Traffic Management in ATM Networks

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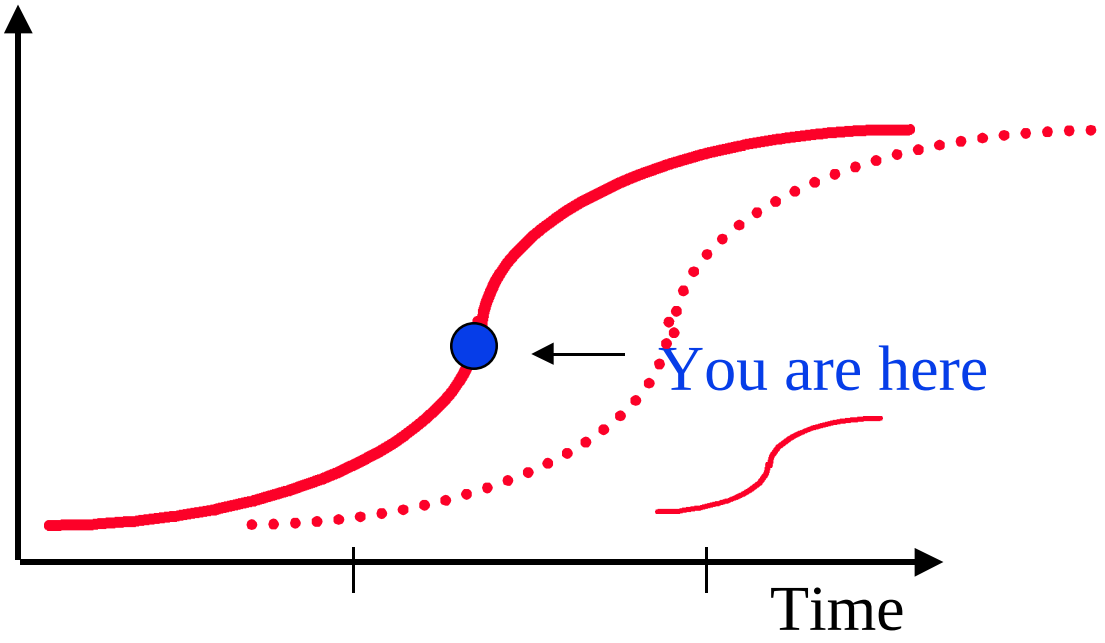
- Trends
- Service Classes
- Traffic management functions
- Binary feedback vs explicit rate
- UBR vs ABR

Life Cycles of Technologies

Number of
Problems Solved

Number of Hosts
Bytes per Hosts
Number of Networks

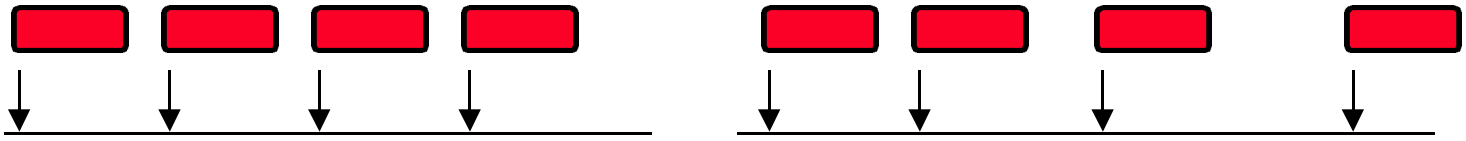


Trends

- Industry is ahead of the academia
  Fast Ethernet, Gigabit Ethernet, ATM Traffic Mgmt
- Standardization ⇒ Can't succeed alone
  ⇒ Innovation + Technology partnerships
- Academics must work with industrial forums.
  Publication alone is not sufficient.
  IETF, IEEE 802, ATM Forum, ...

