97-1085: A Switch Algorithm for ABR Multipoint-to-Point Connections

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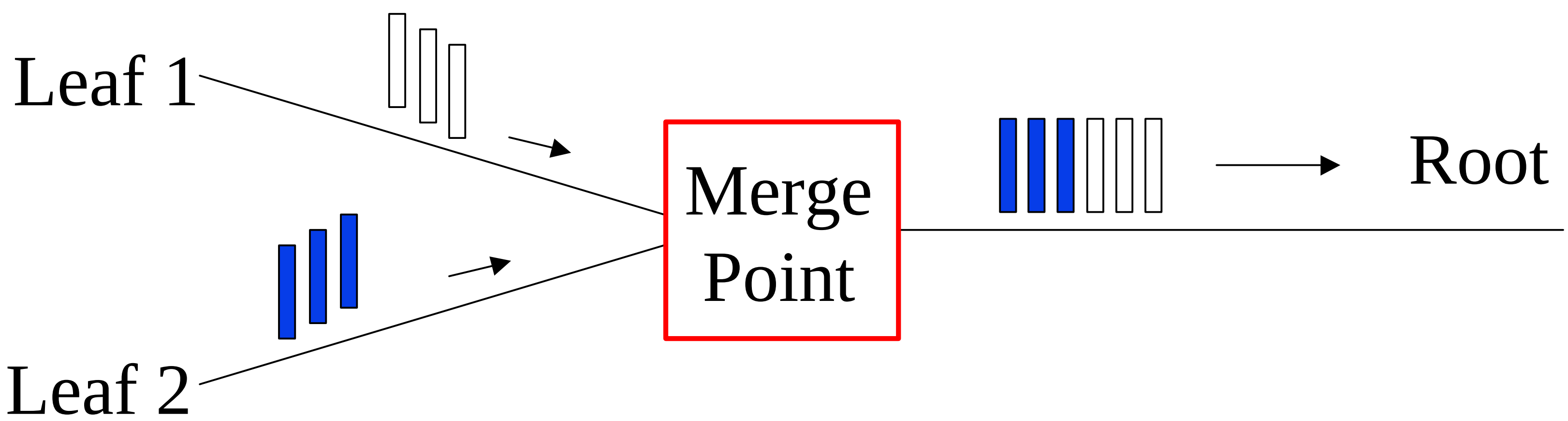
Overview

- Multipoint-to-point VCs
- VC Merging
- Rate Allocation Algorithm
- Merging Point Algorithm
- Design Issues
- Simulation Results

