

# **Power Control MAC Protocol Analysis and Improvement for Ad Hoc Networks**

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# Introduction and Related Work

- The Problem

A wireless node in an ad-hoc network has limited battery power.

# Solutions

- A power control scheme

At the MAC layer, varies the power at which the control and the data packets are sent

# Related Works

- IEEE 802.11

Each packet is sent with the same maximum transmission power

- BASIC scheme

A Control packet (RTS/CTS) is sent with maximum transmission power.

A Data packet is sent with minimum necessary transmission power.

- PCM

The RTS/CTS handshake is sent with maximum transmission power.

A DATA packet is sent with periodically maximum transmission power

# Background

- **Transmission Range ( $A_{tx}$ )**

No collisions

- **Carrier Sensing Range ( $A_{cs}$ )**

Nodes set their NAV to EIFS.

- **Interference Range ( $A_i$ )**

Collisions occur.

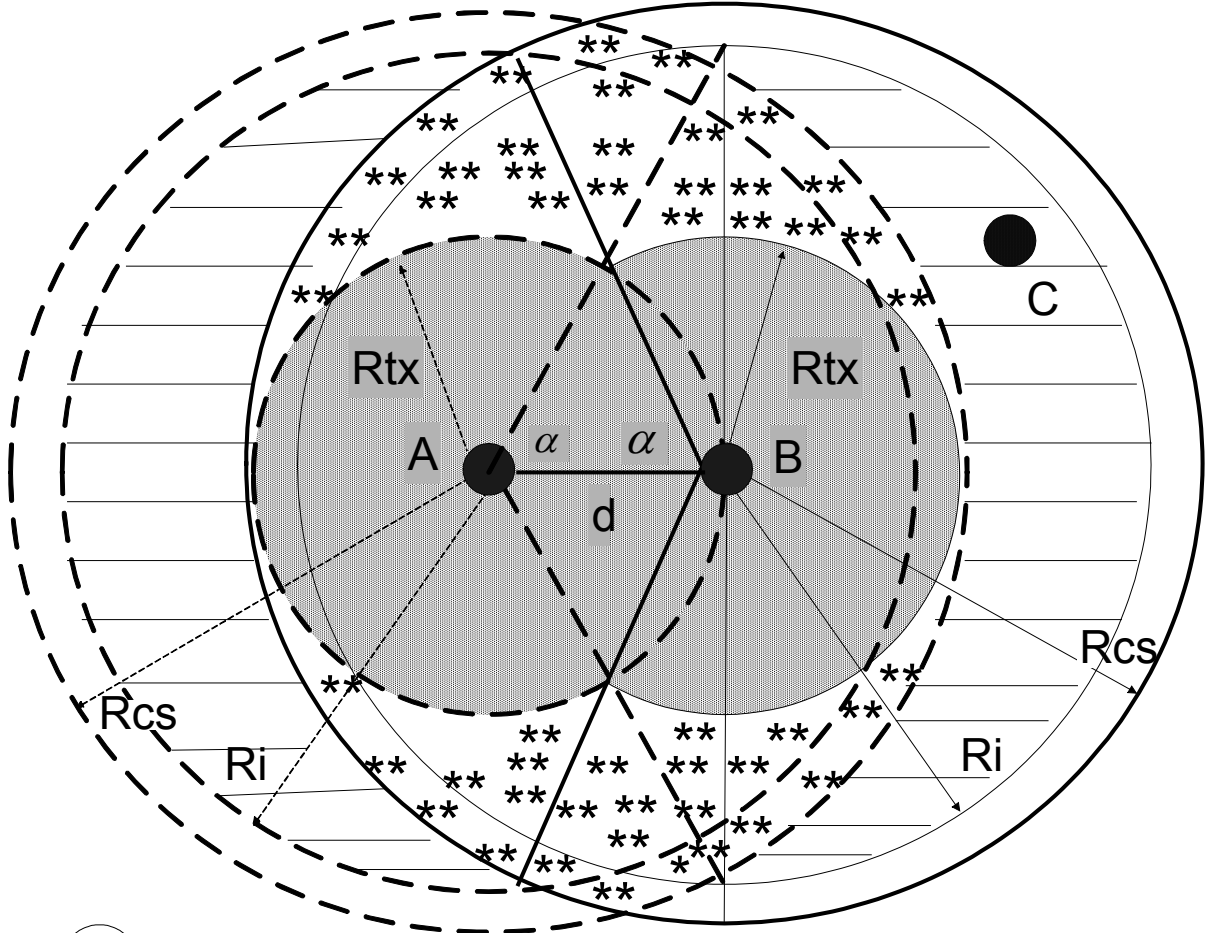
# Power Level and Interference Range




- $R_{cx} = 2R_{tx}$

- $R_i = 1.78n^{1/4}d$        $R_{tx} \geq d \geq 0.56R_{tx}n^{-1/4}$

$P_i = nP_t$      $d$  is the distance from the sender to the receiver.

# Effectiveness of RTS/CTS Handshake



-  ACT interference ranges of nodes A or B
-  Interference ranges covered by carrier sensing ranges of nodes A or B
-  Interference ranges covered by transmissions ranges of nodes A or B

$$E_{RTS/CTS} = \frac{\text{Effective Area}}{\text{Total Interference Area}}$$

$$E_{RTS/CTS} = \begin{cases} 1 & \text{if } 0 \leq d \leq 0.56R_{tx} \\ \left( \frac{1}{2} - \frac{\alpha}{\pi} \right) + \frac{R_{tx}^2}{R_i^2} \left( \frac{1}{2} + \frac{4\alpha}{\pi} \right) & \text{if } 0.56R_{tx} \leq d \leq R_{tx} \end{cases}$$

# Conclusion

- The larger transmission power will not help to reduce the interference range (hidden nodes).
- The larger transmission power will reduce throughput.

# Analysis of Power Control MAC Protocols

- IEEE 802.11 and PCM

The same number of hidden and deferring nodes.

- BASIC

Two times hidden nodes as 802.11 and PCM have and the same number of deferring nodes.

# Efficient Low Power Control MAC Protocol

- Find the minimum necessary transmission power
- Each packet is sent with same minimum transmission power

