Channel Dependent Class Based Queuing

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Outline

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  - problems with CSMA-based MAC
  - simulation results
- Link scheduling solution
- Summary
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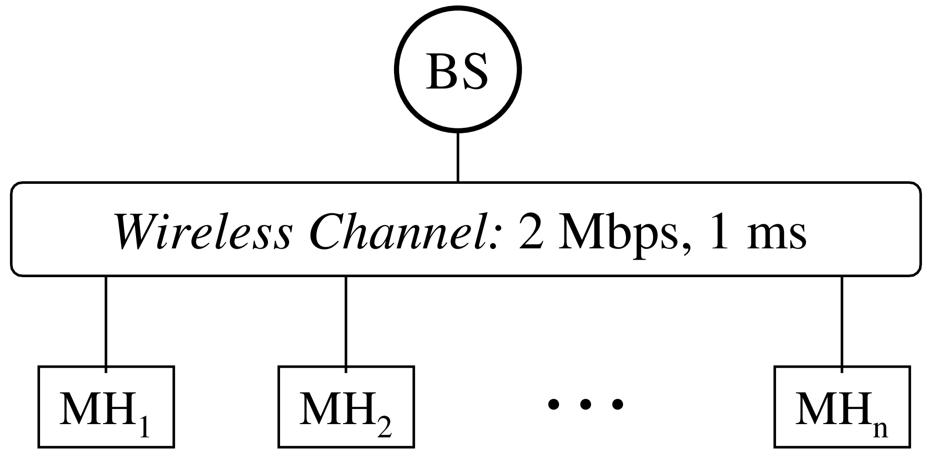
Motivation

- Wireless LAN characteristics
  - Channel quality varies over time and space
  - Errors are bursty (correlated) due to fading
  - Limited bandwidth shared among users
  - Cannot support large number of users effectively
- Our goal:
  - Cell Scaling: support large number of users
  - Adaptive to loss and delay requirements

Wireless MAC

- Carrier Sense Multiple Access (CSMA)
  - Collision detection not possible: hidden-terminal
  - Lower utilization as number of users increase
  - Unfairness
- CSMA/CA MAC (WaveLAN)
  - Collision Avoidance using exponential backoff
- IEEE 802.11 MAC
  - Distributed Coordination based on CSMA/CA
  - Optional: RTS/CTS, Point Coordination