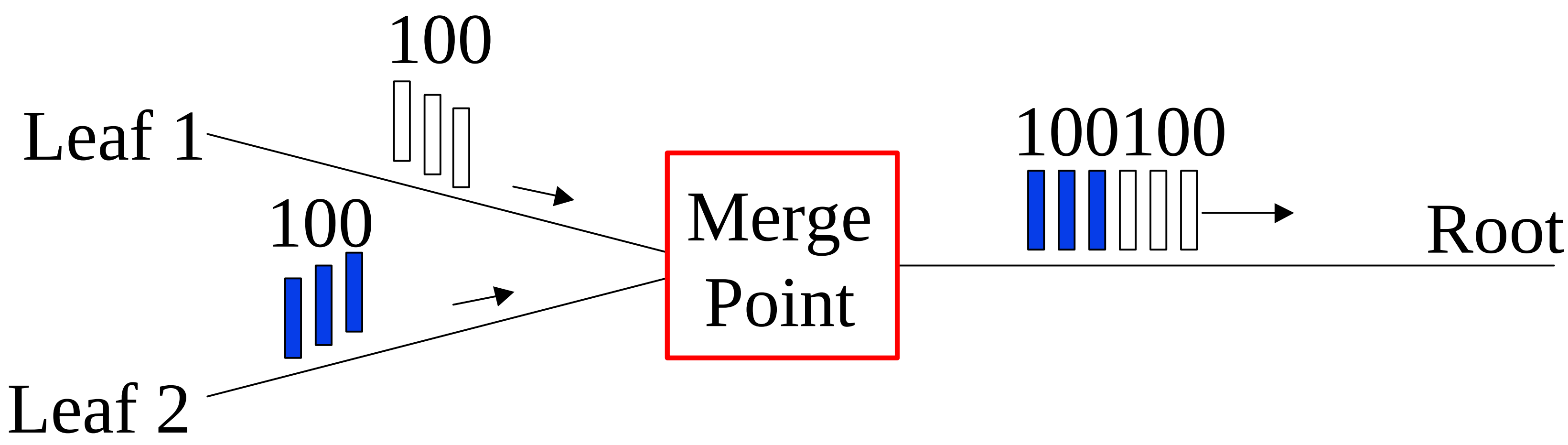
Multipoint-to-Point VCs

- More than one concurrent sender
- Traffic at root
  = Σ traffic originating from leaves
- Source-based fairness:
  N-to-one connection = N one-to-one connections
  ⇒ max-min fairness among sources



VC Merging

- Buffer cells at merging point till EOM bit = 1
- Cells of senders in the same multipoint-to-point VC cannot be distinguished
- Question: Can we achieve source-based fairness?



ERICA+

- Time is slotted into averaging intervals
- ABR capacity = [link capacity – (VBR + CBR load)] × f(queue length)
- Estimate input rate = Σ CCRj
- overload = input rate/ABR capacity
- ERj_efficiency = CCRj/overload
- ER_fairshare = ABR capacity/# of active sources
- IF overload ≤ 1+ δ THEN ERj =
  max (ERj_efficiency, ER_fairshare, maxERprevious)
  ELSE ERj = max(ERj_efficiency, ER_fairshare)
- maxERcurrent = max(maxERcurrent, ERj)
- ER in BRMj = min(ER in BRMj, ERj)

Changes to ERICA+

- Remove fair share term (# active sources)
- Use CCRjmax instead of CCRj
  Maximum is calculated in successive intervals
- To minimize oscillations, use exponential averaging options for:
  - Input rate
  - ABR capacity
  - maxERprevious

Rate Allocation Algorithm

1. FRM cell is received for VC j:

CCRj = CCR from FRM

OR:

IF FirstFRMj THEN

    CCRj = CCR from FRM

    FirstFRMj = FALSE

ELSE

    CCRj = max (CCR from FRM, CCRj)

Algorithm (Cont.)

2. BRM cell to be sent out for VC j:

IF overload > 1+δ THEN

ER = CCRj/overload

ELSE

ER = max (CCRj/overload, maxERprevious)

ER = min (capacity, ER)

maxERcurrent = max (ER, maxERcurrent)

ER in BRM = min (ER, ER in BRM)

[note: $\delta = 0.1$ in our simulations]

Algorithm (Cont.)

3. End of averaging interval:

input rate = exponential average

capacity = exponential average scaled by queue function

overload = input rate/capacity

$\forall j$: FirstFRMj = TRUE

maxERprevious = maxERcurrent

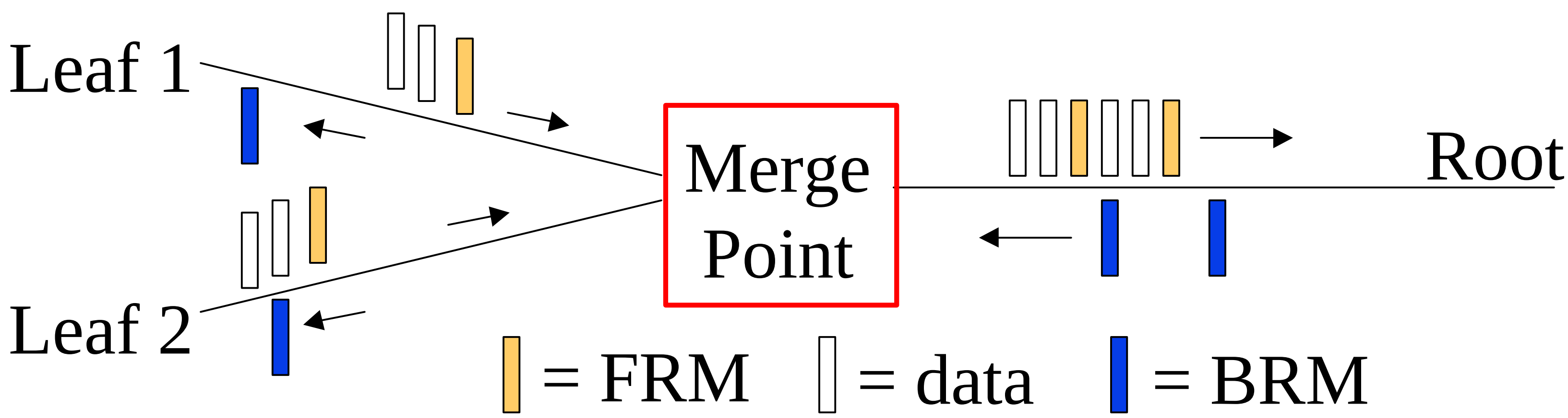
OR: maxERprevious = $(1-\alpha) \times$ maxERcurrent + $\alpha \times$ maxERprevious

