# 98-0408: Overload Based Explicit Rate Switch Schemes with MCR Guarantees

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- General Fairness Definition
- Overview of ERICA+
- Overload Based Algorithms
- Simulation Configurations
- Simulation Results
- Comparisons of Algorithms
- Conclusions

# General Fairness

- Define following :
  - $A_l$ = Total available bandwidth
  - $A_b$ = Sum of bandwidth of underloaded connections
  - $A = A_l - A_b$, excess bandwidth
  - $N_a$ = Number of active connections
  - $N_b$ = Number of active connections bottlenecked elsewhere
  - $n = N_a - N_b$, number of active connections bottlenecked on this link

# General Fairness (Cont)

- M = Sum of MCRs of active connections
- B(i) = Generalized Fair allocation for connection i
- MCR(i) = MCR of connection i
- w(i) = pre-assigned weight associated with VC i
- FairShare

$$B(i) = MCR(i) + \frac{w(i)\,(B - M)}{\Sigma_{j=1,n}\, w(j)}$$

# ERICA Scheme: Basic

- Explicit Rate Indication for Congestion Avoidance
- Set target rate, say, at 95% of link bandwidth
  ABR Capacity = Target Utilization * Link Bandwidth
- Monitor input rate and number of active VCs
  Overload = ABR Input rate/Target ABR Capacity
- This VC's Share = VC's Rate/Overload
- Fair share = Target rate/ Number of Active VCs
- ER = ***Max***{Fair share, MaxAllocPrevious, VC's Rate/Overload}
- MaxAllocCurrent =Max{MaxAllocCurrent, ER}

# Activity Level

- AL(i) =Min{1, VC's Rate/FairShare}
- Effective # of Active VCs = Σ AL(i)
- FairShare = ABR Capacity/Effective # of Active VCs
- Recursive definition.
  Converges in just a few iterations.

# New Algorithms

- ER = Max{FairShare, MaxAllocPrevious, VC's Rate/Overload}
- If FairShare is based on effective number of active VCs, we do not need all three terms
  ⇒ Four algorithms