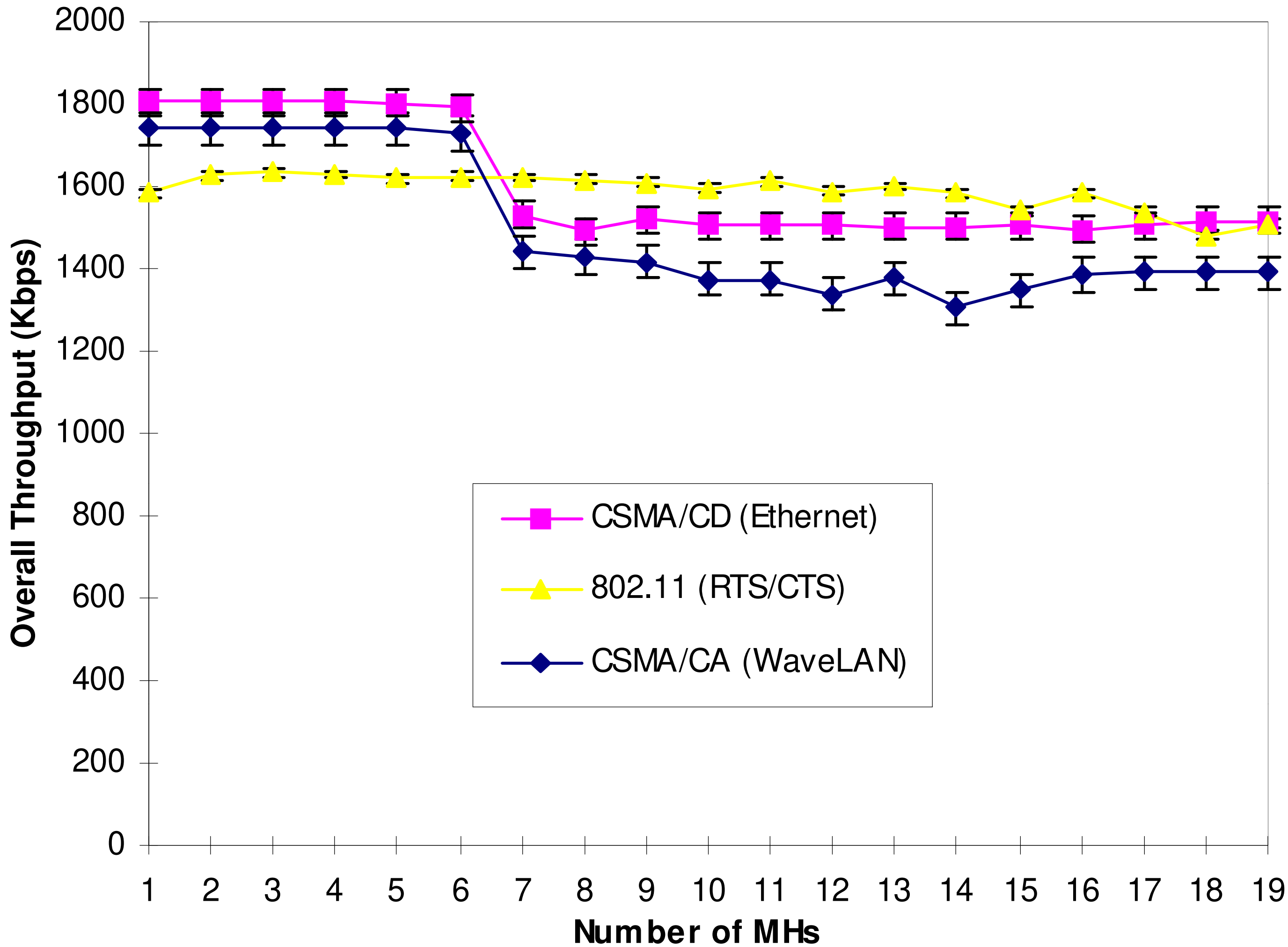
Simulation Setup



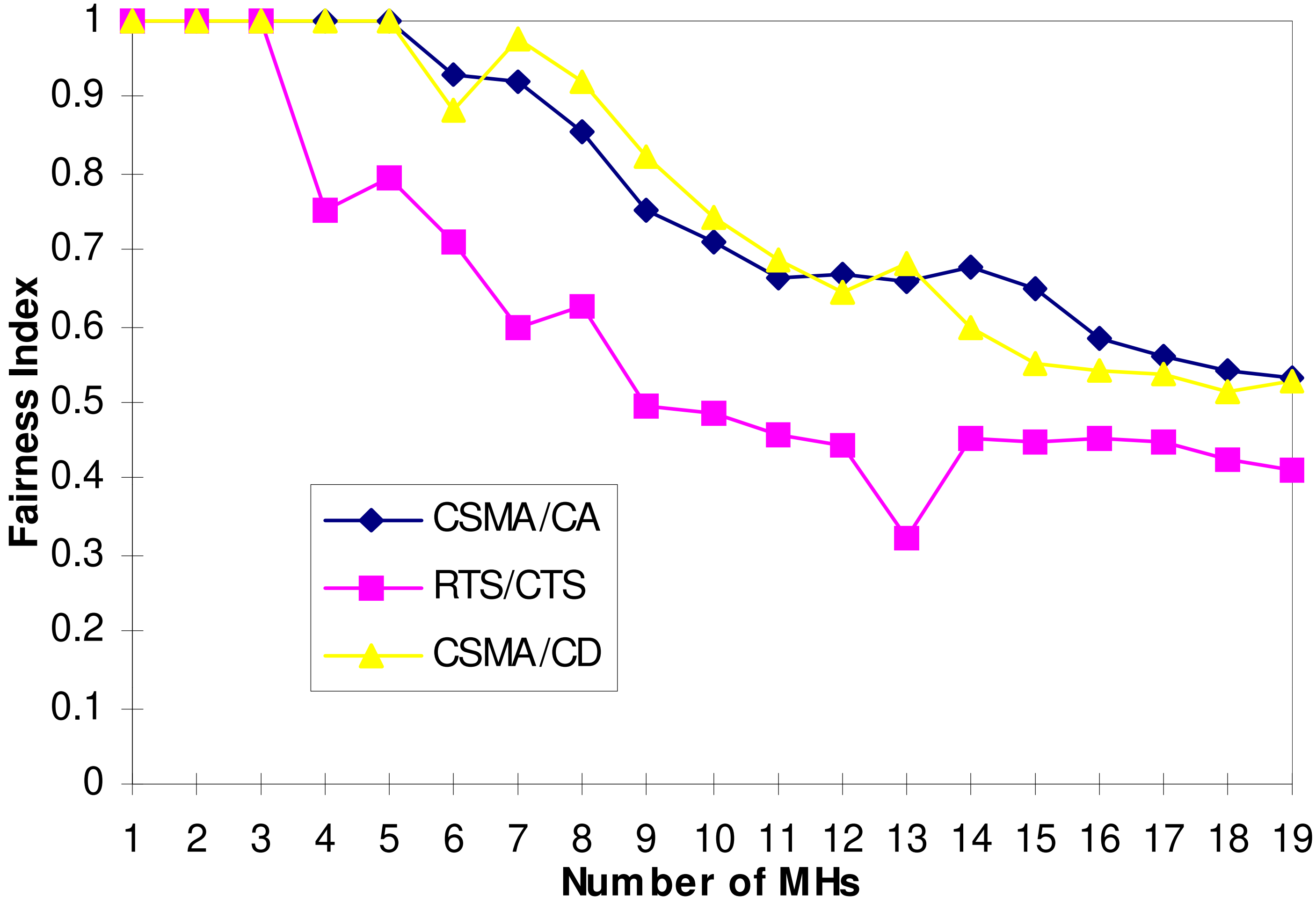
- Parameters chosen to model WaveLAN system
- Each MH has a single FTP download and error model
- Metrics
  - Throughput and Fairness Index

$$\frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n \sum_{i=1}^{n} x_i^2}$$

Throughput of MAC protocols



Fairness of MAC protocols