maxERcurrent = 0

[note: $\alpha = 0.1$ in our simulations]

Merging Point Algorithm

- Maintain a bit at the merging point for each flow being merged
  Bit = 1
  $\Rightarrow$ FRM received from this flow after BRM sent to it
- BRMs are duplicated and sent to flows whose bits are set, then bits are reset



Design Issues

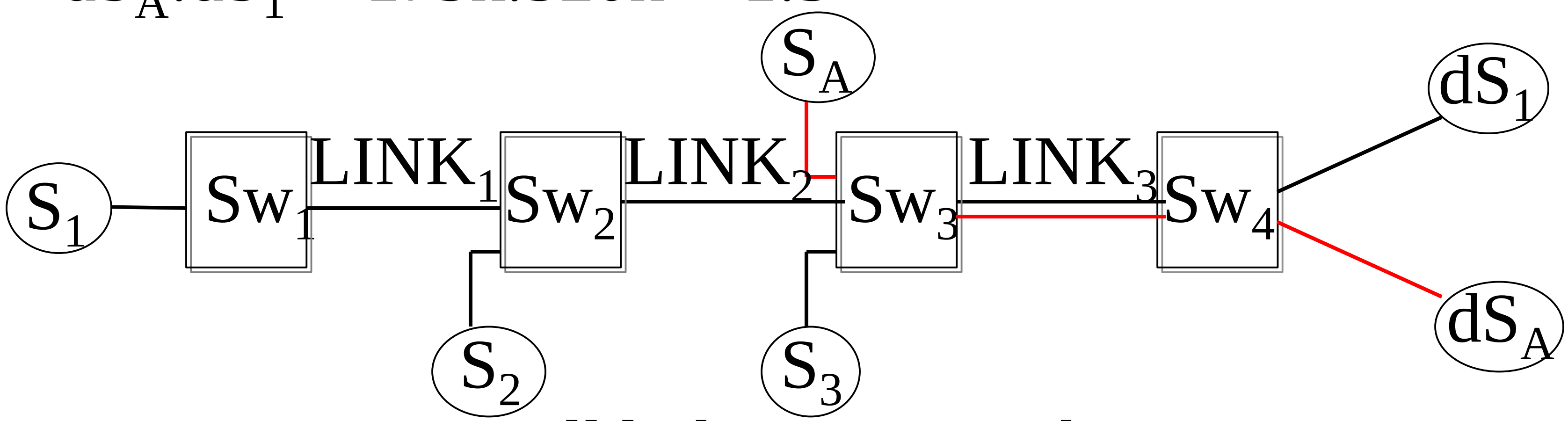
- Per-source accounting is avoided
- Using CCR from BRM cells can cause unfairness because CCR in BRM may belong to a source with a higher bottleneck rate than all upstream sources
- CCR from FRM cells is adequate because of maxERprevious term and properties of merging point
- BRM to FRM ratio at sender and inside the network is close to 1
- Destinations (not merging points) turn around BRMs for scalability, insensitivity to levels of tree and to avoid noise