A: ER = Max{FairShare, VC's Rate/Overload}

B: ER = FairShare/overload

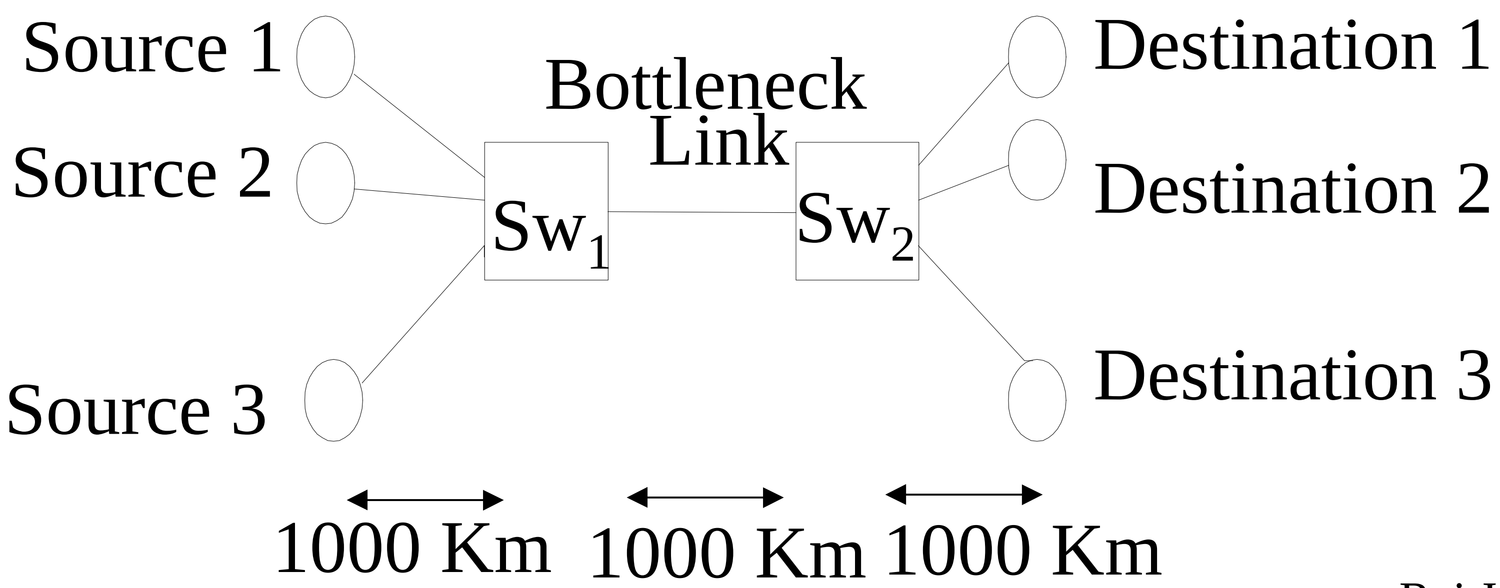
C: ER = MaxAllocPrevious/overload

D: ER = Max{MaxAllocPrevious, VC's rate/Overload}

Detailed pseudo-codes in the contribution.

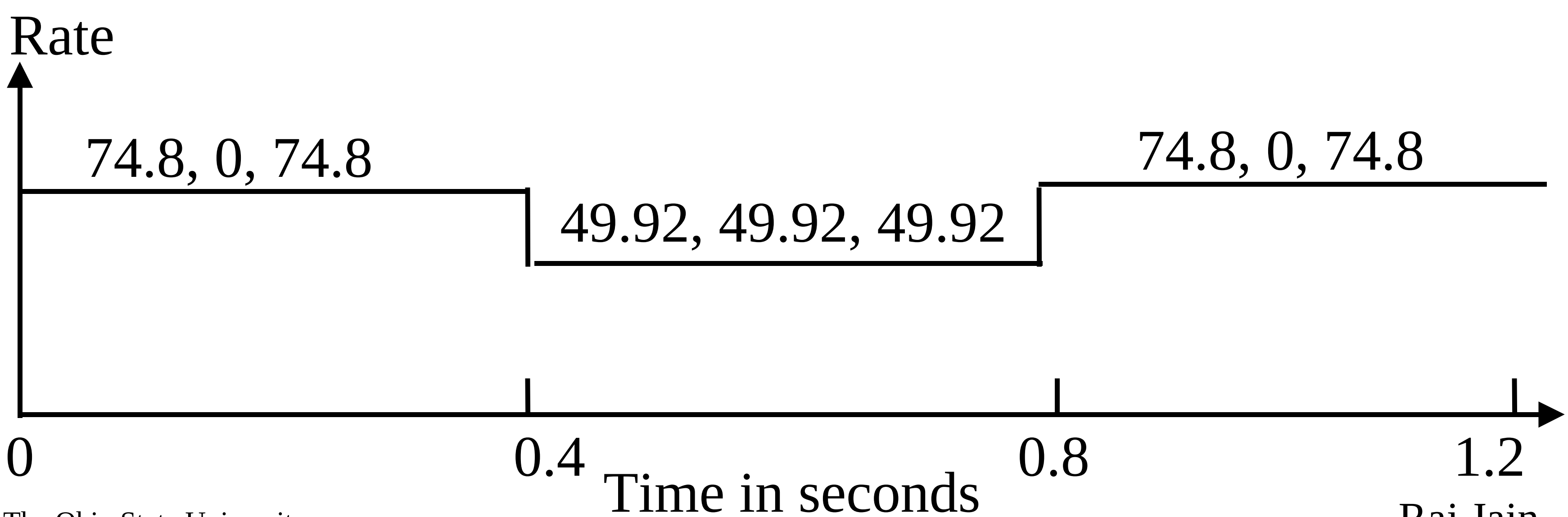
# Configuration 1

- 3 Sources. Unidirectional traffic
- MCRs of (10, 30, 50) Mbps were used.
- Excess bandwidth (149.76 - 90) = 59.76 was shared equally to achieve an allocation of (29.92, 49.92, 69.92)



