Scheduling in WiMAX: Baseline Multi-class Simulations

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These slides are available on-line at:

http://www.cse.wustl.edu/~jain/schd704.htm

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Overview

❏ Admission Control

❏ Fair scheduling algorithm

❏ Simulation results

Configuration

❑ Frame Duration: 5 ms

❑ Downlink ratio: 0.6 (DL 60%, UL 40%) ~ 1.5:1 (0.66 crashes)

❑ Initial Modulation Scheme: DIUC = 2 (QPSK1/2)

  ❑ 2 bit/symbol $\times$ 1/2 repetition $\Rightarrow$ 1 bit per symbol

❑ Bandwidth: 10 MHz (FFT: 1024)

❑ PUSC #DL Subchannels: 30, #UL Subchannels: 35

❑ ARQ Disabled (Bug: Higher loss with ARQ)

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Configuration (Cont)

SS1

SS2

SS3

BS

SSn
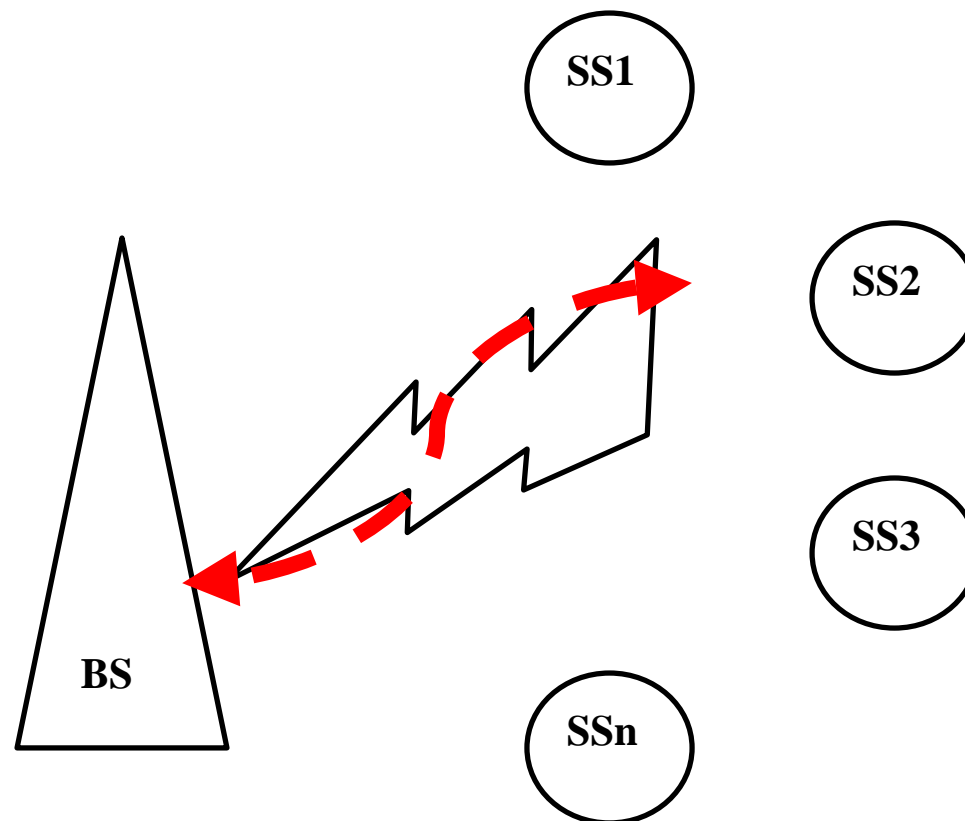
❑ Single BS with multiple SSs

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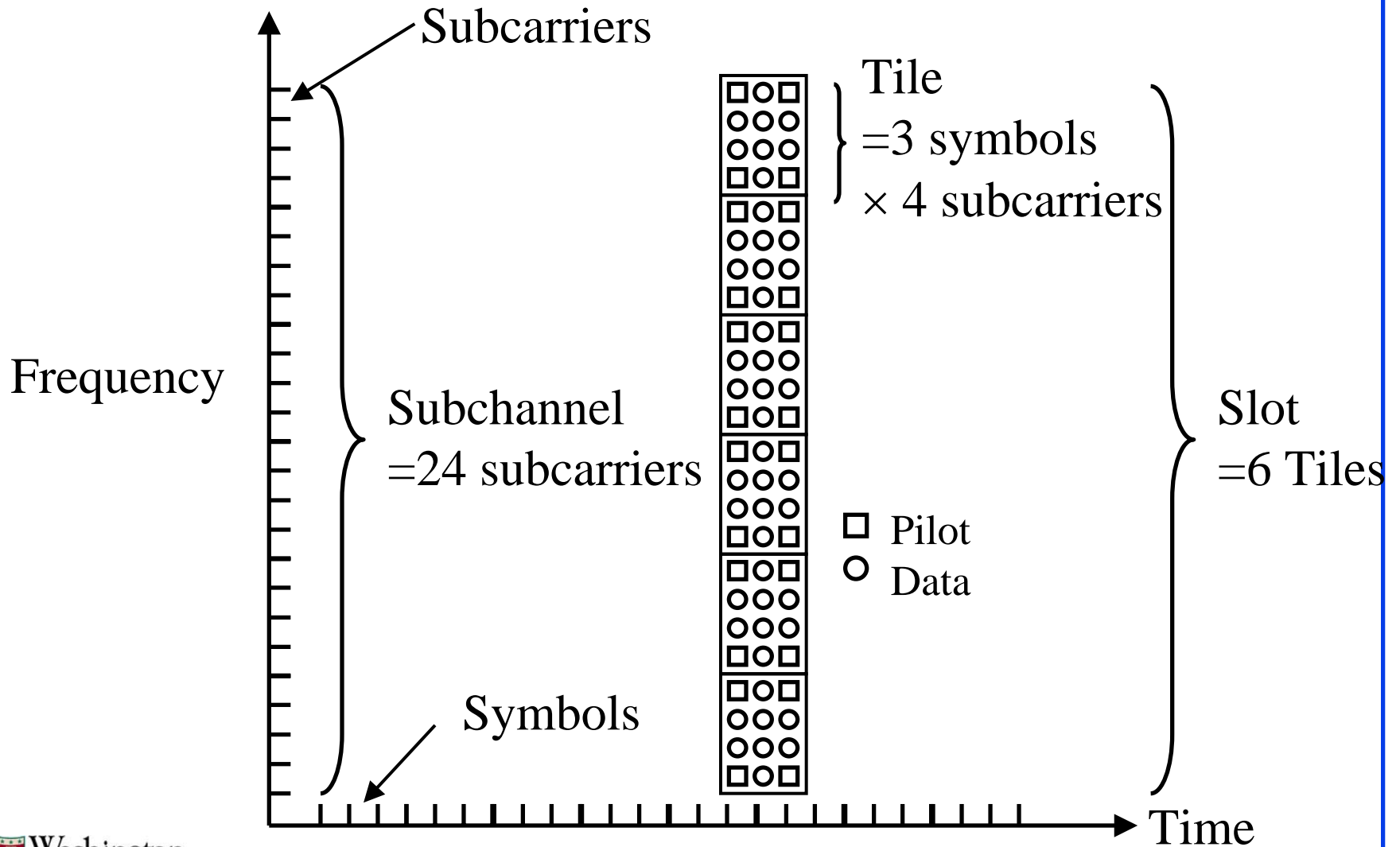# Workload

- UL only:
  - UGS: UDP (CBR) at rate 200 kbps (500 Bytes APDU)
  - BE: UDP at rate 150 kbps or 700 kbps (500 Bytes APDU)
- UGS: MAC request: 275 bytes every 10 ms ~220 kbps
- 1 BS, 1 SS or 3 SSs
- Metrics: Application Throughput (kbps)
- Simulation starts from 20 sec to 50 sec

