Performance of TCP/IP Using ATM ABR and UBR Services over Satellite Networks

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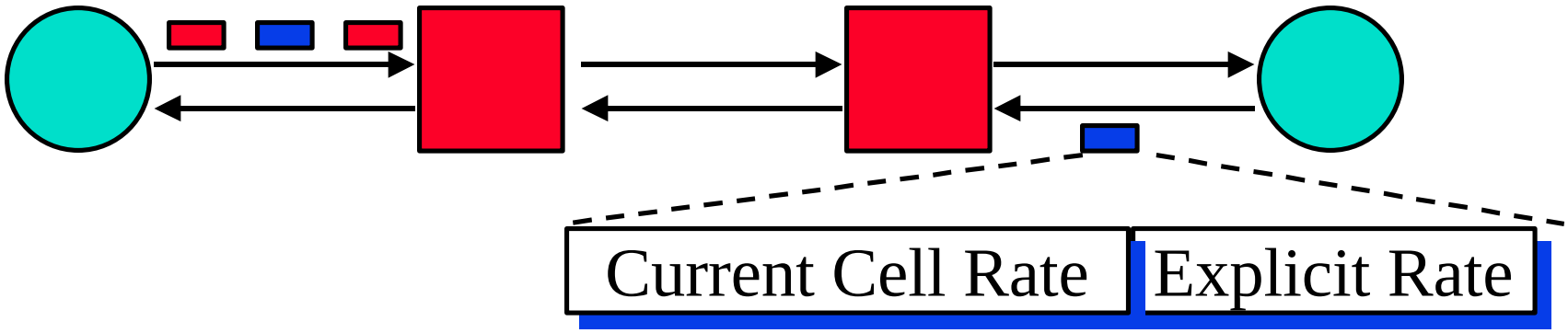
Overview

- ABR, UBR, VBR, CBR
- TCP
- ERICA and ERICA+ Switch Schemes
- Effects of # of sources, feedback delay, switch scheme, VBR background

Classes of Service

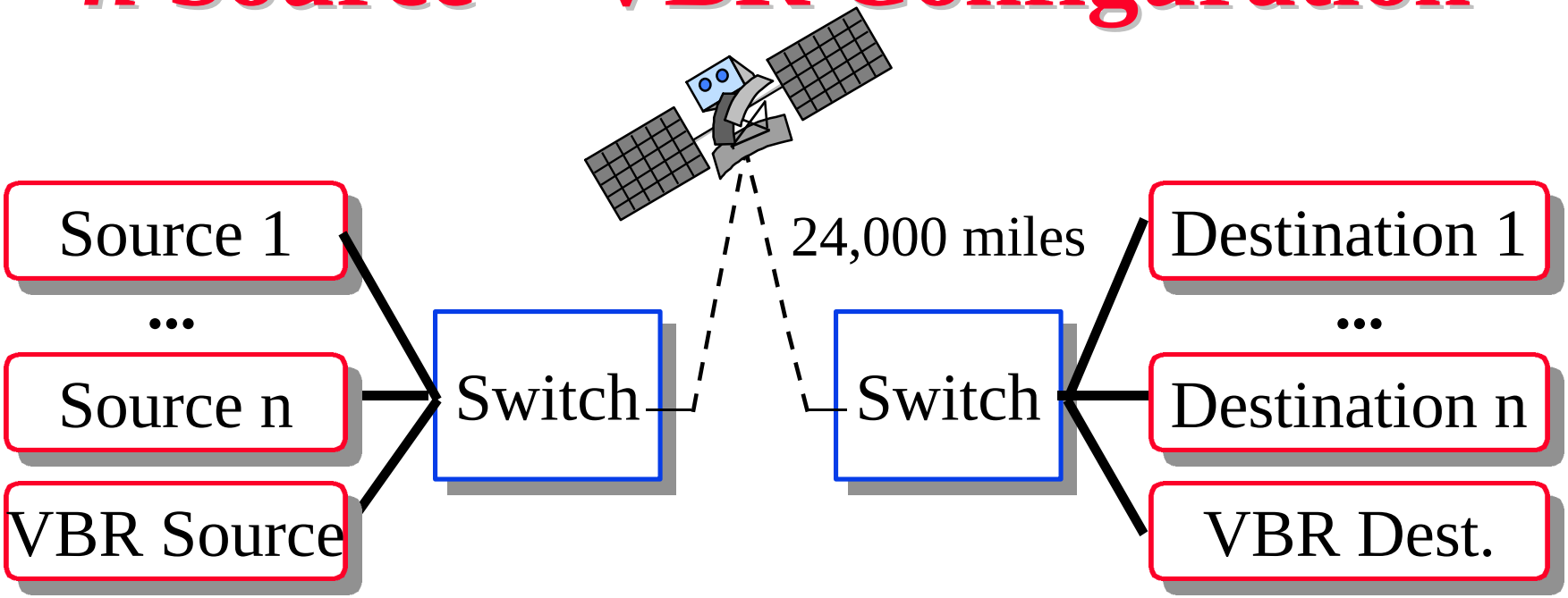
- ABR (Available bit rate): Follows feedback
  Network gives max throughput with minimum loss.
- UBR (Unspecified bit rate):
  User sends whenever it wants. No feedback. No guarantee. Cells may be dropped during congestion.
- CBR (Constant bit rate): User declares required rate.
  Throughput, delay and delay variation guaranteed.
- VBR (Variable bit rate): Declare avg and max rate.
  - rt-VBR (Real-time): Conferencing.
    Max delay and delay variation guaranteed.
  - nrt-VBR (non-real time): Stored video.
    Mean delay guaranteed.

