

# Transmission Power Management in Ad Hoc Networks: Issues and Advantages

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# Introduction

- We present two power control schemes to demonstrate issues and advantages of power control in wireless networks.
- Compare power control with no power control.

# Background

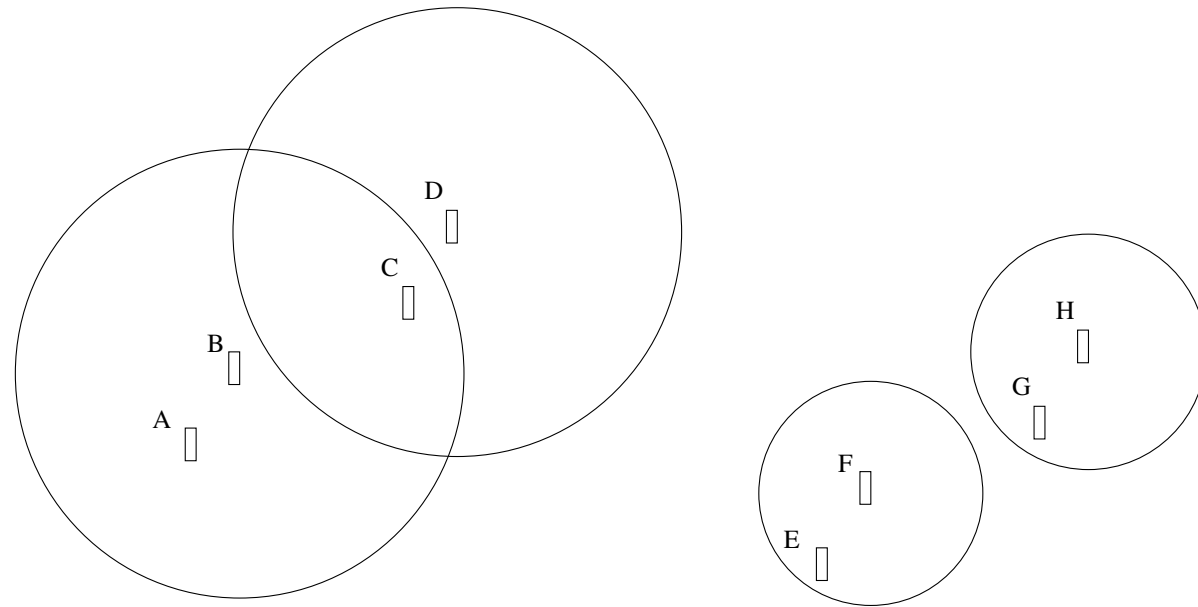
Power control has taken three directions:

- choosing a power level that will maintain network connectivity, or bounding the number of one-hop neighbors
- designing power efficient routing algorithms
- modification of the MAC layer to support a sleep mode

We focus on control of transmission power levels.

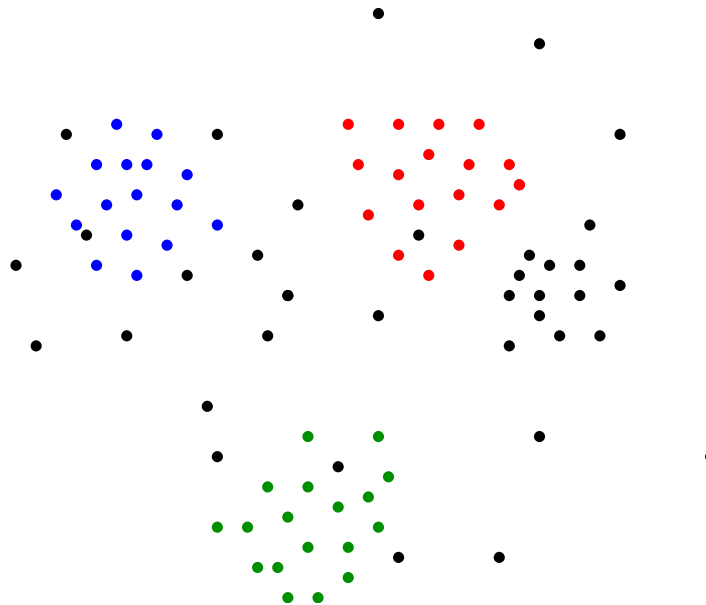
# Motivation

- Transmission power affects communication range
- If A and B are talking then C and D must remain silent
- Because of reduced communication range, E and F can talk while G and H can talk