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Error Model

❑ Channel model: Cost231

❑ Fading Model: ITU_PDP PED_A

Symbols, Tiles, and Slots (Uplink)

Subcarriers

Frequency

Tile
=3 symbols
× 4 subcarriers

Subchannel
=24 subcarriers

Slot
=6 Tiles

□ Pilot
○ Data

Symbols

Time

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Max BW and SS Calculation (Uplink)

- 1 frame (5 ms): 44 symbols after RTG and TTG
- With DL ratio=0.6, DL=26 and UL=18 symbols
- Ranging = *2+1*, Contention=1+1, 12+1 left for data
- Each tile is 3 symbols wide $\Rightarrow$ 12/3 tile-columns
- Each slot is 6 tiles high $\Rightarrow$ 1 subchannel
- PUSC $\Rightarrow$ 35 subchannels
- Per UL Frame = 35 × 12/3 = 140 free slots
- Each slot has 72 symbol-subcarriers but only 48 for data + 24 pilots
- QPSK1/2 = 1 bit/symbol, 48 × 1/8 = 6 bytes per slot
- UL Capacity = 140 × 6 × 8 / (5 ms) = 1.344 Mbps (Max BW)

Original Scheduling Methodology

❑ For UGS: grant = reserved slots;

❑ For others: grant = request

❑ Problems:

    ❑ Can't support overload traffic

    ❑ Does not allocate BW fairly

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New Scheduling Methodology

❑ For UGS: grant = reserved slots;

   ❑ Left slots = free slots after UGS

   ❑ Fair Share = left slots/#non-UGS connections;

❑ For others: if (request < Fair share) grant = request,
                        else grant = Fair share