ABR: The Explicit Rate Scheme



- Sources send one RM cell every n cells
- The RM cells contain "Explicit rate"
- Destination returns the RM cell to the source
- The switches adjust the rate down
- Source adjusts to the specified rate
- Interoperates with all switch algorithms

n Source + VBR Configuration



- All links 155 Mbps
- If VBR background , 1 ms on (80%), 1 ms off, start at t = 2ms
- All traffic unidirectional, Large file transfer.

Effect of # of Sources

# of Sources	Feedback Delay (ms)	Max Queue (cells)
5	0.01	1229 (0.006 × RTT)
15	0.01	2059 (0.010 × RTT)
5	10.00	18356 (0.090 × RTT)
15	10.00	17309 (0.086 × RTT)

- Queue increases with sources but only slightly Not proportionately.
- Queue depends upon the round trip delay
- Queue increases with feedback delay (proportionately)

Effect of Long Feedback Delay

# of Sources	Feedback Delay (ms)	Switch Scheme	Max Queue (cells)
15	550	ERICA	Unbounded
15	550	ERICA+	1.6 × RTT

- ERICA = Explicit Rate Indication for Congestion Avoidance
- The simple scheme becomes unstable with long feedback delay
- Need a more sophisticated scheme
  ⇒ ABR results depend upon the switch scheme

Effect of High Frequency VBR

# of Sources	Feedback Delay (ms)	Switch Scheme	Max Queue (cells)
15+VBR	0.01	ERICA	Unbounded
15+VBR	10.00	ERICA	Unbounded
15+VBR	0.01	ERICA+	2006 (0.010 × RTT)
15+VBR	10.00	ERICA+	5824 (0.028 × RTT)

- The simple scheme diverges with high variance in capacity
- Need averaging schemes or ERICA+ queue control

UBR Service

# of Sources	TCP Window	Max Queue (cells)
5	200,750 cells	817,819 ≈ (n × Window)

- Buffer requirement = Σ $Window_i$
- Proportional to the number of sources
  $\Rightarrow$ Not scalable

Summary

- ABR does provides an effective control of congestion in the network. The network queues are very small. Most of the queues are in the sources ⇒ ABR pushes TCP queues to the edge of the network.
- 2 to 4 times RTT buffers in the switches are sufficient with ABR.
- TCP and VBR produce a variable demand and variable capacity workload
  ⇒ Unbounded queues with simple ABR schemes.
- UBR requires switch buffers equal to the sum of window sizes ⇒ UBR is not scalable.

TCP/IP Parameters

- Maximum Segment Size = 512 bytes
- Timer granularity = 100 ms
- No TCP processing time
- Max window = 16 × 64 kB = 24576 cells
  One-way delay = 15 ms = 291 kB
- No delay ack timer
- Fast retransmit/recovery or Early packet drop (EPD) have no impact when there is no loss.

Simulation Parameters

- Source: Parameters selected to maximize ACR

  TBE = 512

  CDF = 0.5

  ICR = 10 Mbps

  ADTF = 0.5 sec

  PCR = 155.52 Mbps, MCR= 0, RIF (AIR) = 1,

  Nrm = 32, Mrm = 2, RDF = 1/512

  Traffic: TCP/IP with Infinite source application

- Switch: ERICA+

  Averaging interval = min{100 cells, 1000 μs} and other values

TCP over ABR: Buffering

- Buffering depends heavily upon switch scheme.
- For the ERICA scheme and the traffic loads considered:
  - W/o VBR, 3×RTT buffers will do for any number of TCP sources
  - In general, Qmax = a×RTT + b×Averaging Interval + c×Feedback delay + d×fn(VBR)
- After TCP sources are rate-limited:
  Switch queues become zero, source queues build up