97-1087R1: Design and Analysis of Queue Control Function for Switch Schemes

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Depa sity

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- Switch Scheme Model
- Queue Control Functions
- Metrics
- Analytical Explanation (in the contribution)
- Simulation Results
- Conclusion

Queue Control Function

- Used to adjust switch congestion feedback (ER) based on the queue length
- Target rate = f(q) × fn{current load, link rate, Higher priority (CBR, VBR) load}
  f(q) is the queue control function.
- Assume explicit rate feedback switch (Results may not apply to EFCI switch)
- ERICA+ fits the above model
- Queue control is required for stability and robustness

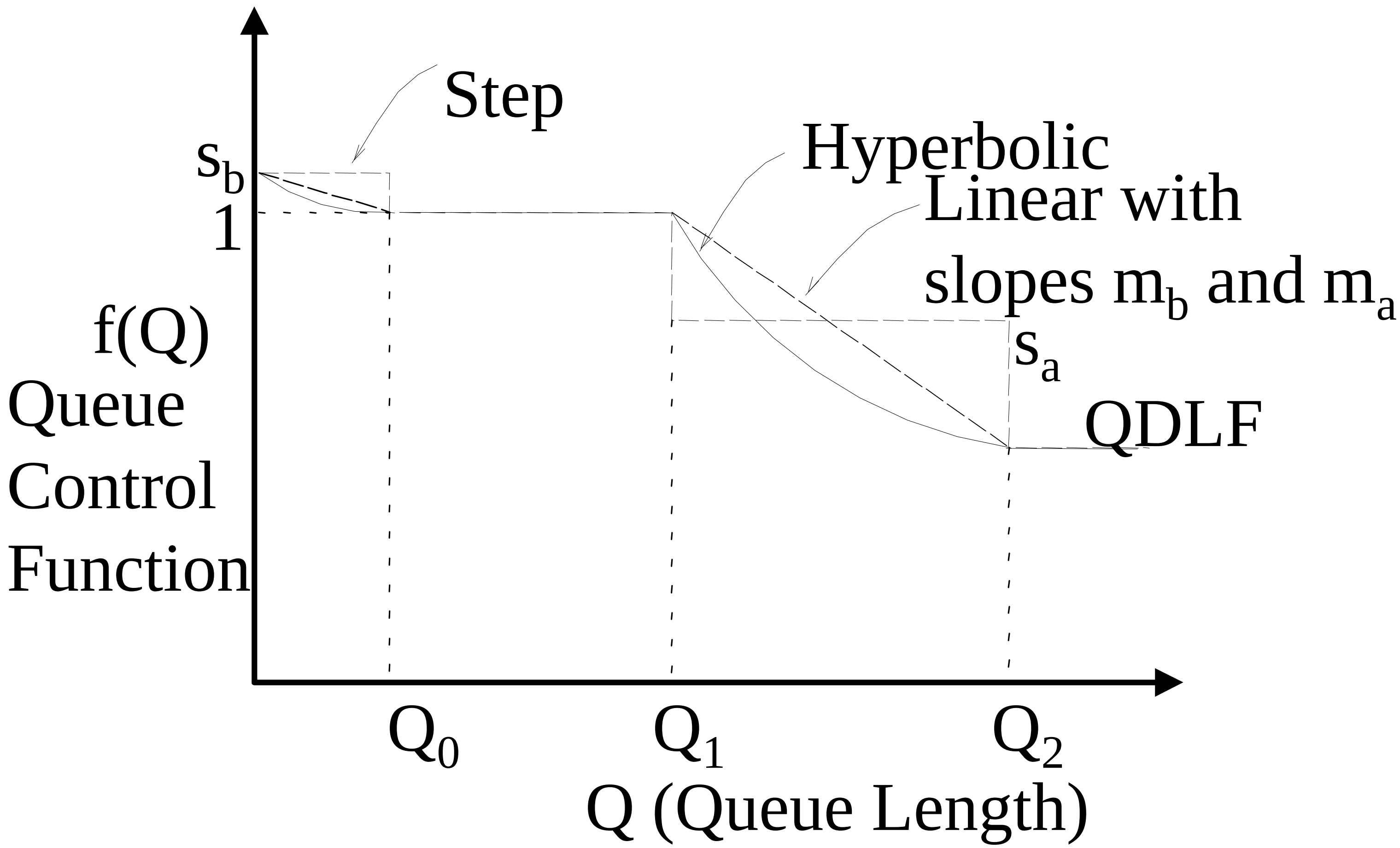
Background

- For real-time ABR:
  - Queue lengths should be small
    $\Rightarrow$ Queue control is required
  - Any change in ACR changes quality
    $\Rightarrow$ ACR should remain constant for some time
- Queue control should be simple.
  Can we use simple static queue thresholds?