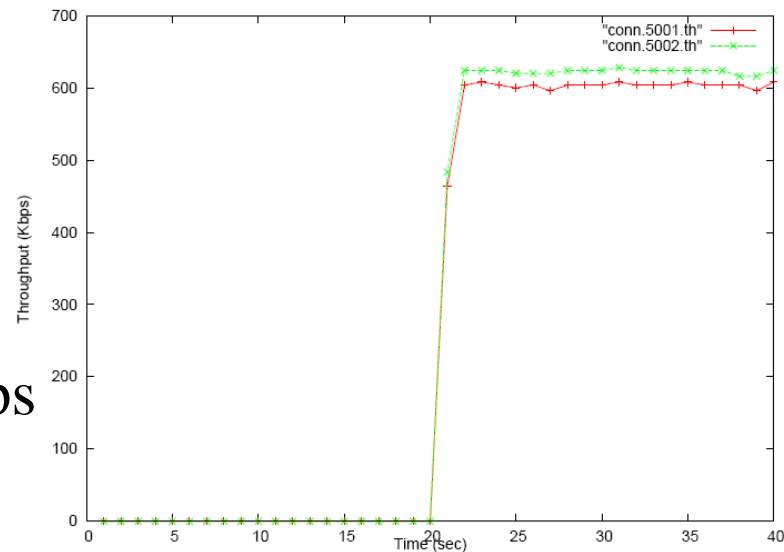   ❑ Loop till no more free slots

UL Throughput for BE (2SS), 700Kbps
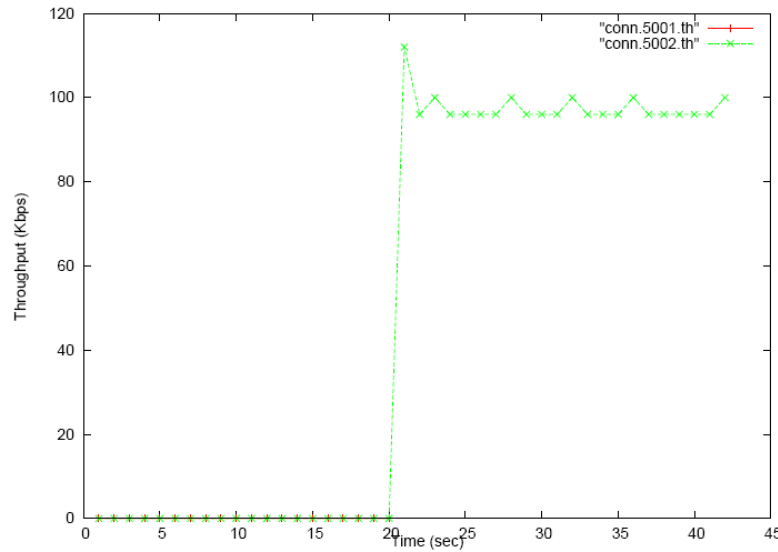
Old Scheduler:

$\longleftarrow$ $\quad$ Th_{avg} = :97.97 Kbps

Drop = 6459 packets

2nd User does not get fair share

New Scheduler: $\longrightarrow$

Th_{avg} = 1208.03Kbps
Drop = 956packets
Fair Allocation

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Simple Admission Control

❑ UGS connections are rejected if total load is more than capacity

❑ For UGS (220 kbps)
  Assuming 20 kbps for packing/segmentation overhead
  $\Rightarrow$ Can support max 6 SS connections

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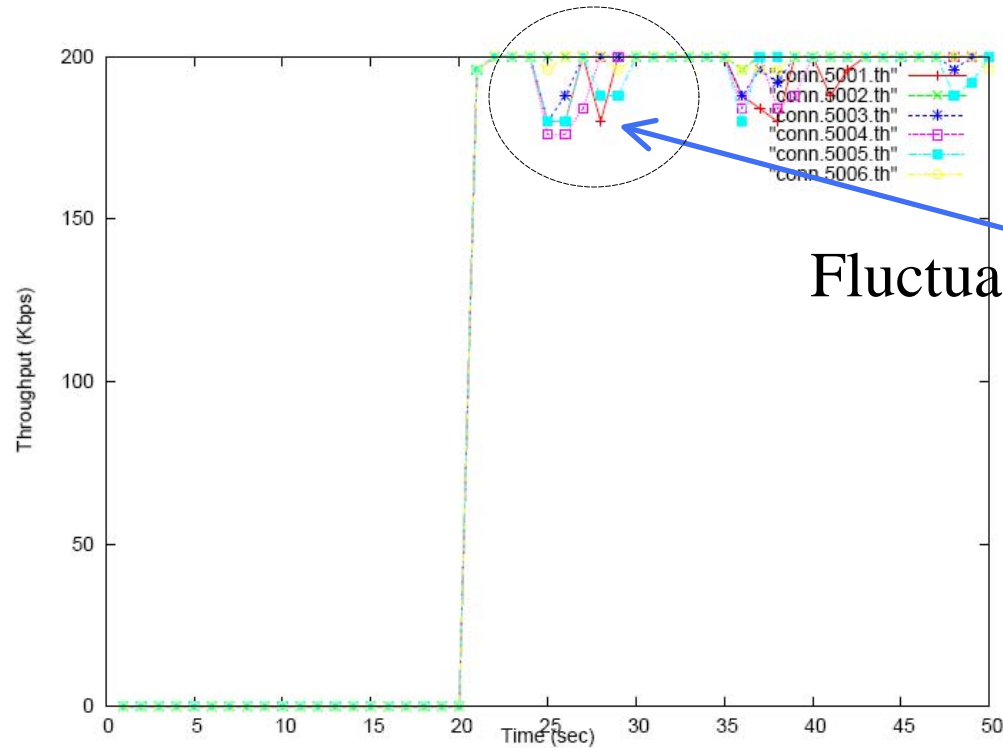# Simulation Results for Simple Admission Control

Throughput: 1 SS (200 kbps)