Simulation Parameters

- Unidirectional traffic
- RIF = 1/32, 1
- Rule 6 disabled
- Queue control: a = 1.15, b = 1, drain limit = 50%, target queuing delay = 1.5 s
- Measurement interval = 5 ms, 200 μs
- One cell long packets (Avoids VC merging issues)
- Max CCR and averaging maxERprevious used
- Link lengths in kms: {LINK1, LINK2, LINK3} = {50, 500, 5000}, {5000, 500, 50}

Downstream Bottleneck

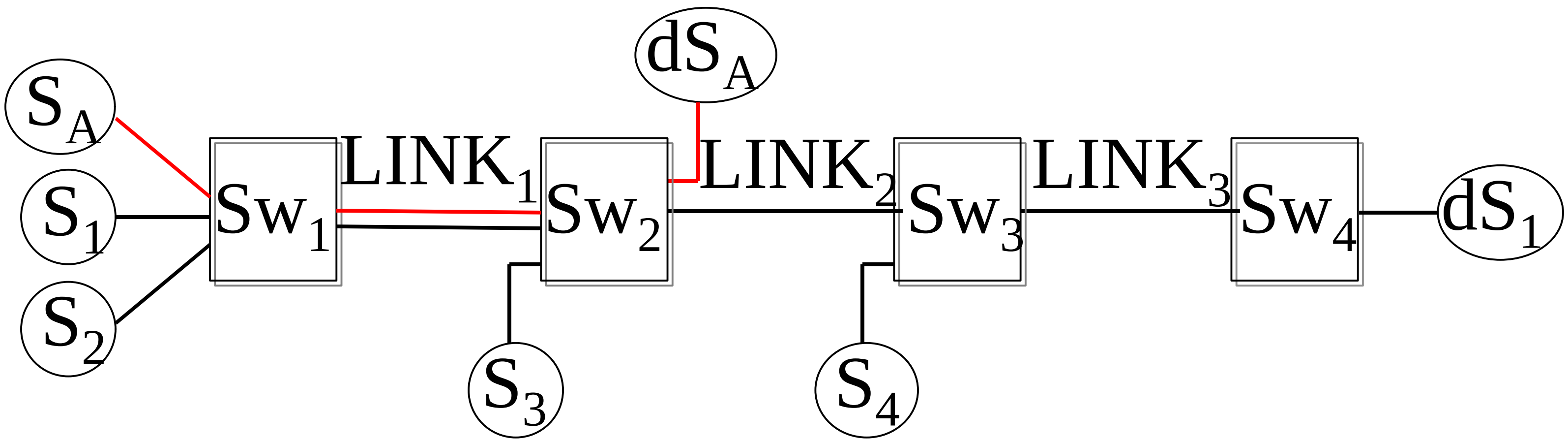
- Goal:{S1,S2,S3,SA}←{37.5,37.5,37.5,37.5}
- ICRs:{S1,S2,S3,SA}←{25,25,25,25}, {100,100,100,100},{65,10,65,10}
- **Result**: All sources are allocated 37.5 Mbps, small queues, LINK3 100% utilized, cells received at $dS_A:dS_1 \approx$ 175k:520k ≈ 1:3