Design Principles

1. If queue length is very small, increase it
   $\Rightarrow$ f(Q) is greater than one
2. In steady state, queue should be constant $\Rightarrow$ f(Q) =1.
3. If queue length is large, use part of link capacity to drain the queue $\Rightarrow$ f(Q) < 1
4. Not all of link capacity should be used for draining
   $\Rightarrow$ threshold for f(Q), known as queue drain limit factor (QDLF)
5. f(Q) has to be continuous.
   Discontinuities $\Rightarrow$ oscillations in Q lengths and rates

Step, Linear and Hyperbolic Functions

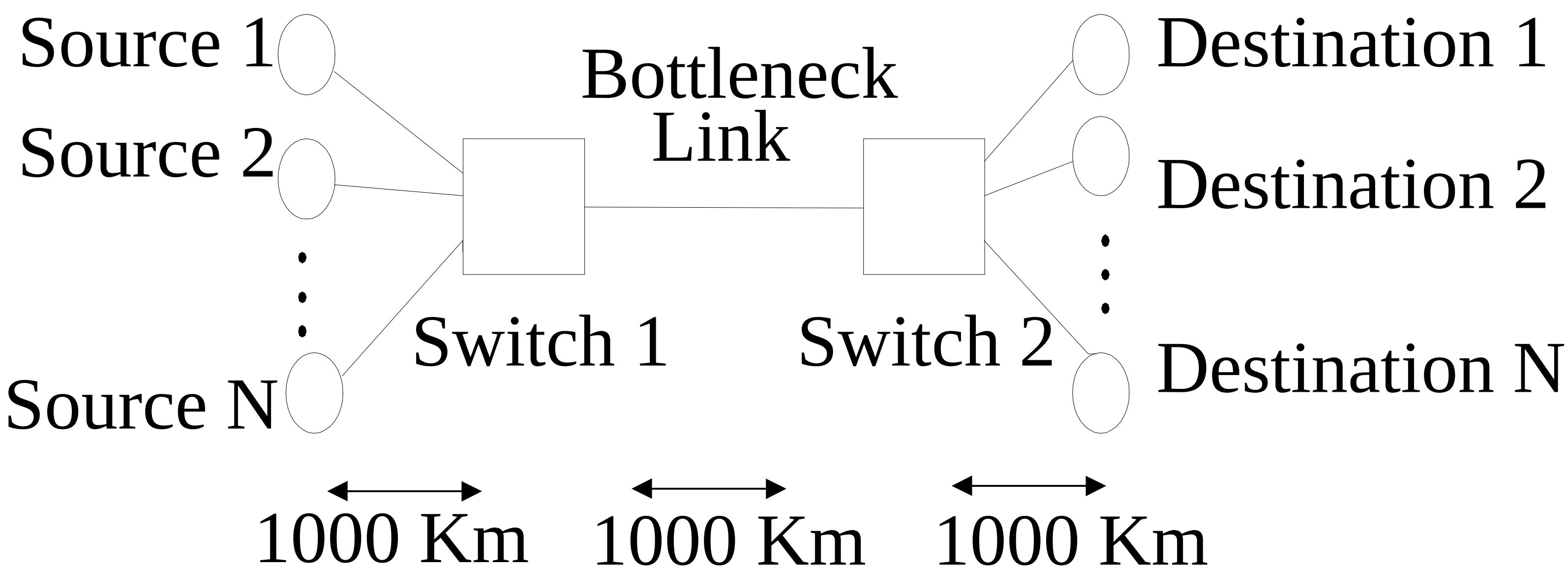


Metrics

- Convergence time seen in graph
- Mean queue length
- Standard deviation of ACR before t = 1s
- Standard deviation of ACR after t = 1s