# goals

- Reducing energy consumption
- Improving throughput

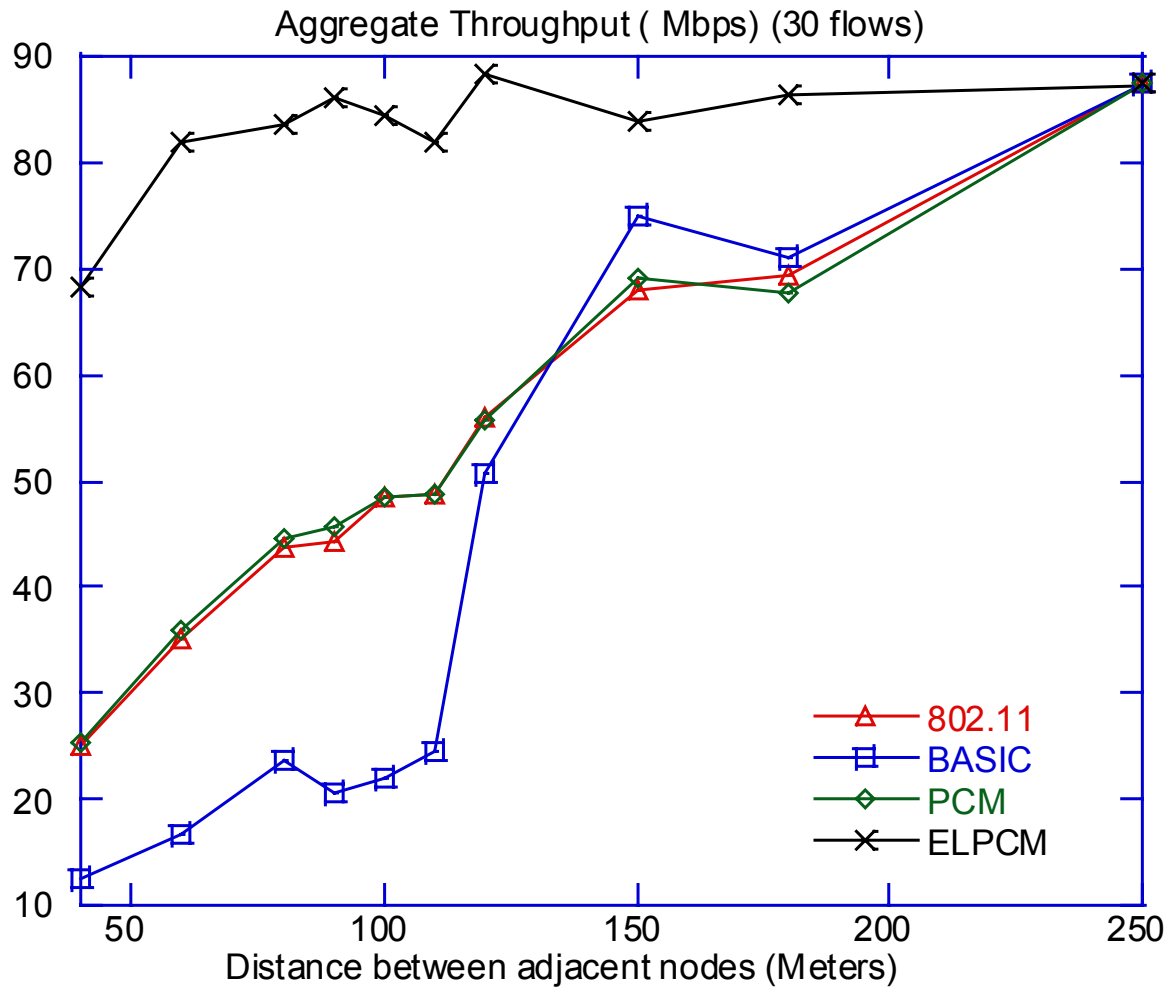
# Simulations

- Chain topology
- Random topology (50 topologies)