All links are 150 Mbps

Upstream Bottleneck

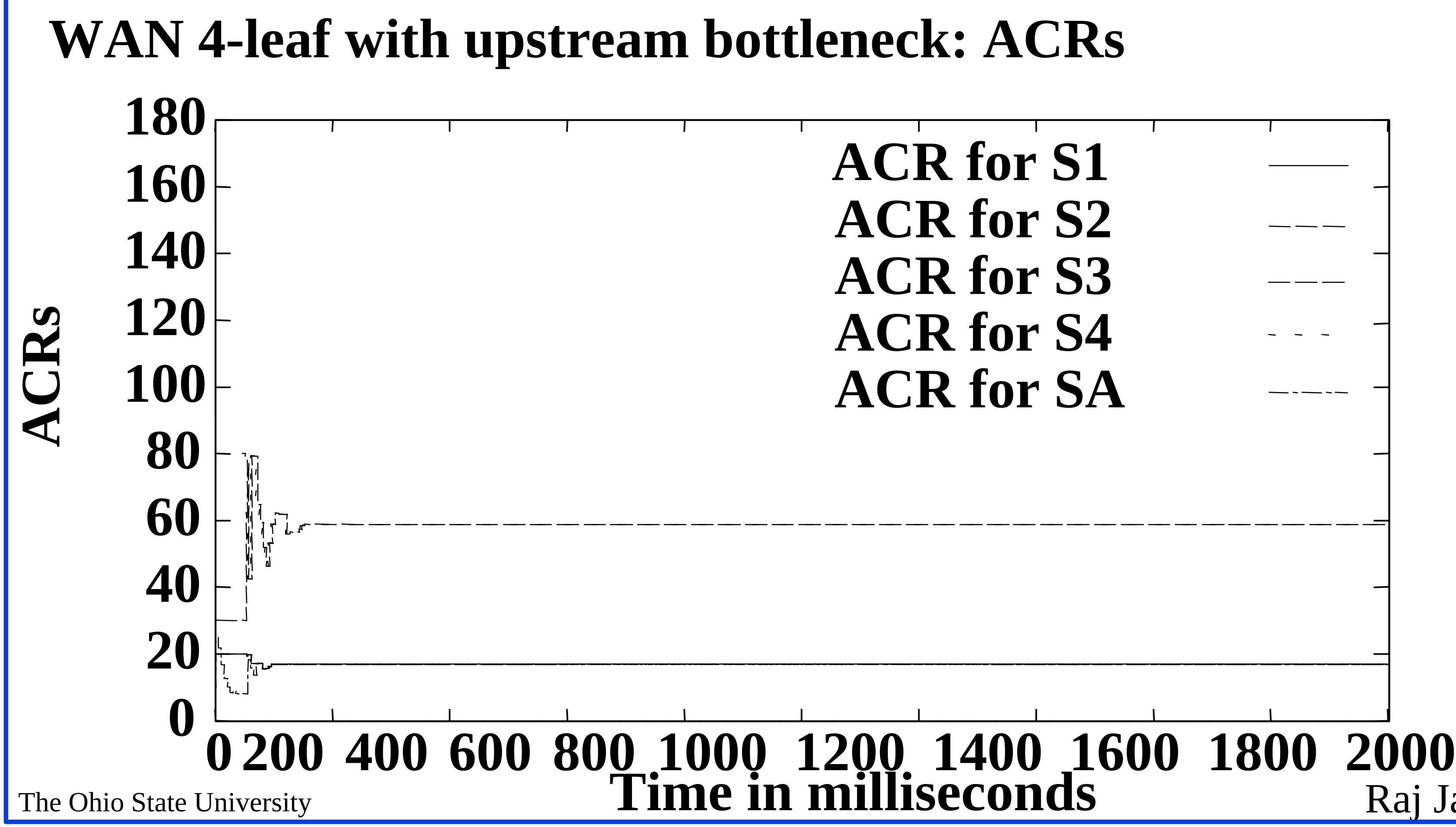
- Goal:{S1,S2,S3,S4,SA} ←{16.7,16.7,58.3,58.3,16.7}
- ICRs:{S1,S2,S3,S4,SA}←{20,20,30,80,10}
- Results are similar with different link lengths, RIF = 1/32, 1, interval length = 5 ms, 200 μs (no RMs for S1,S2 ,SA for 4 intervals; for S3,S4 for 1 interval)