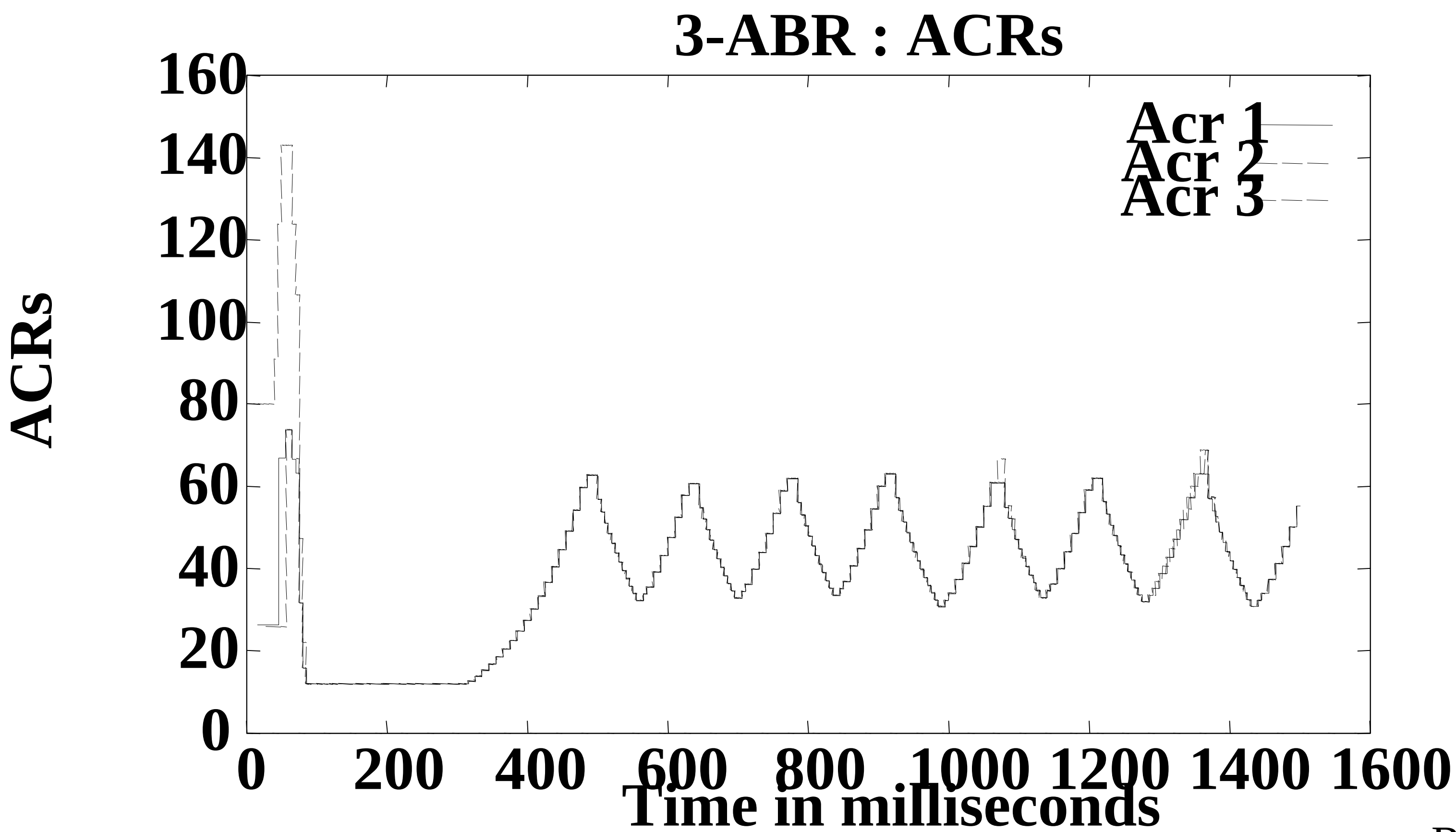
Configuration 1

- Simple configuration
- N infinite ABR sources,
  N ABR destinations
- One way traffic. From sources to destinations.