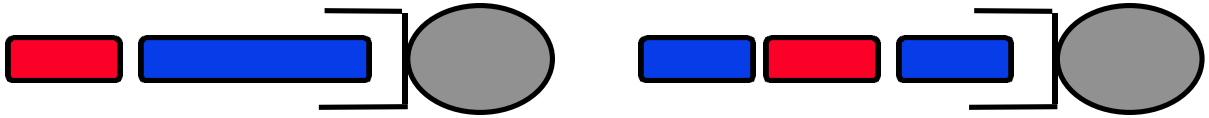
ATM Networks: Overview

- STM = Synchronous Transfer Mode,
  ATM = Asynchronous Transfer Mode

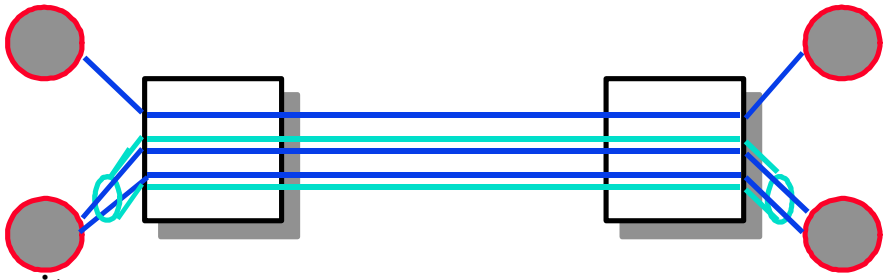


Allows any-speed and even variable rate connection

- ATM = Short fixed size 53-byte cells



- Connection oriented ⇒ Virtual Channels (VC)