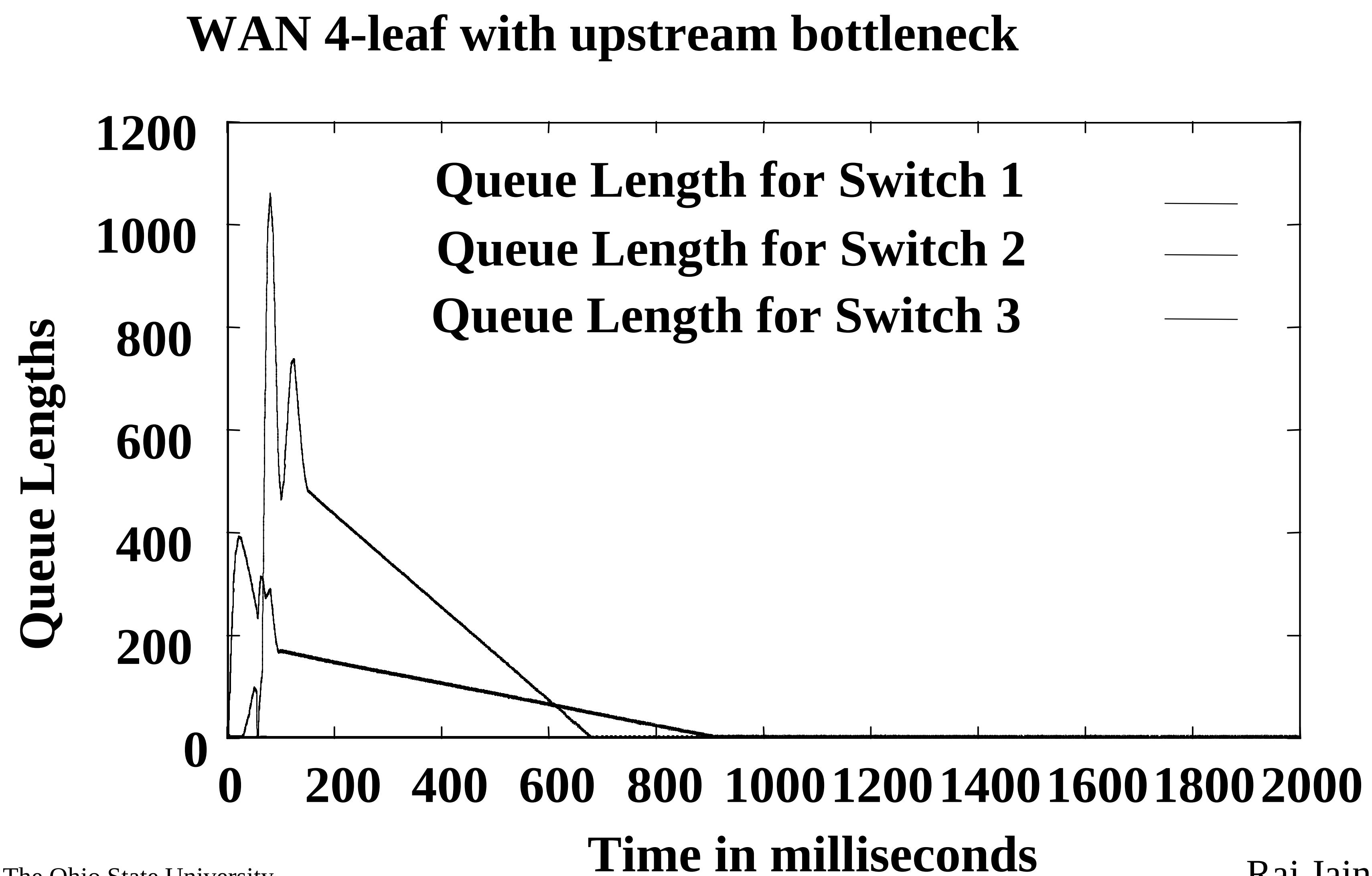
All links are 150 Mbps, except $LINK_1$ which is 50 Mbps