Perfect 200 kbps
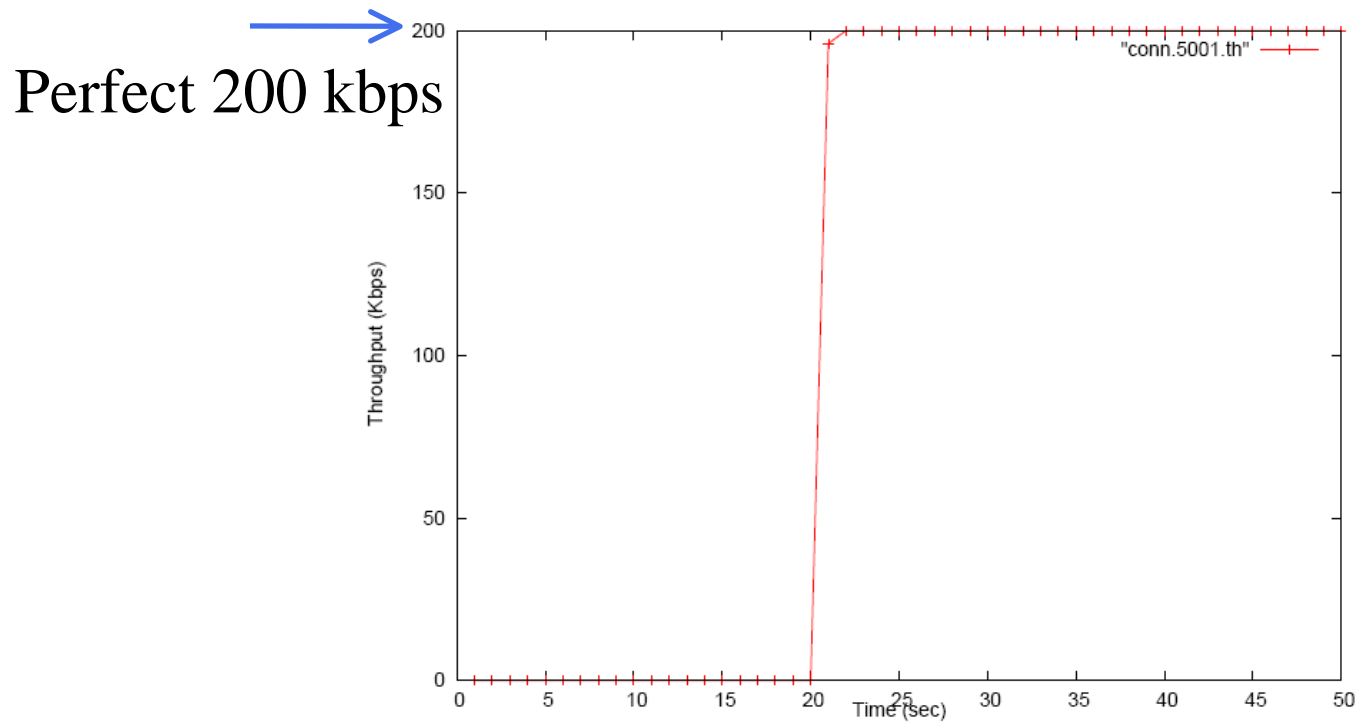
❑ Throughput: 200 kbps, Drop: 0 packet
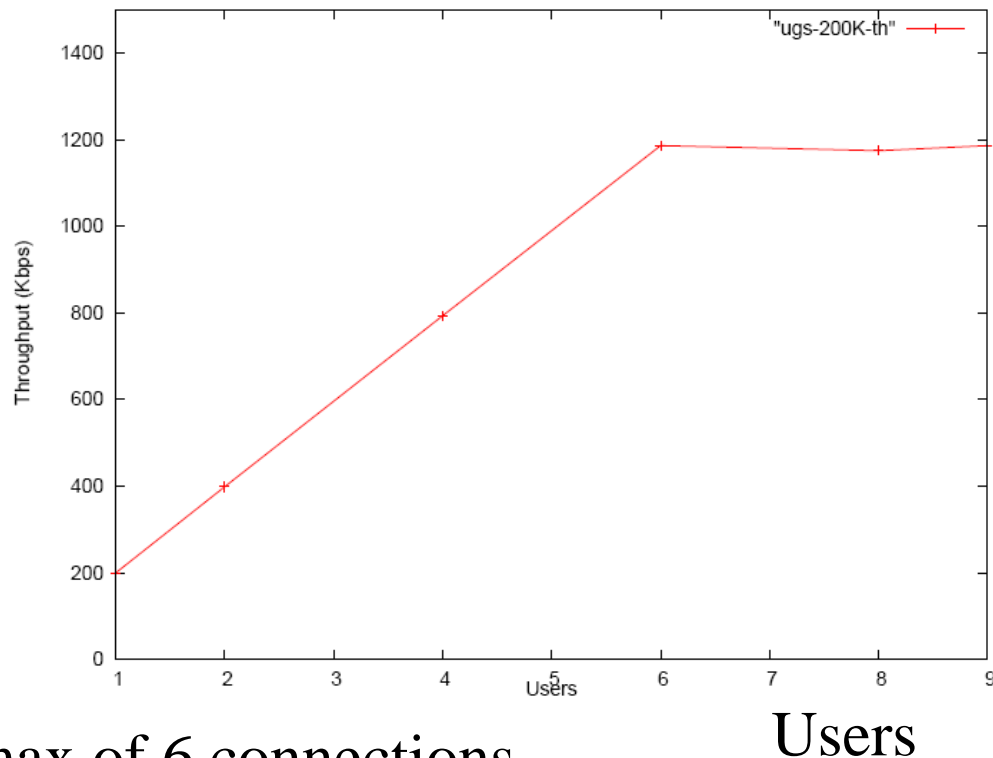
Throughput: 6 SS, 200 kbps