Problems with FIFO scheduler

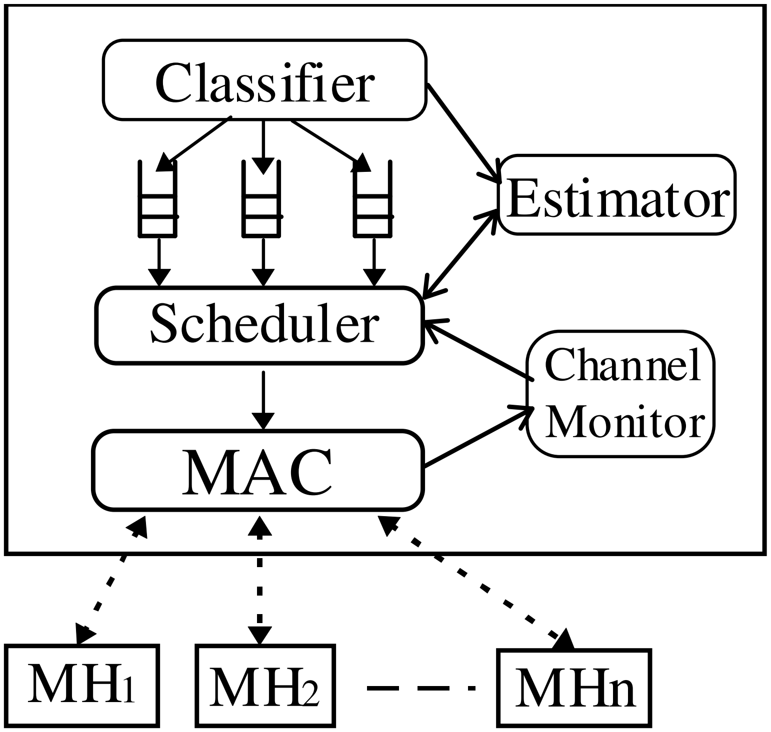
- Inadequate for wireless network
  - assumes all receivers have similar network quality
  - transmission during fades leads to low utilization
- Unfairness
  - Tends to favors faster connections
    - leads to even worse fairness behavior
  - Not sensitive to application requirements such as delay and loss