Simulation Results

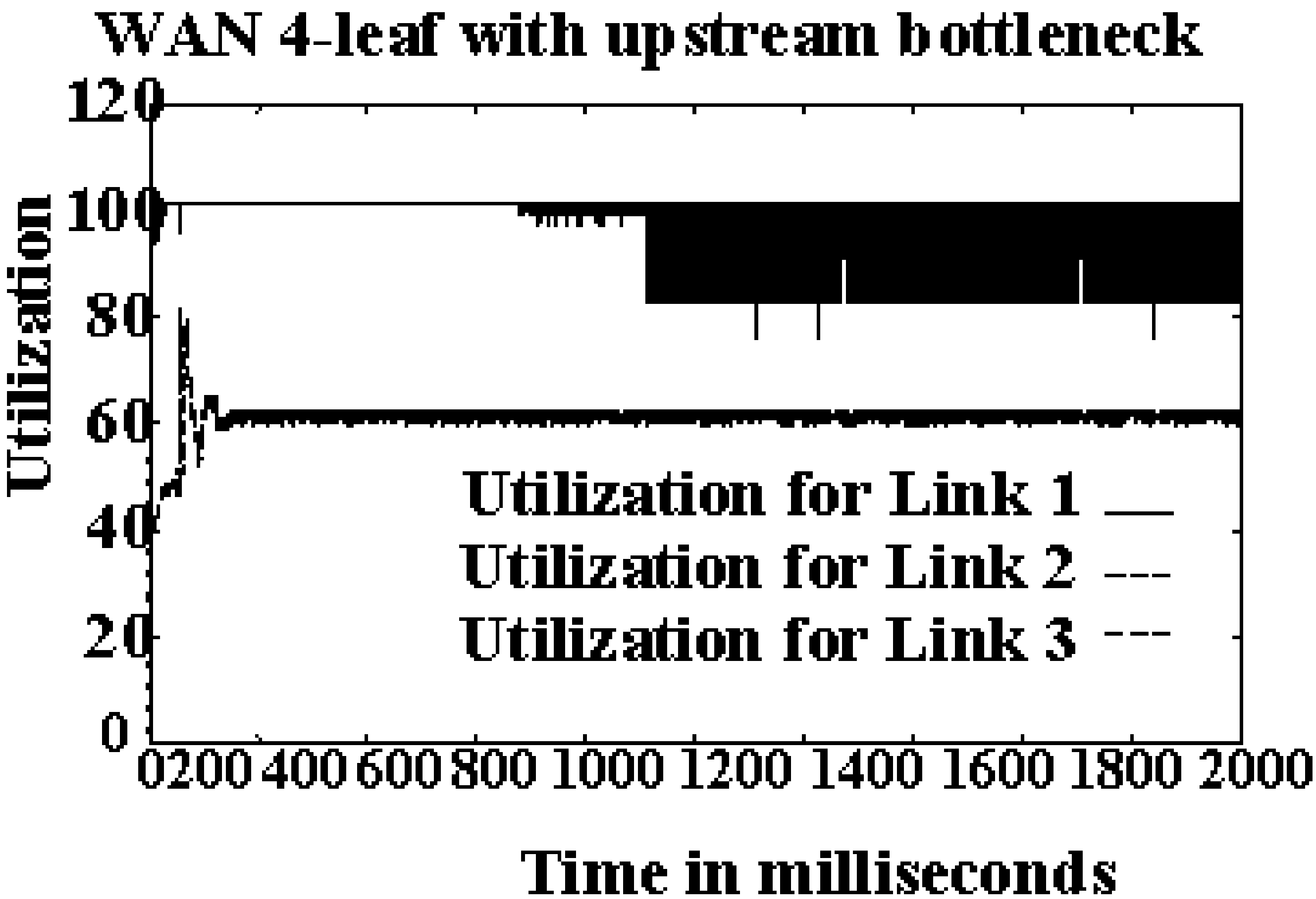
- Upstream Bottleneck, LINK3 = 5000 km, RIF = 1, interval = 5 ms