Throughput

Fluctuation due to drop

Time

❑ Throughput: 1185.97 kbps, Drop: 377 packets

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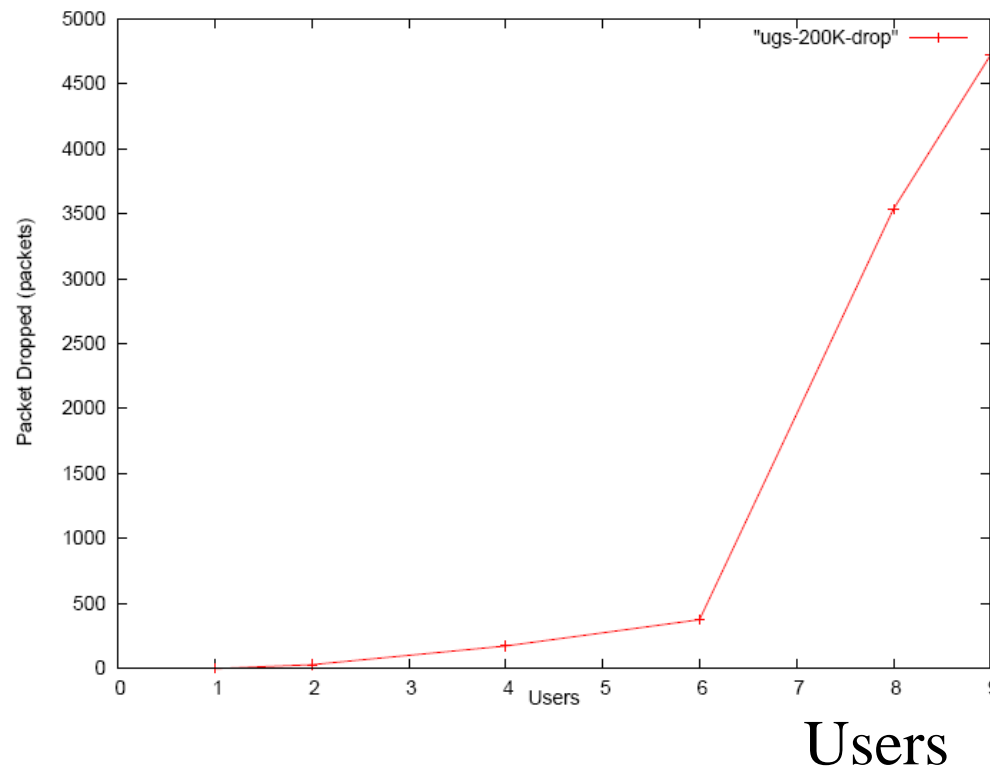
Throughput vs. #SSs