# Configuration 2

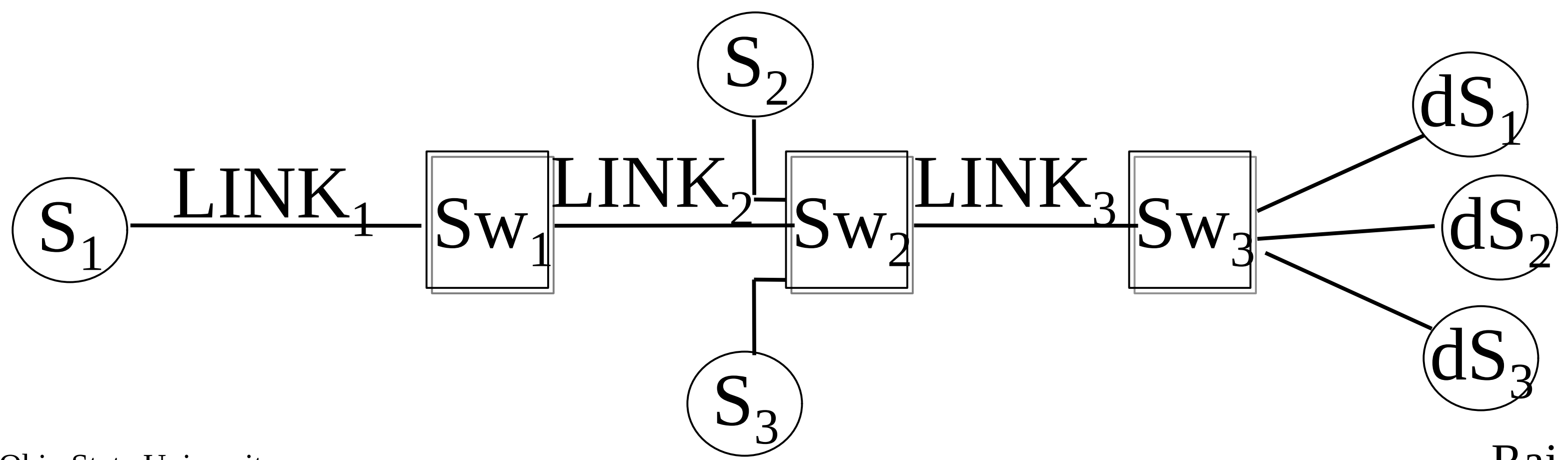
- 3 sources. Source 2, is *transient*.
- MCRs were zero for all sources. Simulation time 1.2 s. Source 2 is active  (0.4, 0.8s). Allocation was (74.8, 0, 74.8) during (0, 0.4s) and (0.8, 1.2s) and (49.92, 49.92, 49.92) during (0.4, 0.8s)