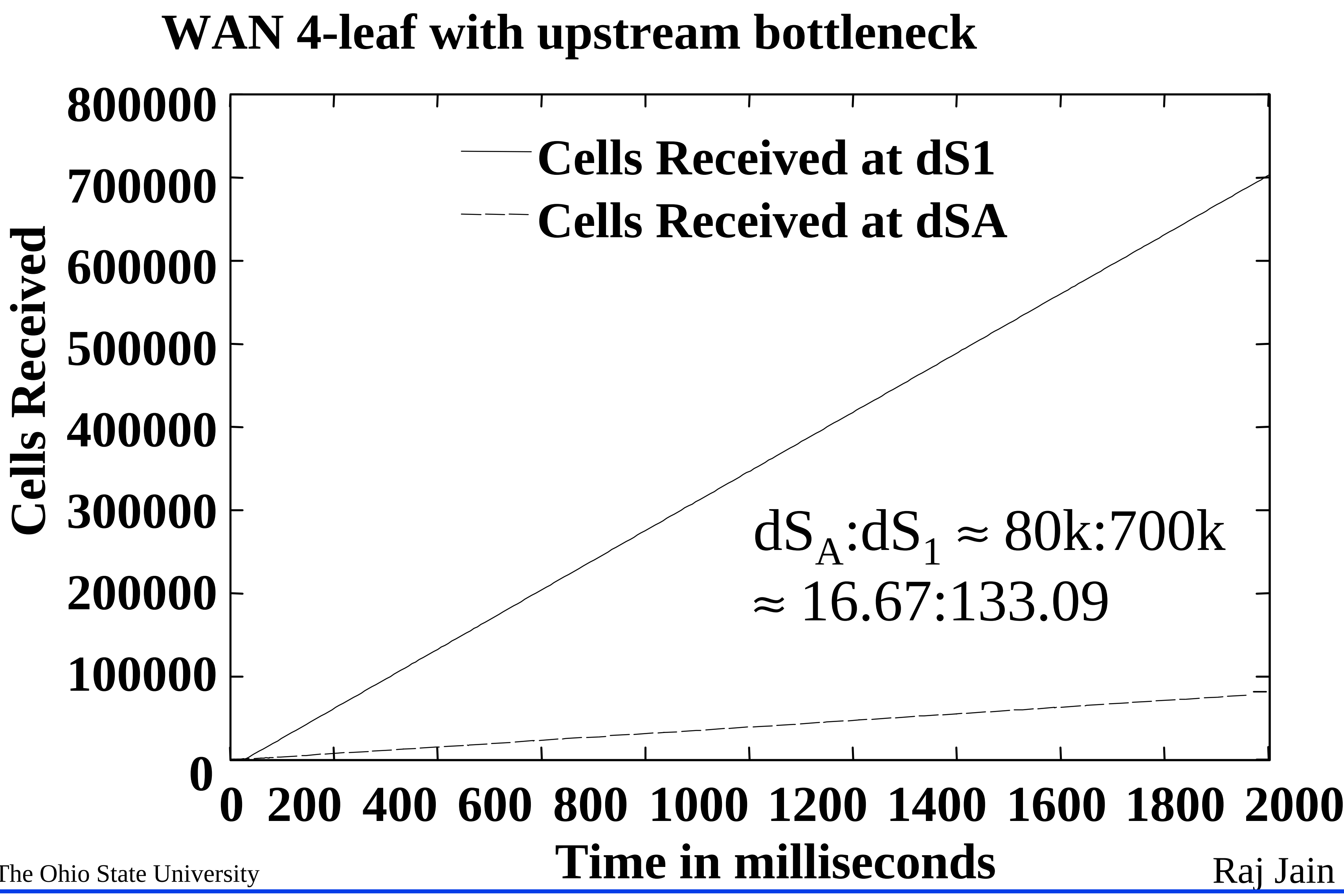
Queue Lengths



Link Utilization



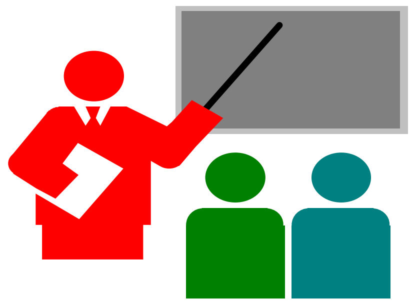
Cells Received



Lessons Learnt

- Avoid determining the effective number of active sources
- Avoid estimation of rates of sources, or determining if a source is bottlenecked at this link
- Use only aggregate measurements
- Do not use CCR values from BRM cells
- CCR from FRM cells can be used
- Using the maximum CCR in an interval, and exponentially averaging the maximum ER in the previous interval can improve performance
- Do not turn around RM cells at merging point

Summary



- Multipoint-to-point ABR congestion control algorithms need to avoid problems that can arise in a naïve extension of point-to-point algorithms
- More extensive performance analysis is needed for proposed multipoint-to-point and multipoint-to-multipoint algorithms