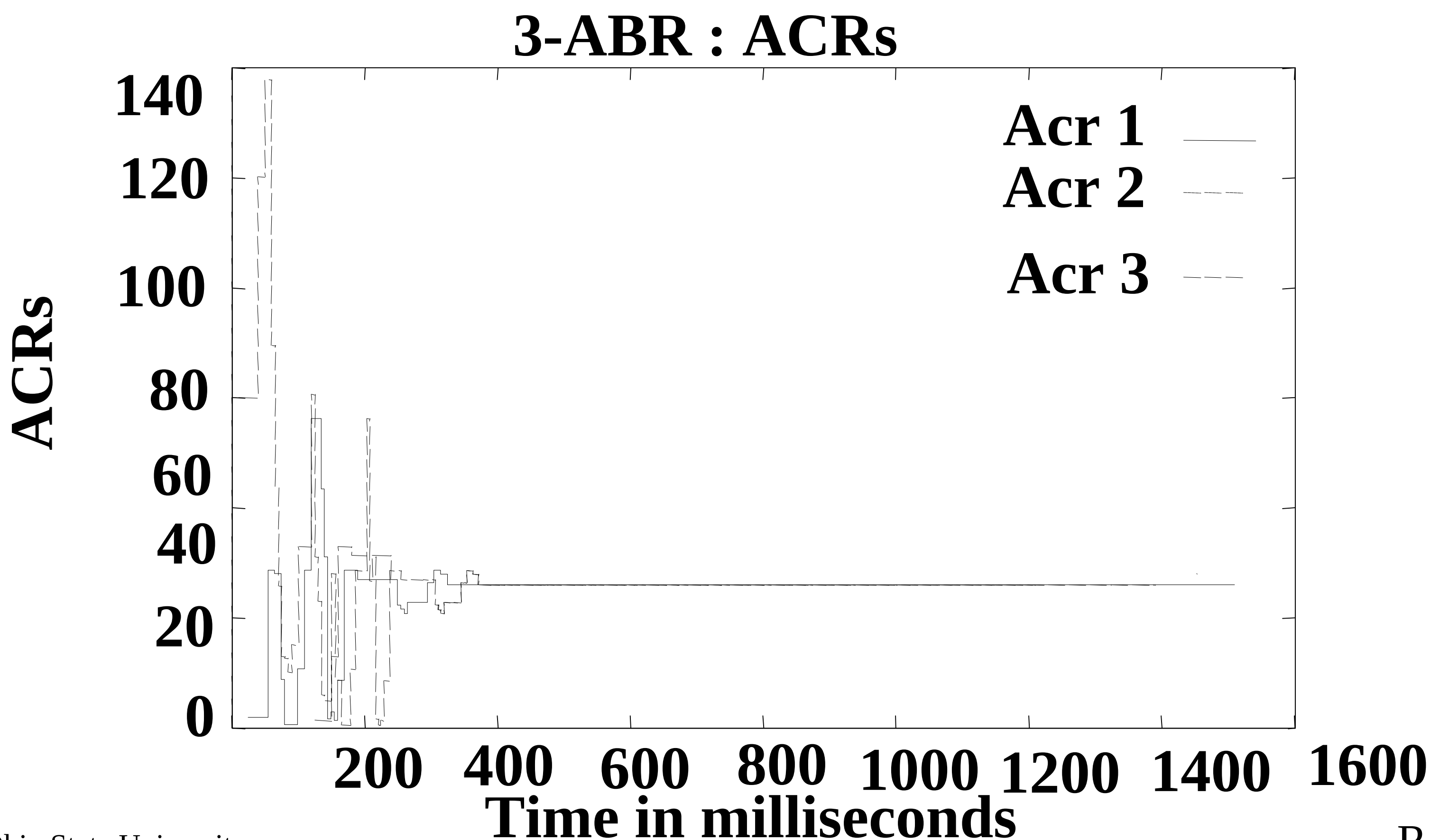
Step Function Graphs

$s_a = 1.05$, $s_b = 0.95$, $Q_1 = 4Q_0$, $Q_2 = 26Q_0$



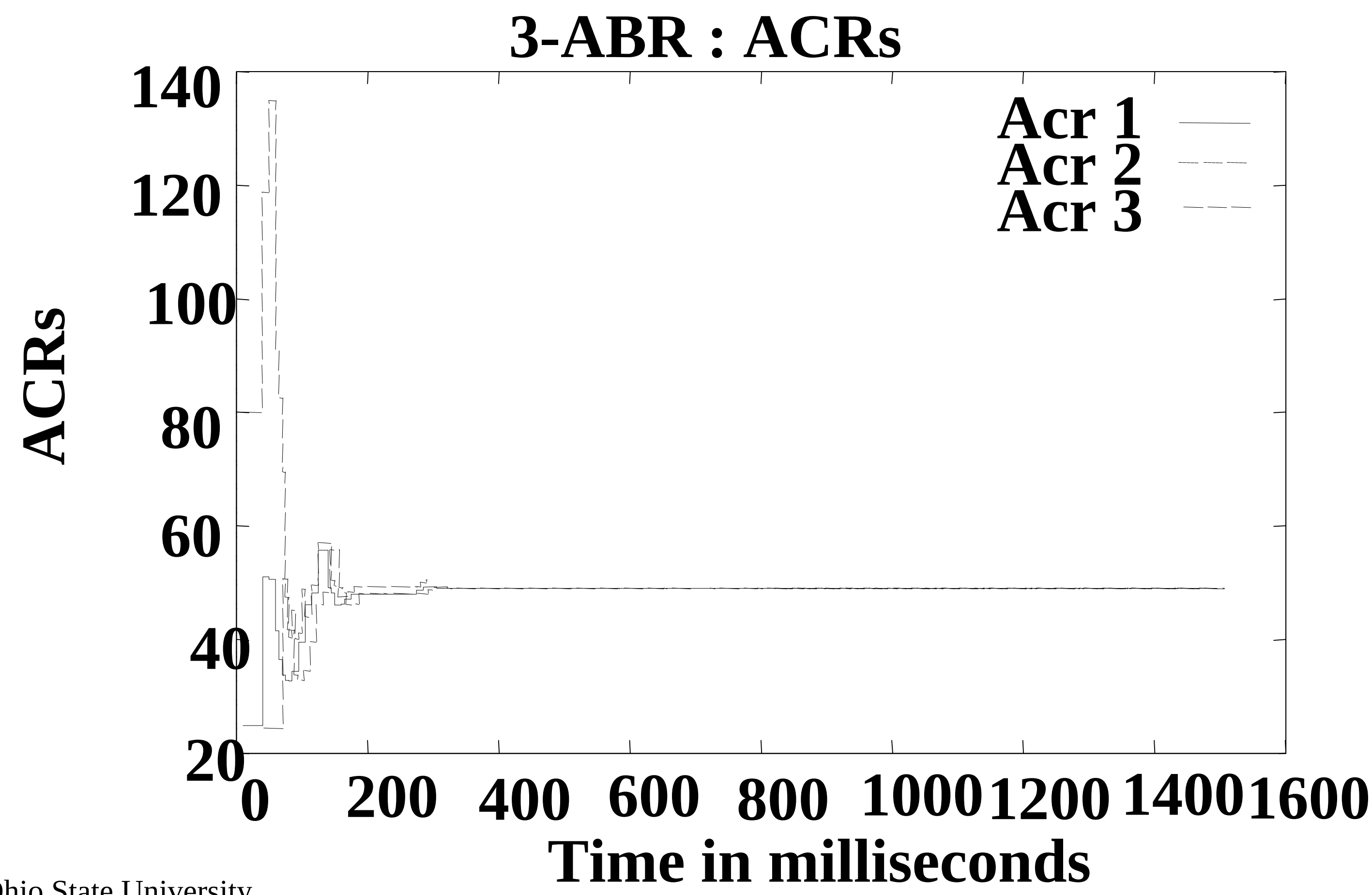
Linear Function Graphs

$m_a = 1/16$, $m_b = 1/16$, $Q_1 = 4Q_0$, $Q_2 = 26Q_0$



Hyperbolic Func. Graphs

$h_a = 1.15$, $h_b = 1.05, Q_1 = 4Q_0, Q_2 = 26Q_0$



Results

- Table 1: Simple configuration: Results

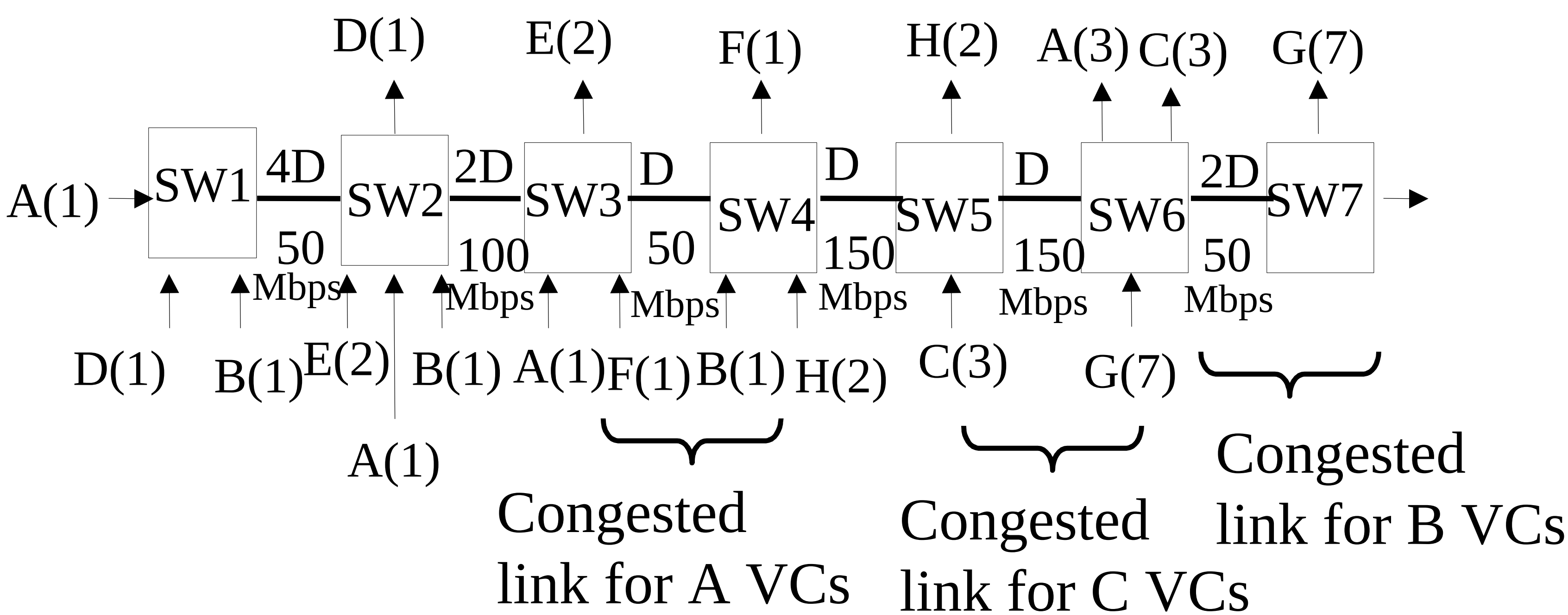
Queue Control	a param	b param	Q1	Q2	Convg time(sec	Mean Q(cells)	Std Dev (bef1sec)	Std Dev (after1)
Step	0.75	1.01	4xQ0	26xQ0	-	252.93	552.21	501.6
Step	0.9	1.01	4xQ0	26xQ0	-	98.04	651.82	241.43
Step	0.9	1.05	4xQ0	26xQ0	-	663.63	1226.7	840.36
Step	0.95	1.01	4xQ0	26xQ0	-	251.51	816.62	393.26
Step	0.95	1.05	4xQ0	26xQ0	-	124.11	805.32	240.04