Link Scheduling Solution

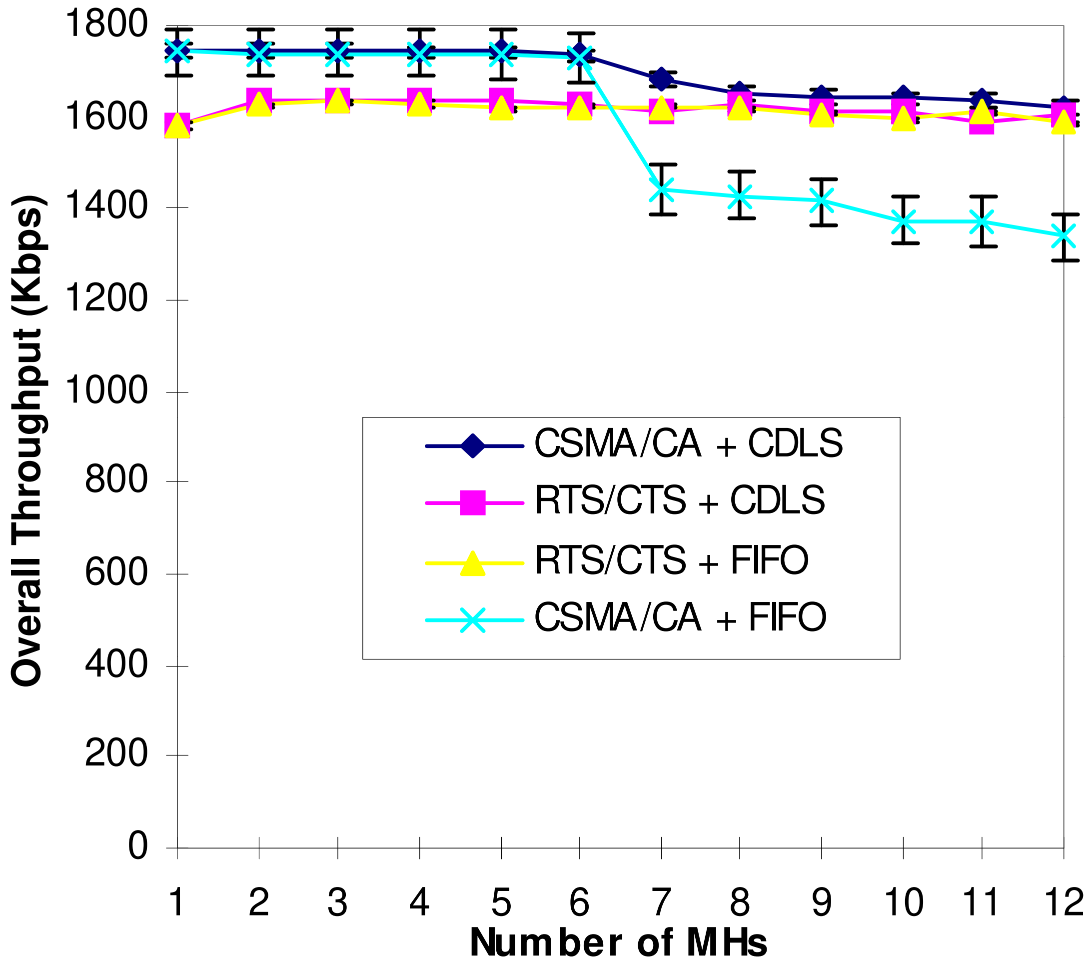
- Based on CSDP work done at U. Maryland
- Works effectively at the base station
  - improve bandwidth allocation
  - improve fairness
  - adapt to application requirements
- Takes into account channel quality
  - Receive-side error rate, SNR
  - Receiver's outgoing queue length

