effective throughput
11. Schedule pkt_{ad} in first layer at rate r_{ij}. and N_{ij} r_{ij} packets in second layer at rate r_{ij}

Superposition Coding Background

Encoding
- Weaker receiver's packet is allocated most power
- Stronger receiver's packet(s) is allocated remaining power
- Finally, modulated signals are summed

Decoding
- Weaker receiver decodes by treating additional packet as interference
- Stronger receiver decodes first layer, subtracts it out, then decodes remaining packet

ns-2 Evaluations

Single transmitter with multiple receivers
- Receivers placed at random around transmitter
- Average gains around 20% with 2 or 4 receivers

GNU Radio Prototype
- Extend 802.11 standards for superposition coding
- First known implementation of superposition coding in GNU Radio
- Measurements show similar gains as displayed in evaluations

Mesh network with multiple gateways
- 25 flows from gateways to non-gateways via multi-hop path
- Average gains range from 26% to 46%

Transmitted Packet

Layer 1

Layer 2

12 Mbps

36 Mbps

36 Mbps

36 Mbps

Throughput gain ratio

Number of receivers

Throughput gain ratio

Number of gateways