Step	0.95	1.01	2xQ0	26xQ0	-	896.9	1386.87	1036.66
Linear	1/16	1/16	2xQ0	26xQ0	0.2	311.85	335.61	0.69
Linear	1/16	1/16	4xQ0	26xQ0	0.32	403.52	457.9	0.69
Linear	1/16	1/16	8xQ0	26xQ0	0.61	402.85	622.02	0.69
Hyperb	1.15	1.05	2xQ0	26xQ0	-	509.94	423.89	205.65
Hyperb	1.15	1.05	8xQ0	26xQ0	0.82	220.96	862.25	0.63

Observations

- Step function never converged
- Linear and hyperbolic functions reached steady state
- As Q_1 increases $\Rightarrow$ Convergence time increases
- For $Q_1 = 2Q_0$ linear function converged, hyperbolic had small oscillations
- $Q_1 = 8Q_0$ convergence time for hyperbolic is more than linear function's.

Configuration 2

- Generic Fairness Configuration (GFC-2)
- D - distance of links = 1000 Km

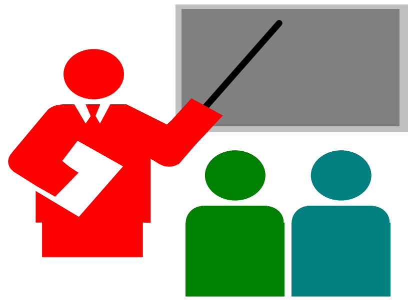


GFC-2 Configuration: Results

Queue Control	Quantity	Convergenc Time (secs)	Mean	Std Dev (bef1sec)	Std Dev (aft1sec)
Step	H(1) ACR	-	72.81	18.4	4.46
	SW5 Que	-	284.28	878.63	281.85
Linear	H(1) ACR	1.25	52.46	14.38	1.08
	SW5 Que	1.3	455.46	1043.71	220.42
Hyperbolic	H(1) ACR	1.45	52.77	13.57	0.58
	SW5 Que	1.3	361.32	968.27	201.86

Step function has larger rate and queue length variations than linear and hyperbolic functions

Summary



- Less oscillations in rates and queue length $\Rightarrow$ support for low quality video over ABR
- Step (multiple thresholds) function is not good
- Hyperbolic and linear provide good queue control functions
- Linear function is recommended for simpler implementation