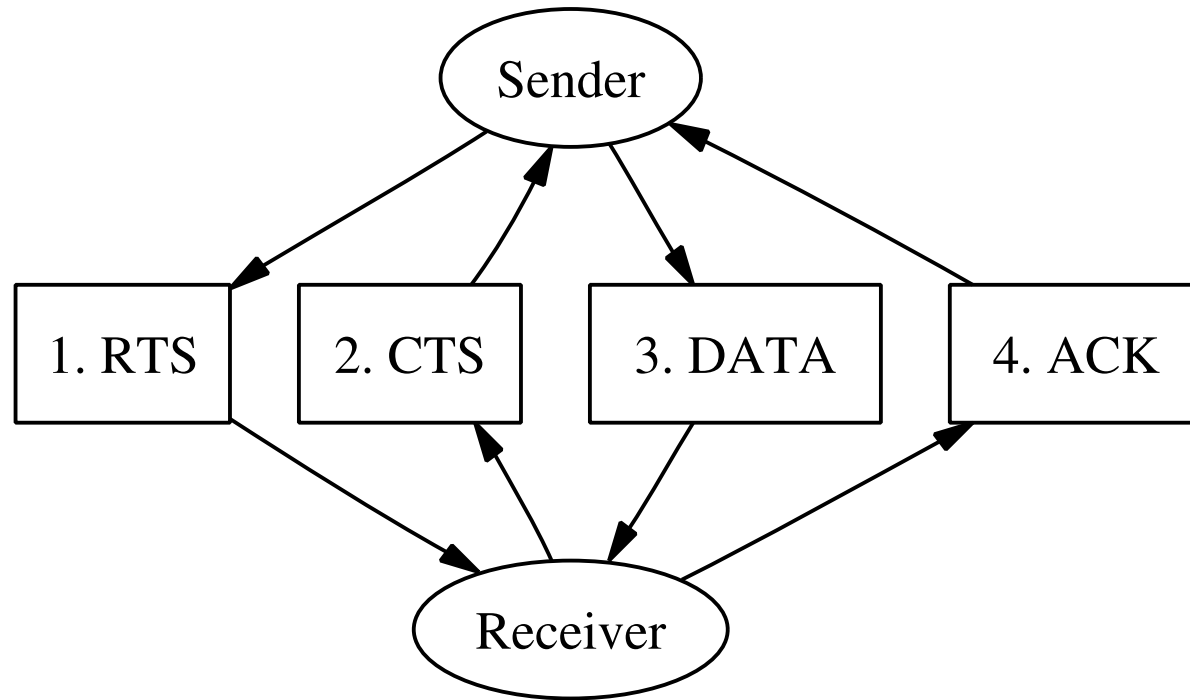
# Motivation (cont.)

- networks are non-homogeneous
- physical topology can change
- communications occur mostly with nearby nodes



# Low-Level Power Control

- Assume a scheme similar to IEEE 802.11



# Low-Level Power Control (cont.)

- Attach transmission power to each packet
  - so the receiving node can estimate the link gain
- Each node tracks the last transmission power used
- An expiration policy is attached to each item in the table

# Low-Level Power Control (cont.)

- Capacity of spread spectrum networks is limited by interference
- Power control algorithms maintain a fixed signal-to-interference ratio at each node

# Low-Level Power Control (cont.)

- Transformed transmission power control into a state space control problem
- Use an optimal control technique to control transmission power levels
- Optimal control will be compared with BASIC control

# Simulation Environment

## Using NS-2.27

- supported by DARPA in 1995
- supports IEEE 802.11 through CMU Monarch extensions

## NS Limitations:

- No mechanism for adaptive control of transmission power
- Interference model too simple