Channel Dependent CBQ

- Components
  - Classifier
    - class based queuing
    - based on receiver and traffic
  - Channel Monitor & Estimator
    - monitor channel quality for individual mobile host (MH)
    - estimate future error rates
  - Scheduler
    - select queue for dispatching

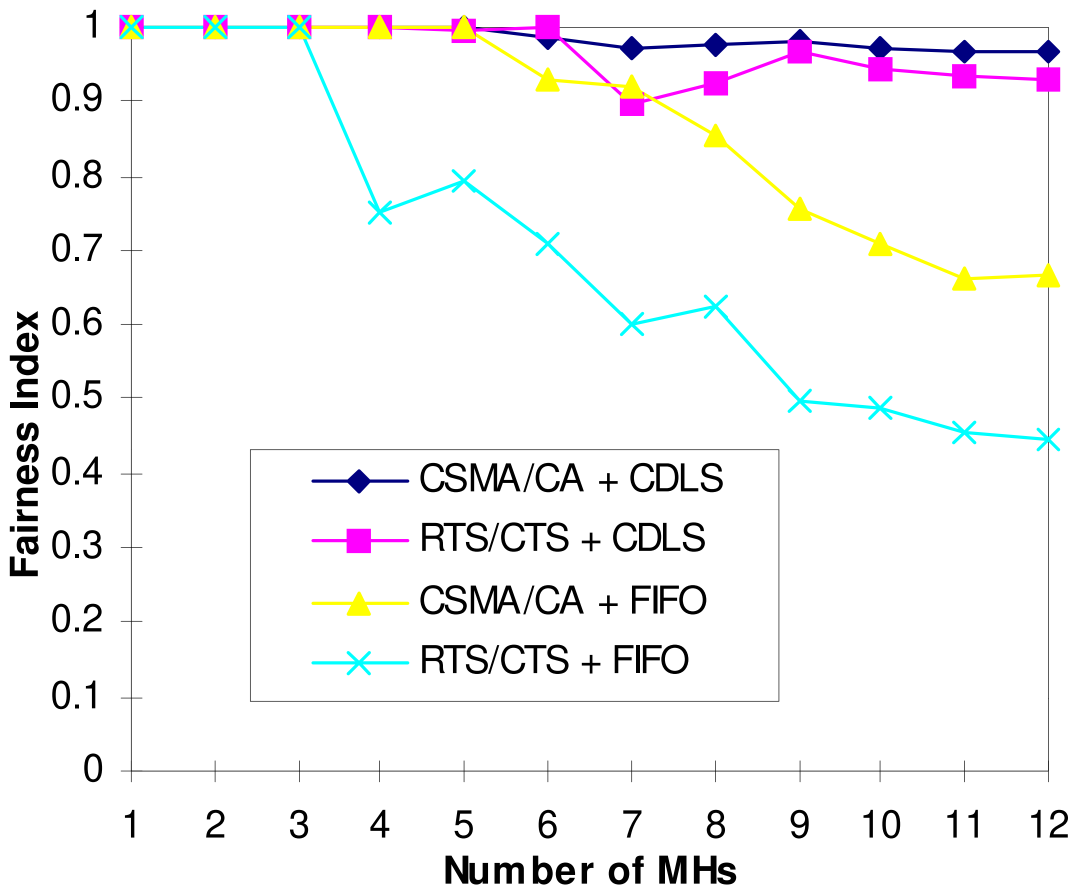


Link Scheduler's Throughput



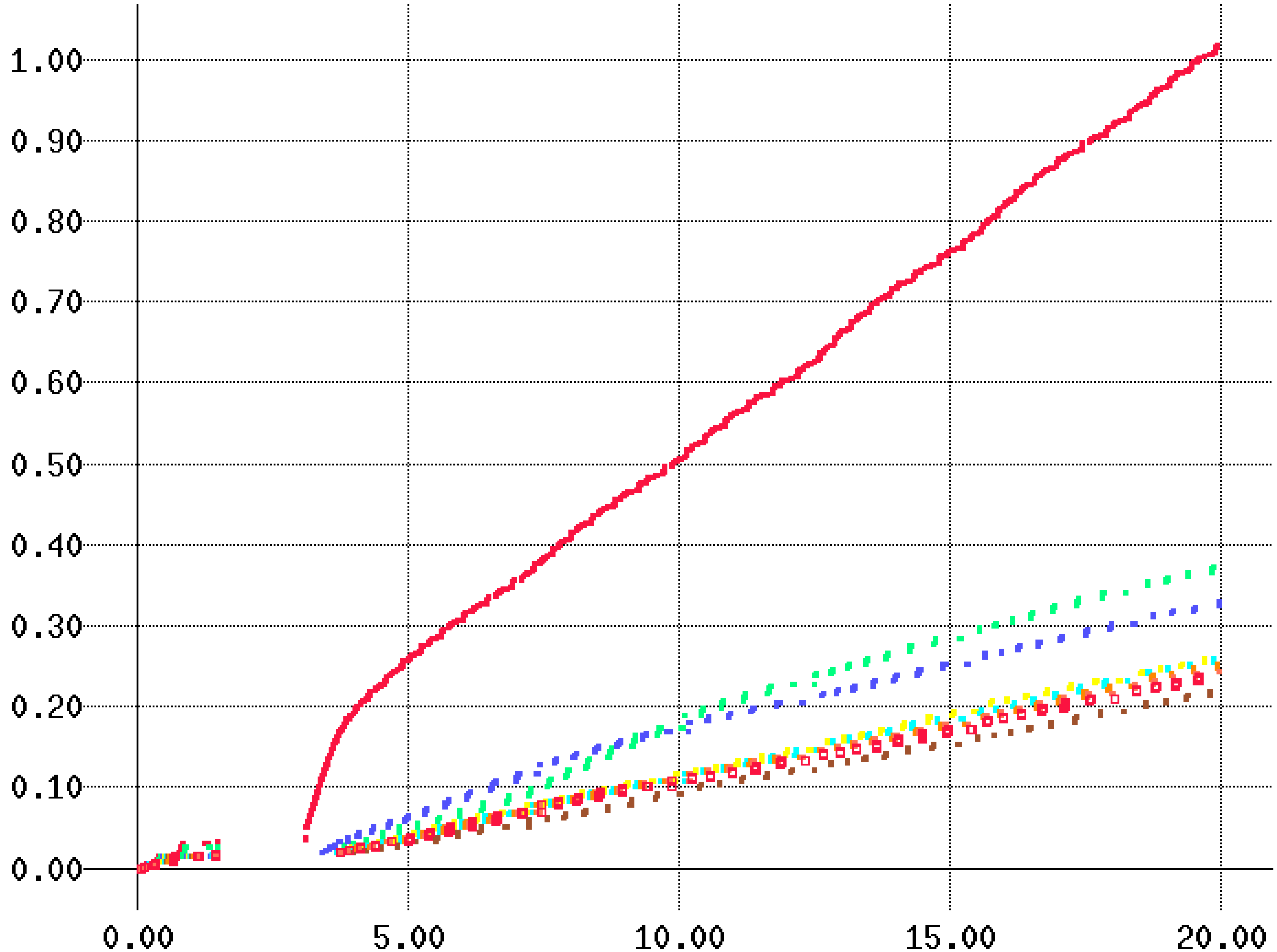
- Improvements
  - 10-20% for CSMA/CA MAC
  - negligible for RTS/CTS MAC