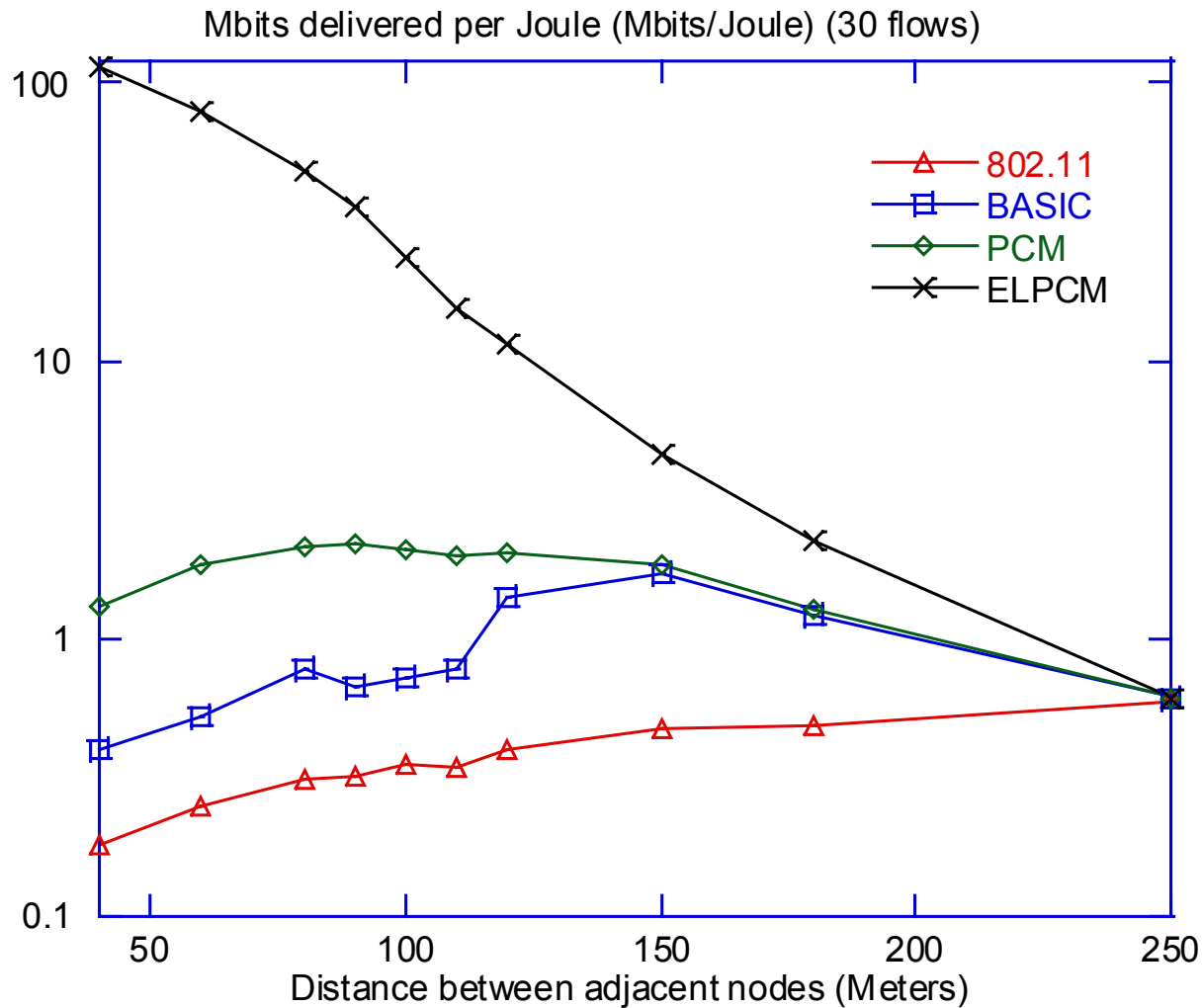
# Metrics

- Throughput
- Data delivered per joule