# Configuration 3

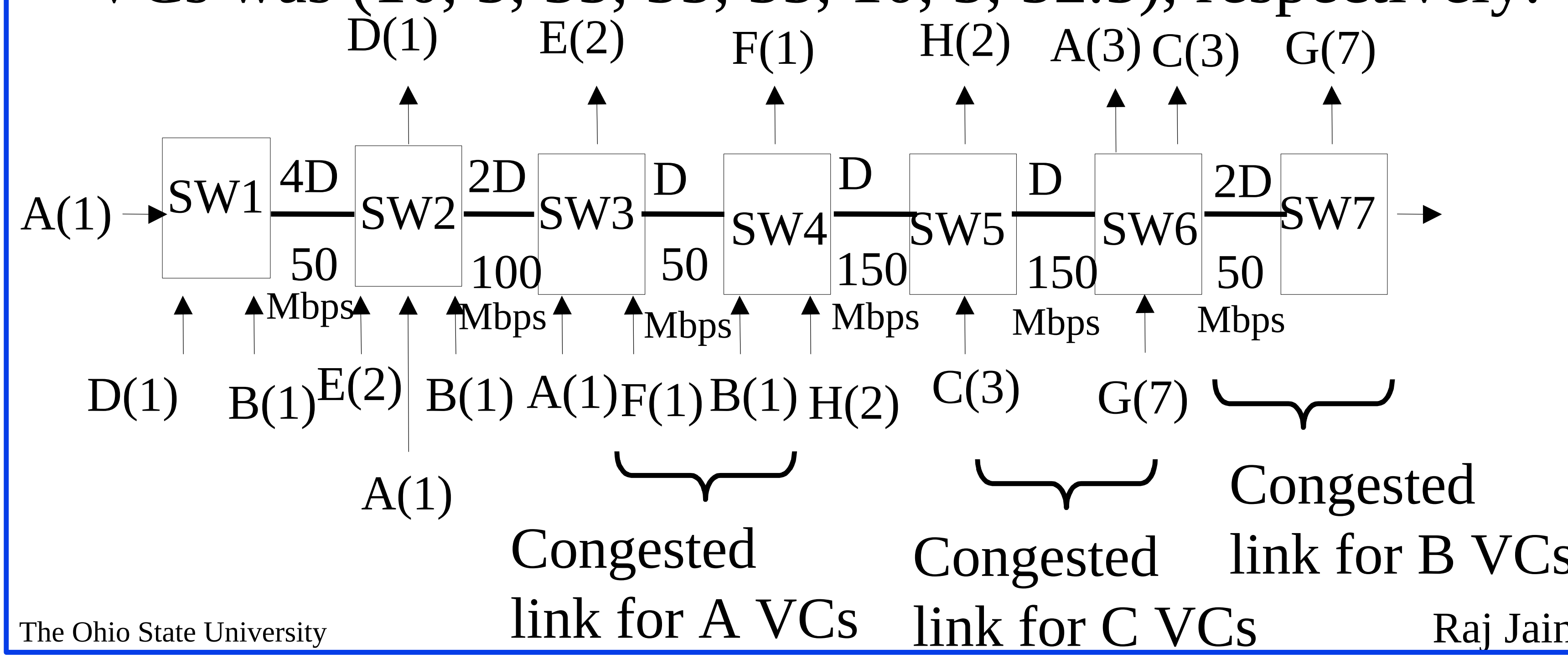
**Source Bottleneck configuration**

- Source S1 is bottlenecked at 10 Mbps for first 0.4 s (i.e., it sends data at a rate of min{10 Mbps, ACR})
- MCRs= {10, 30, 50} Mbps
- Fair Allocation = {39.86, 59.86, 79.86} during (0, 0.4s) and {29.92, 49.92, 69.92} during (0.4, 0.8s).



# Configuration 4

- Generic Fairness Config GFC-2 with D=1000 km
- MCRs of zero for all source were used. Simulation time 2.5 seconds.
- Allocation for each of (A, B, C, D, E, F, G, H) type VCs was (10, 5, 35, 35, 35, 10, 5, 52.5), respectively.



# Table 1: Simulation Parameters

| Configuration Name | Link Distance | Averaging Interval | Target Delay | Wt Func |
|---|---|---|---|---|
| Three Sources | 1000 Km | 5 ms | 1.5 ms | 1 |
| Source Bottleneck | 1000 Km | 5 ms | 1.5 ms | 1 |
| GFC-2 | 1000 Km | 15 ms | 1.5 ms | 1 |

- Exponential averaging of overload with decay factor of 0.8 was used for algorithms A and D. B and C are more sensitive to variation, so decay factor of 0.4 was used.

# Simulation Results

- Configuration 1: Three Sources
  - All algorithms achieved the generalized fairness allocation.
- Configuration 2: 3-Source Transient
  - All algorithms achieved the generalized fairness allocation.
  - Algorithm B has oscillations

# Results (Contd)

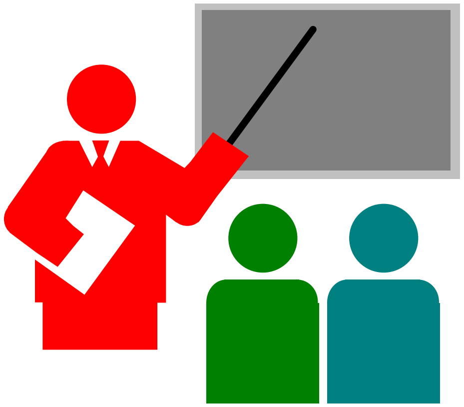
- Configuration 3: Source Bottleneck
  - Algorithm A and B do not converge since they use CCR field for estimating source rate. If measured source rate was used A and B also converge.
- Configuration 4: GFC2
  - Algorithm B and D have rate oscillations due to queue control.
  - Algorithm C had large switch queue, since it uses maximum always.

# Comparison of Algorithms

| Algo- rithm | End of Interval | Feed back | Max Queue | PerVC SrcRate | Sensitive to Queue control |
|---|---|---|---|---|---|
| A | O(N) | O(1) | Medium | Yes | Yes |
| B | O(N) | O(1) | Medium | Yes | Yes |
| C | O(1) | O(1) | Large | No | No |
| D | O(1) | O(1) | Medium | No | No |

- Algorithm D is the best

# Summary



- Algorithm A and B use activity levels. Need measured source rate in presence of source bottlenecks
- Algorithm C based only on MaxAlloc can have large switch queues
- Algorithm D based on VCs rate and MaxAlloc is the best algorithm.