Link Scheduler's Fairness

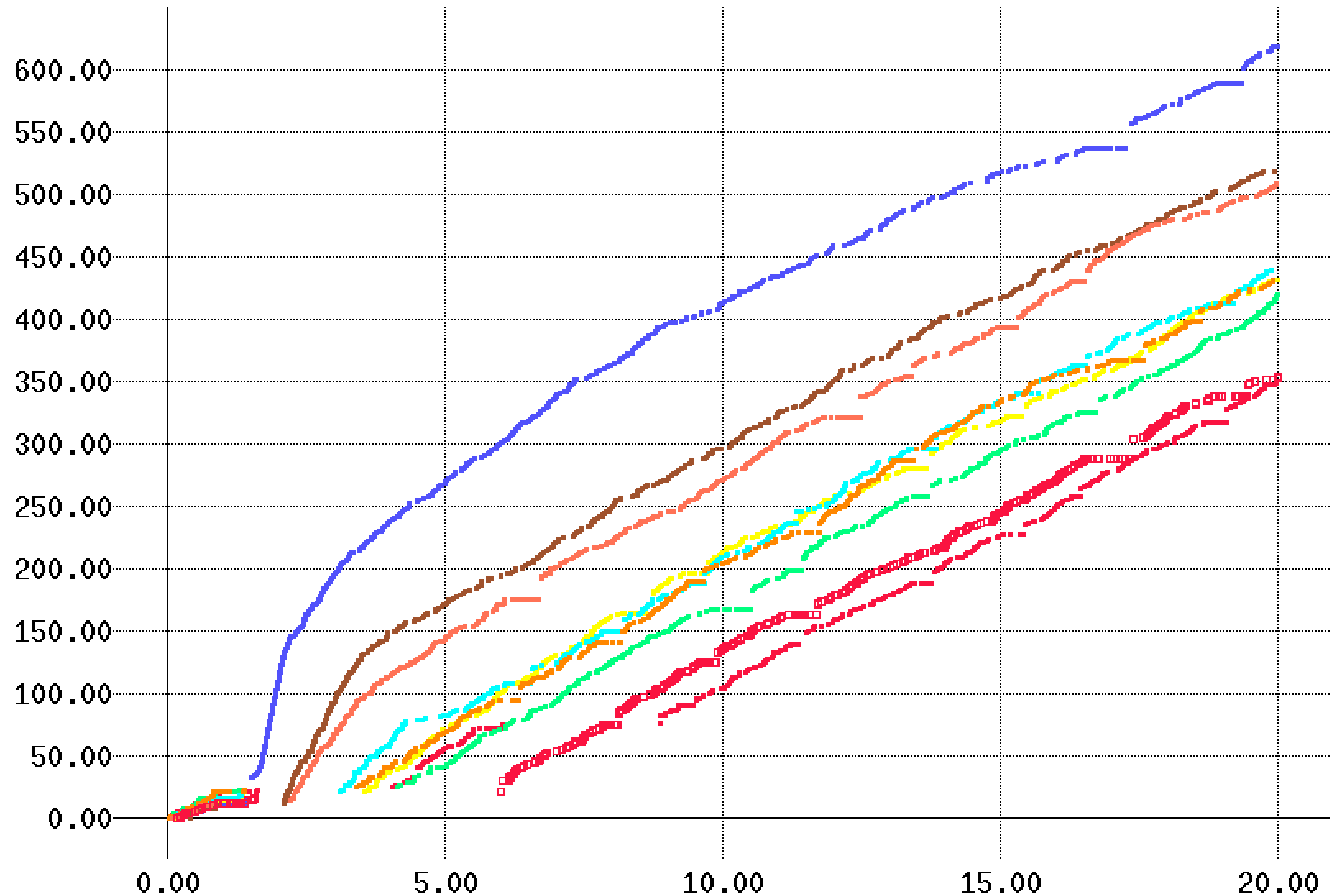


- FIFO's fairness
  - significantly degrade with more users
- CDLS's fairness
  - stable around 0.9

Packet Trace: FIFO



Packet Trace: CD-CBQ



Summary

- Key to effectively supporting more users
  - Improve fairness: everyone can make progress
  - Reducing collision
- Link scheduling solutions
  - improve the fairness in bandwidth allocation
  - improve overall throughput
  - further improvements are possible
    - sensitive to application needs: delay and loss requirement

Future Work

- Simulation studies
  - More diverse network condition
    - Hidden terminals
    - Effect of mobility
  - Optimizations based on application needs
  - Scheduling of multicast packets
- Implementation
  - Prototype the solutions on our wireless testbed
  - Validate our simulation results