Total
Throughput

Users

❑ Supports max of 6 connections

❑ Throughput increases linearly

❑ Original simulation w/o admission control crashes on overload
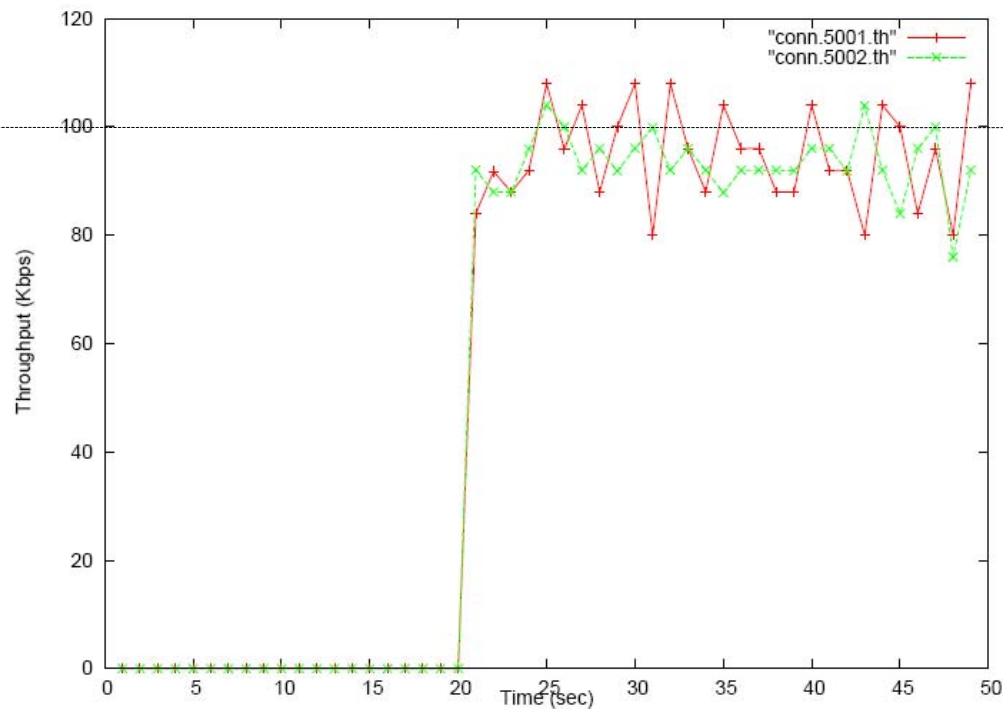
Loss vs. #SSs