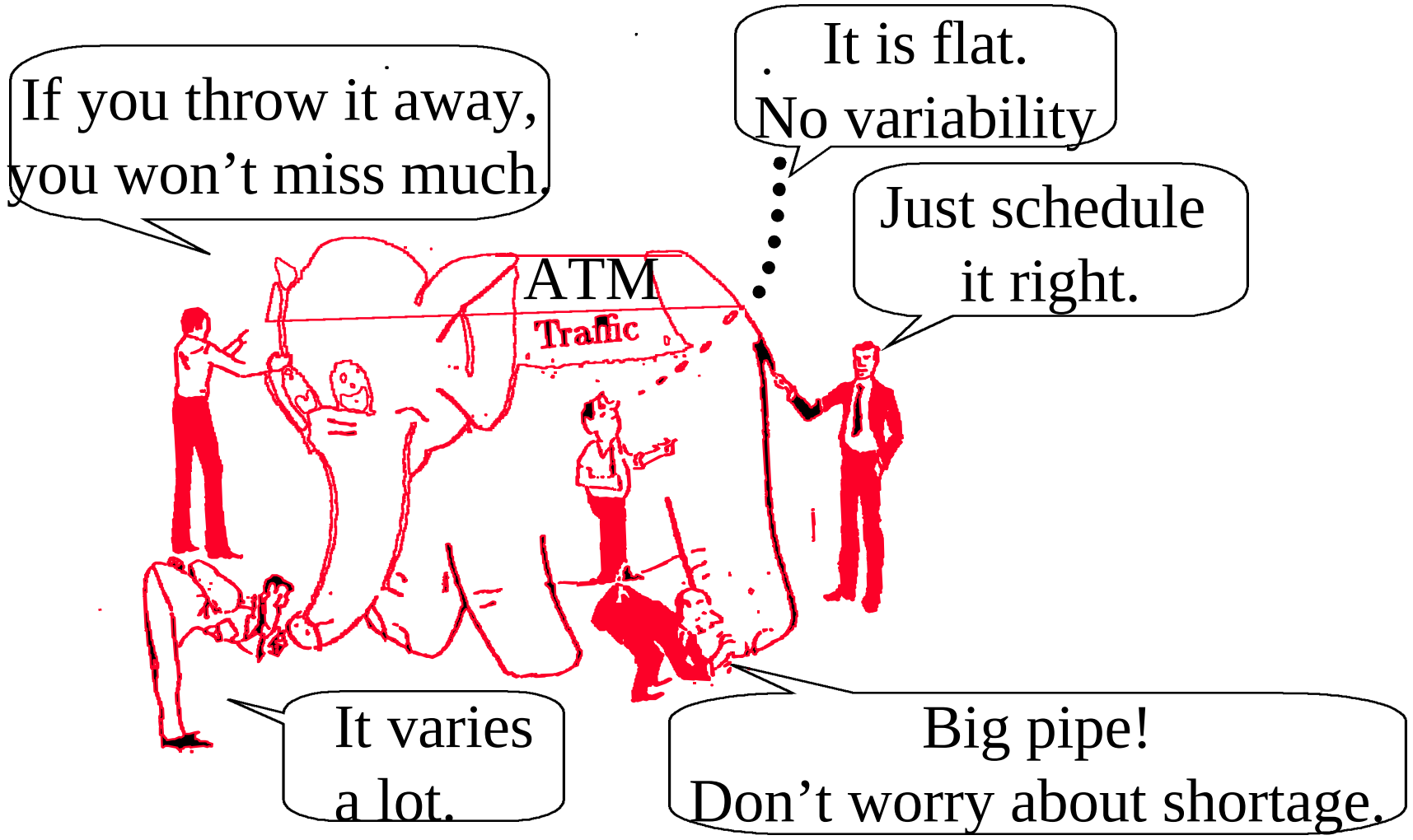
Classes of Service

- 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.

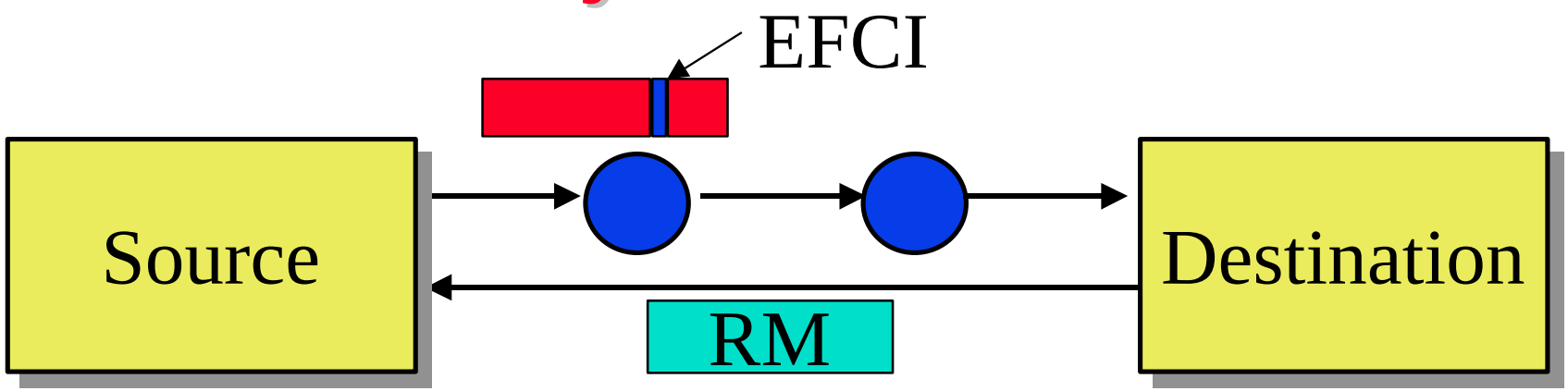
Traffic Management Functions

- Connection Admission Control (CAC):
  Verify that the requested bandwidth and quality of service (QoS) can be supported.
- Traffic Shaping: Limit burst length. Space-out cells.
- Usage Parameter Control (UPC):
  Monitor and control traffic at the network entrance.
- Network Resource Management:
  Scheduling, Queueing, resource reservation
- Priority Control: Cell Loss Priority (CLP)
- Selective Cell Discarding: Frame Discard
- Feedback Controls: Network tells the source to increase or decrease its load.