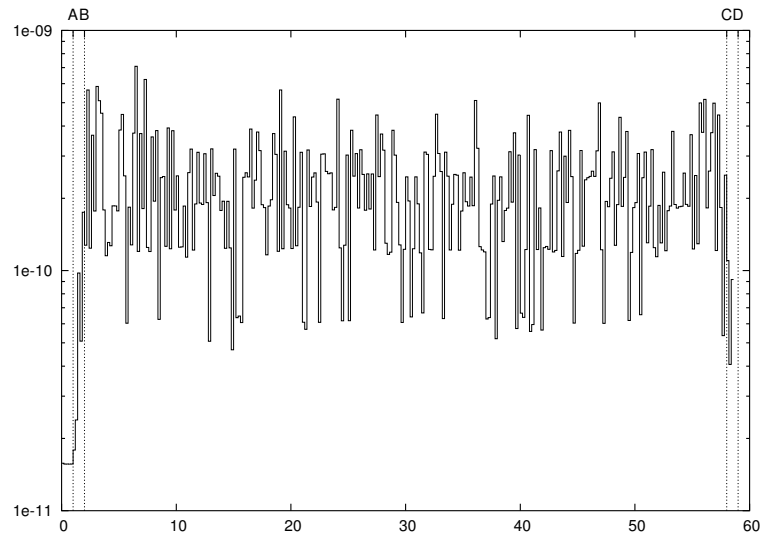
# Simulation Environment (cont.)

## NS Modifications:

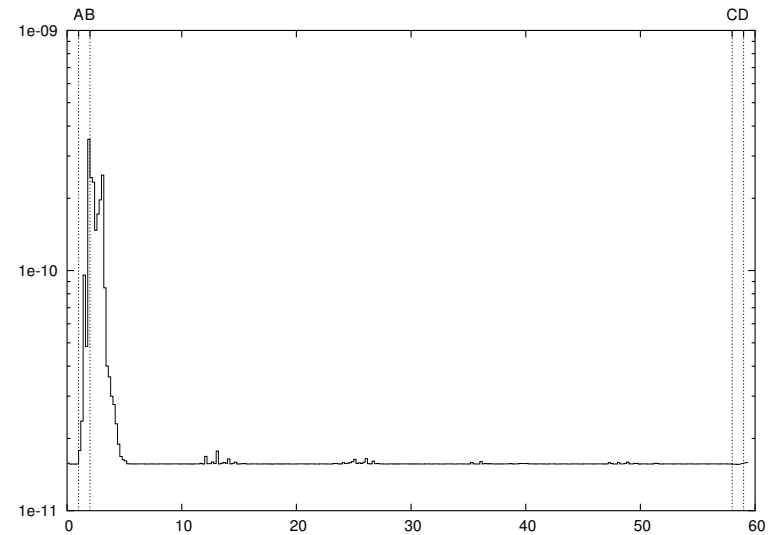
- Hooked the PHY and MAC layers
- now possible to control transmission power levels
- Interference is now computed from all transmissions
  - now possible to determine the SIR of each received packet

# Simulation Results: Interference

- (a) no power control, (b) with power control



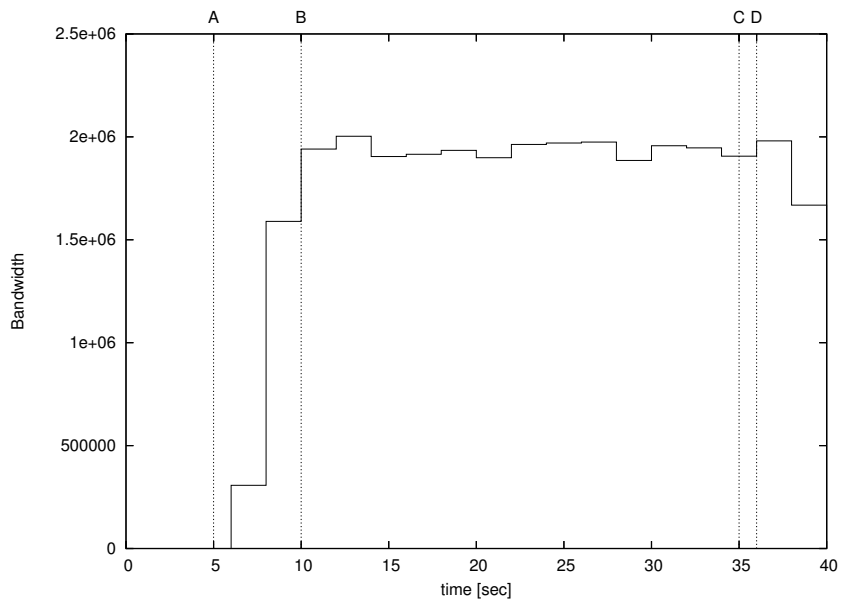
(a)