- Data packet corruption ratio

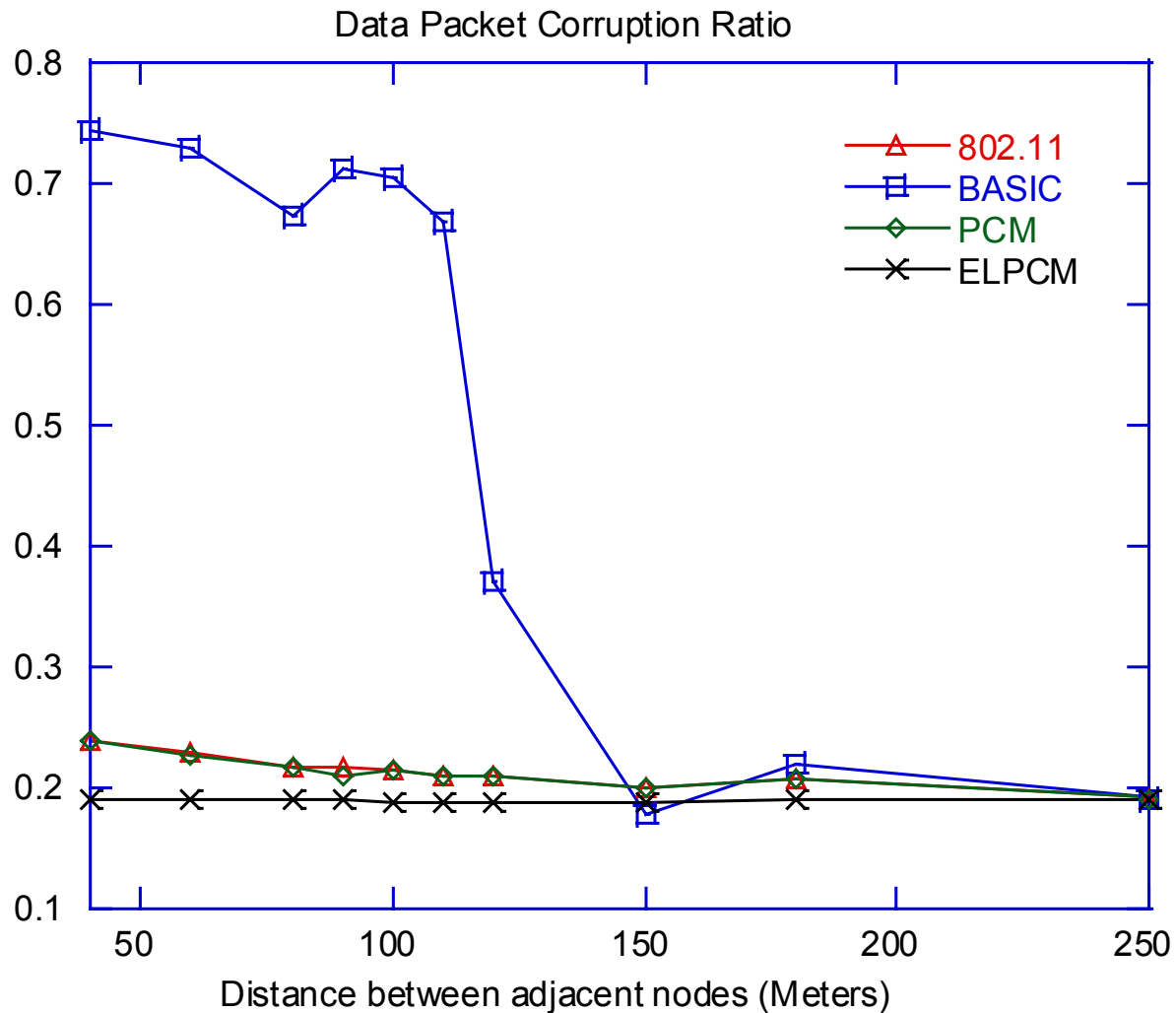
# Chain Topology