Packets Dropped

Users

❏ Packets dropped increases linearly

❏ Conclusion: Admission control is effective

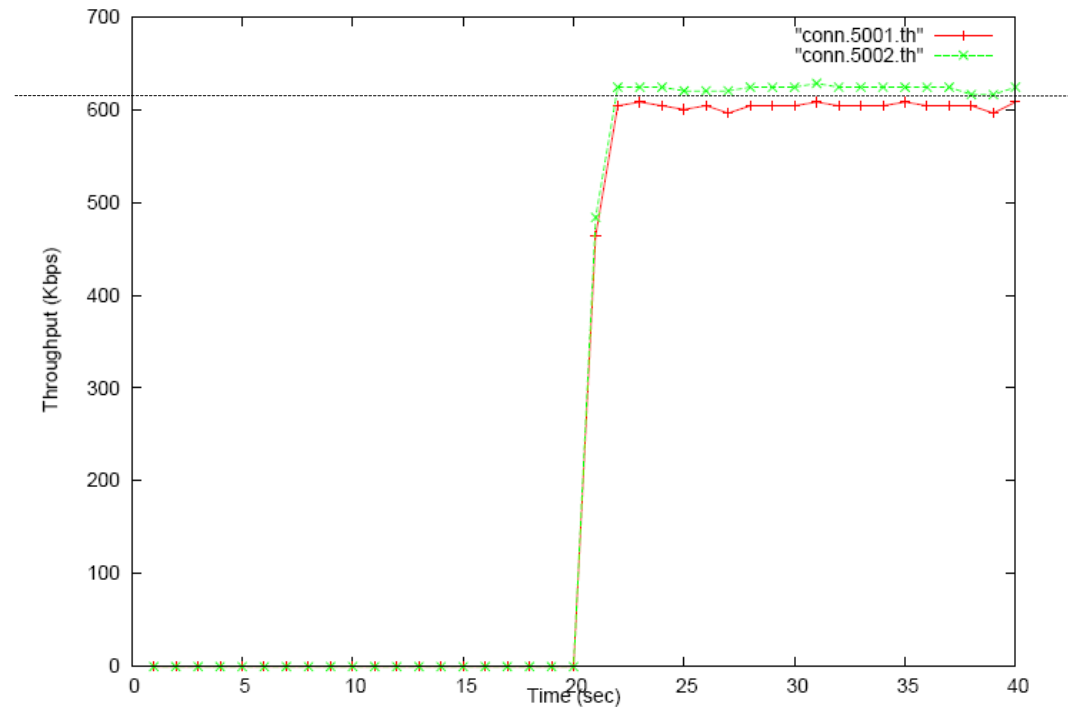# Simulation Results for BE Traffic

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Throughput for BE (2 SSs, 100 kbps)

100 kbps
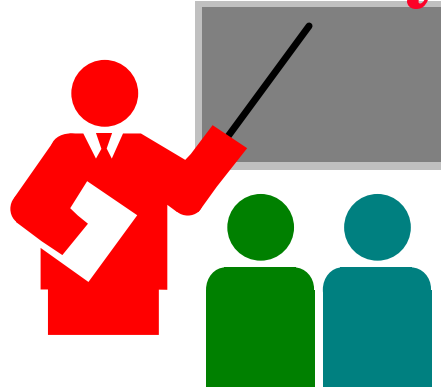

- ❑ Capacity = 1.33 Mbps, Load = 0.2 Mbps ⇒ Under-load Scenario
- ❑ Throughput: 189.13 kbps, Drop: 189 packets
- ❑ Statistically fair

Throughput for BE (2 SSs, 700 kbps)

- ❑ Capacity = 1.33 Mbps, Load = 1.4 Mbps ⇒ Overload Scenario
- ❑ Throughput: 1218.86 kbps, Drop: 1432 packets
- ❑ Statistically fair

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Summary

- ❑ Need admission control for classes with guaranteed service
    - ❑ Implemented a simple admission control
    - ❑ Allows us to do simulations with larger number of users without crashing
- ❑ Need fairness for overload situations
    - ❑ Implemented a simple fairness mechanism
    - ❑ Both UGS and BE simulations now show fair throughput
    - ❑ Old simulation used to starve some users.

Future Work

❑ Debug BE traffic (stop crashes)

❑ Study delay behavior

❑ Simulate other classes of traffic

❑ Fixed Modulation per connection
   $\Rightarrow$ Allows different modulations per SS

❑ Fixed 1 connection per node
   $\Rightarrow$ Allow multiple connections and classes per SS

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