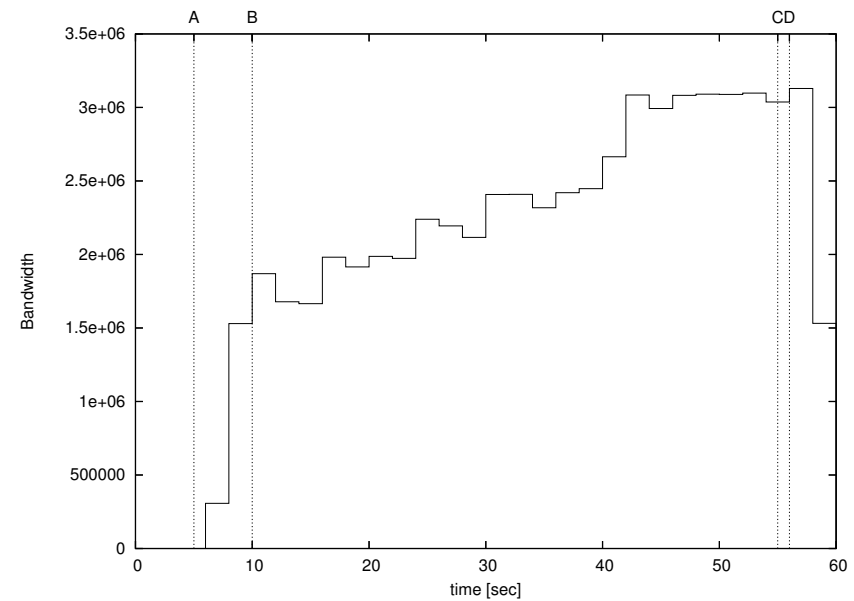
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# Simulation Results: Bandwidth

- (a) no power control, (b) BASIC power control



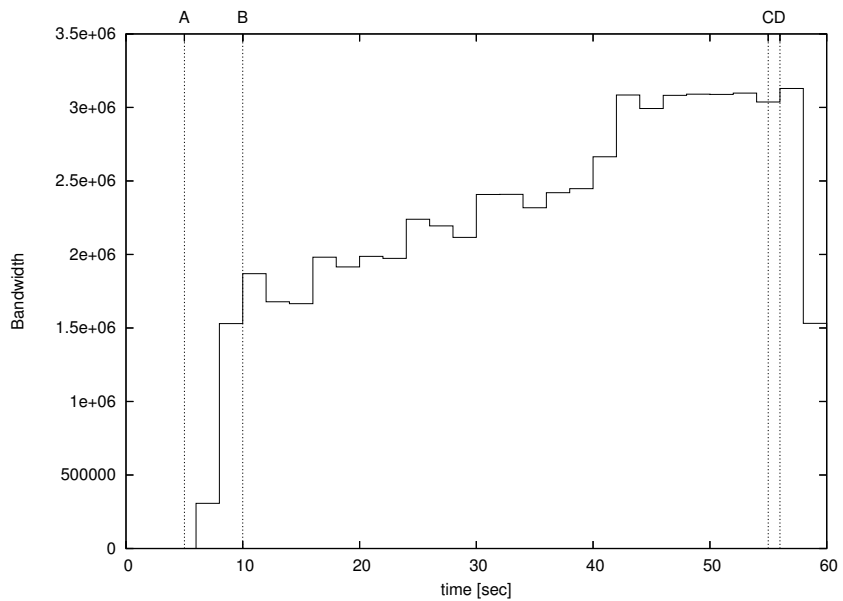
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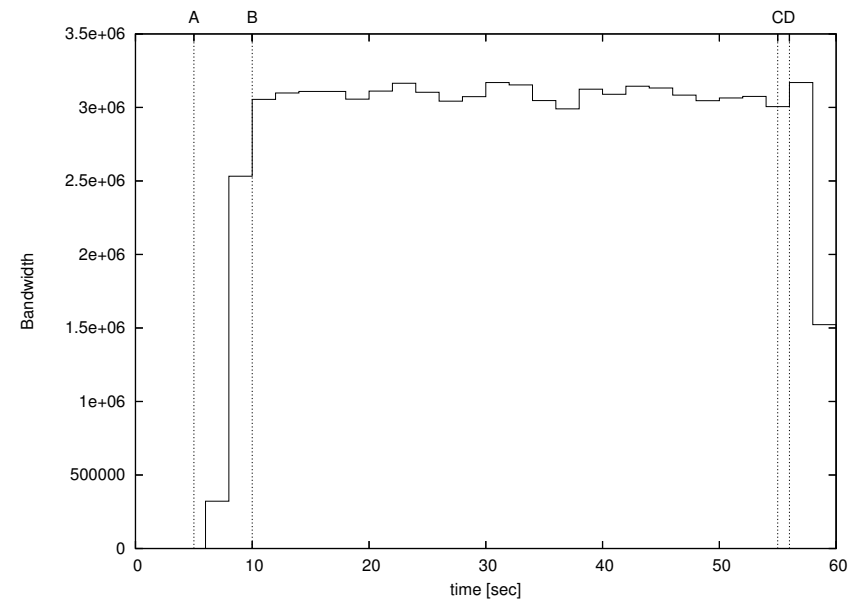
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# Simulation Results: Bandwidth (cont.)