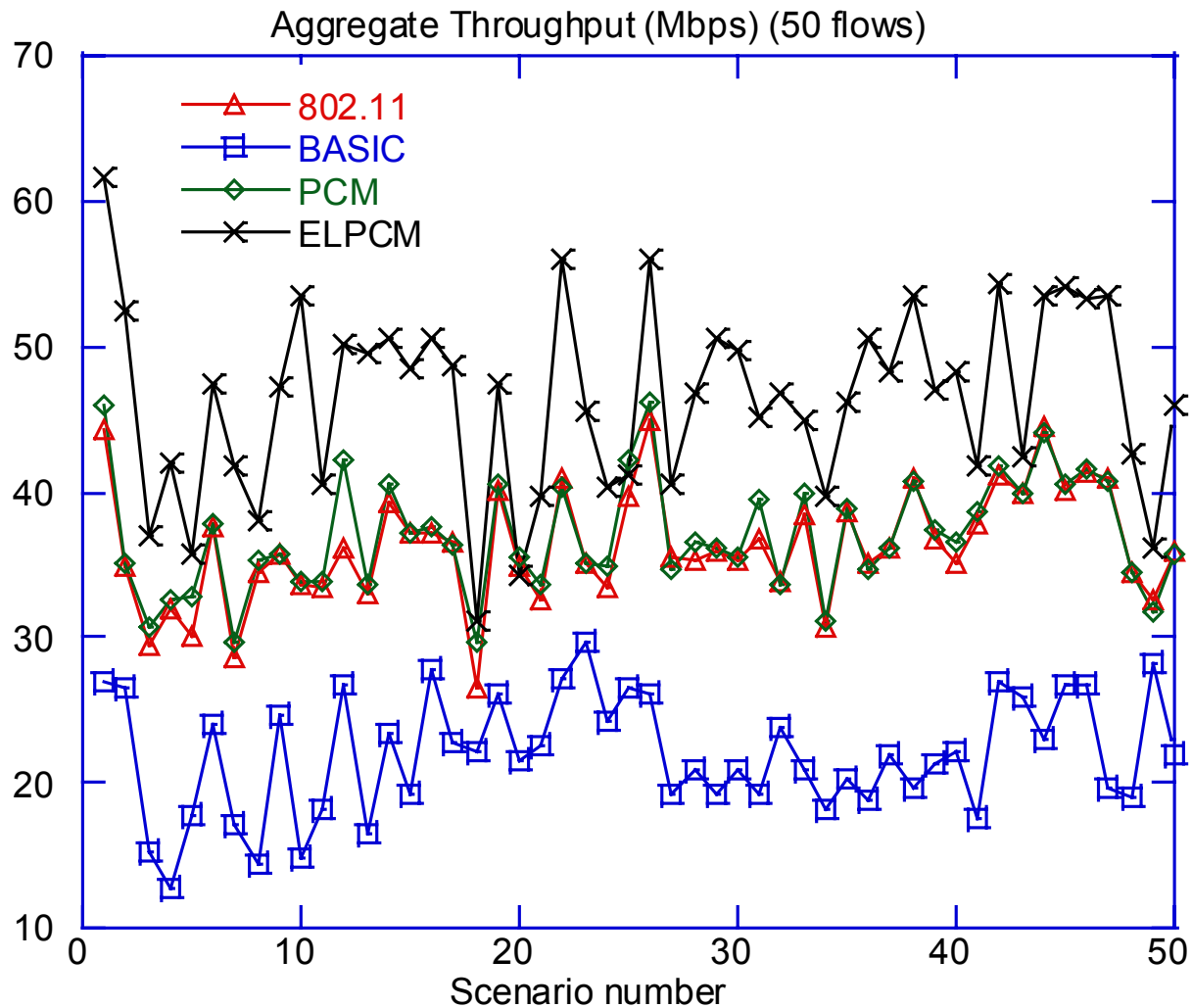
# Chain Topology



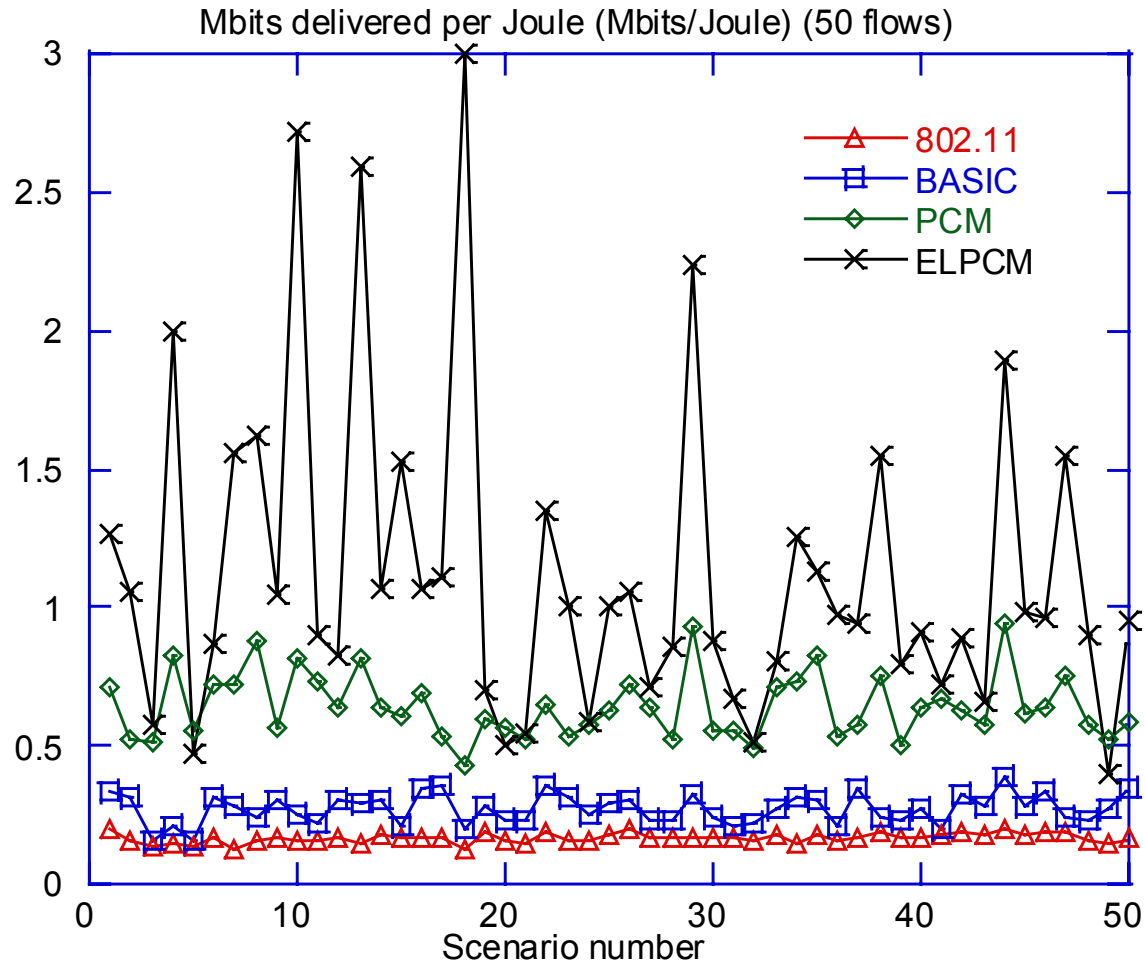
# Chain Topology



# Random Topology



# Random Topology



# Random Topology