- (a) BASIC power control, (b) optimal control



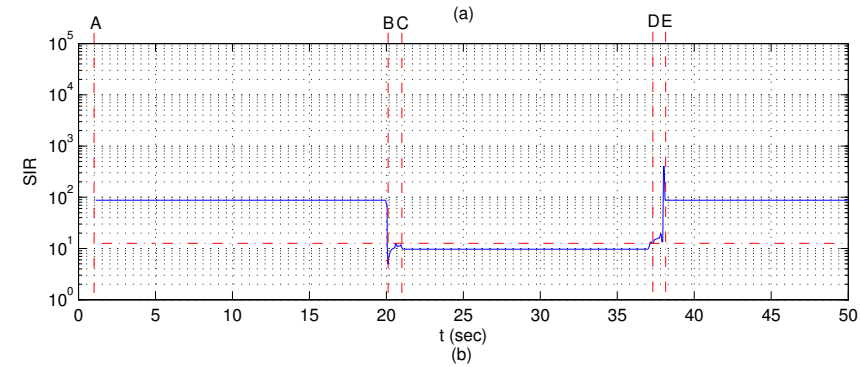
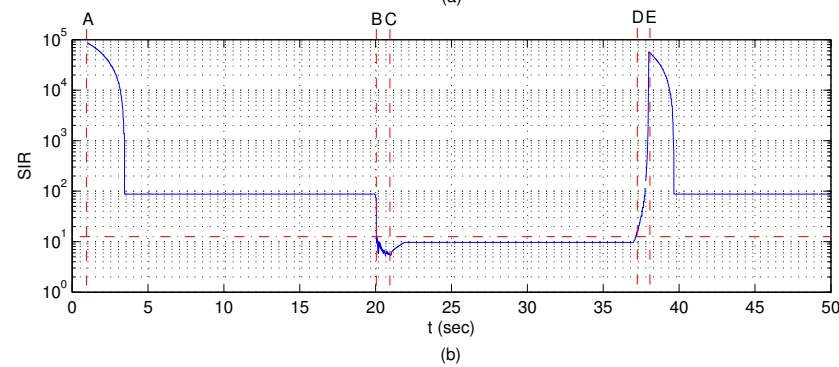
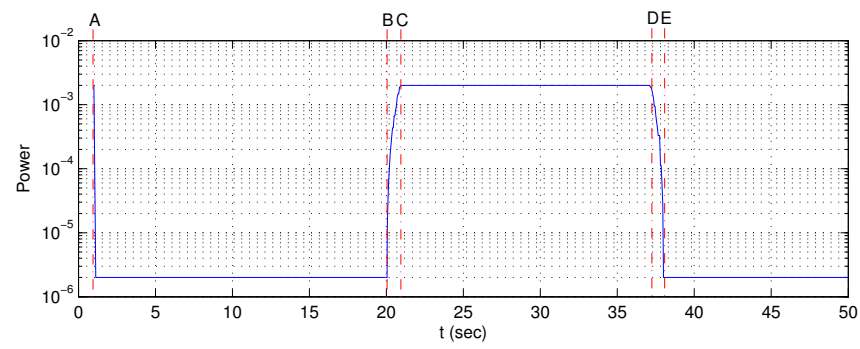
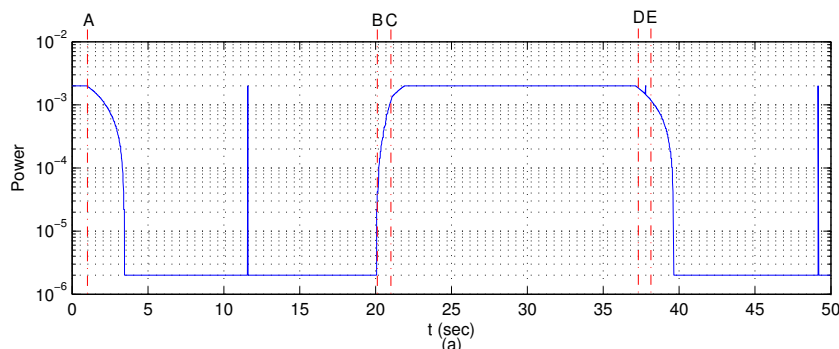
(a)



(b)

# Simulation Results: Power Levels

- (a) BASIC power control, (b) optimal control

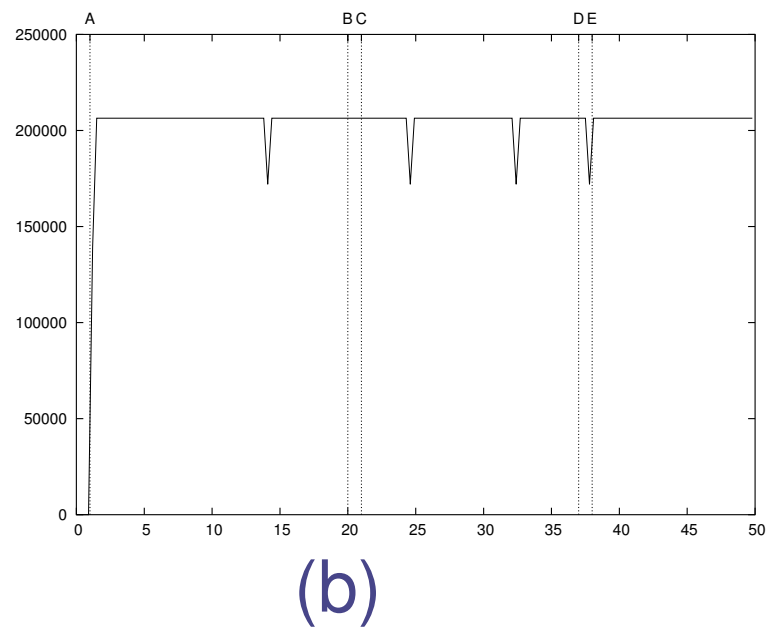
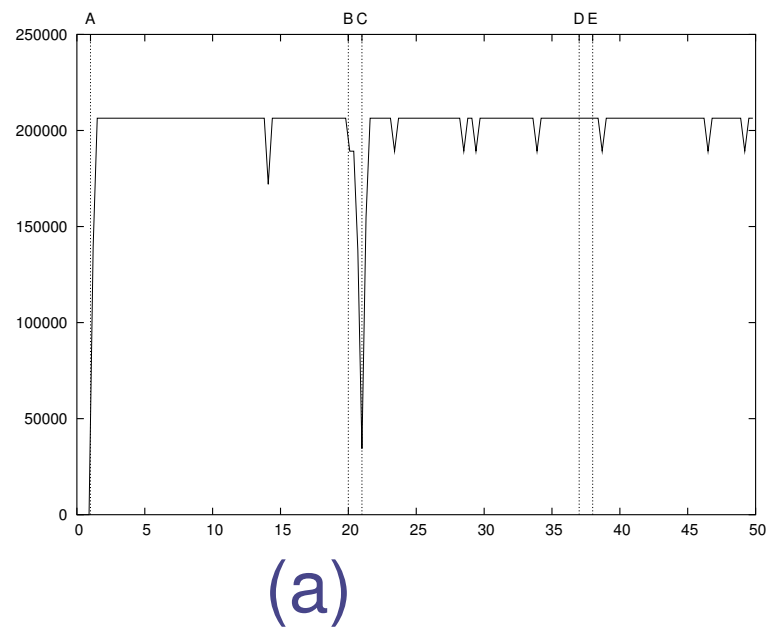


(a)

(b)

# Simulation Results: Bandwidth Loss

- (a) BASIC power control, (b) optimal control



# Conclusions

- Power control can be used improve performance.
- But if not carefully designed, power control can have the opposite effect.

# Future Work

Because the design of power control is dependent on system topology, it is hard to generalize the effectiveness of power control.

Future directions may be in pursuing a learning algorithm that reacts to changes in topology.

# Questions