ATM Traffic

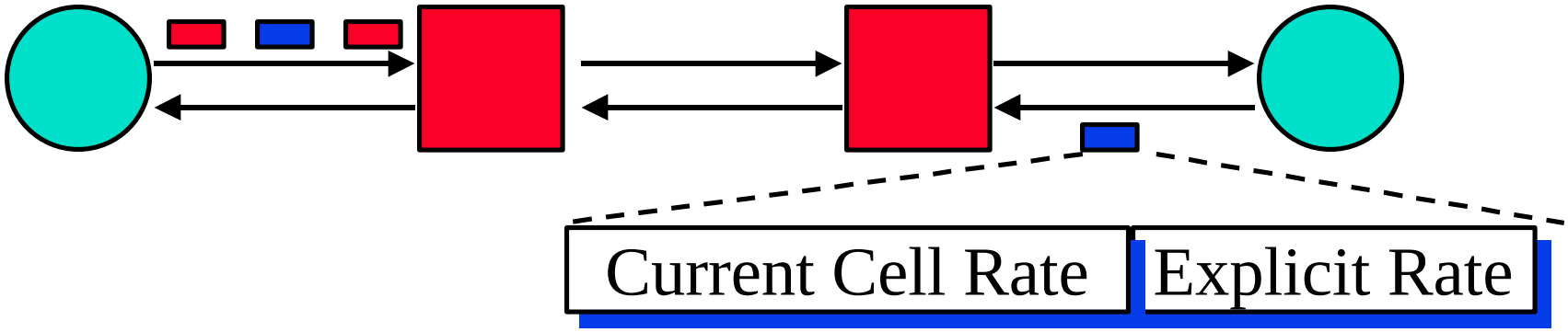

If you throw it away, you won't miss much.
It is flat. No variability
Just schedule it right.
ATM
Traffic
It varies a lot.
Big pipe! Don't worry about shortage.

Initial Binary Rate-based Scheme



- Explicit forward congestion indicator (EFCI) set to 0 at source
- Congested switches set EFCI to 1
- Every *n*th cell, destination sends an resource management (RM) cell to the source indicating increase amount or decrease factor
- Unfair without selective feedback

The Explicit Rate Scheme

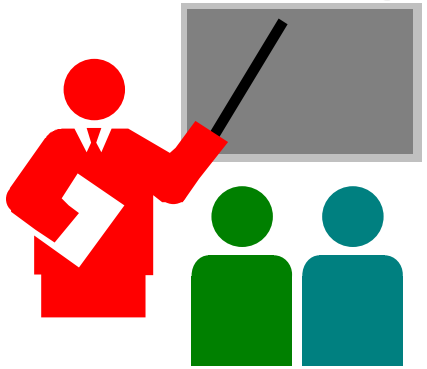


- Sources send one RM cell every n cells
- The RM cells contain "Explicit rate"
- Destination returns the RM cell to the source
- The switches adjust the rate down
- Source adjusts to the specified rate

ABR vs UBR

ABR	UBR
Sources follow feedback	Sources send at peak rate
Switches reduce rate	Switches drop if congested
Small queue in the switch	Small queues in the source
All queues in the source	All queues in the network
Pushes congestion to edges	No backpressure
Max buffering = 4 ×RTT	Max Buffering = n ×RTT
Good if end-to-end ATM	Same end-to-end or backbone
Fair	Generally unfair
Good for the provider	Simple for user

Summary



- Exponential phase of life cycle
  ⇒ Participate with the industrial forum
- Binary feedback is too slow for high speed networks
  ⇒ Explicit rate feedback
- ABR pushes the congestion to edges
  ⇒ Good for large distance-bandwidth product
- UBR may be OK for slow speed or LANs

Our Papers/Contributions

All our past ATM forum contributions, papers and presentations can be obtained on-line at http://www.cis.ohio-state.edu/~jain/

- S. Kalyanaraman, R. Jain, S. Fahmy, R. Goyal and S. Kim, "Performance and Buffering Requirements of Internet Protocols over ATM ABR and UBR Services," Submitted to IEEE Communications Magazine, September 1, 1996.
- S. Kalyanaraman, R. Jain, R. Goyal, S. Fahmy and S. Kim, ``Performance of TCP/IP Using ATM ABR and UBR Services over Satellite Networks," submitted to IEEE Communication Society Workshop on Computer-Aided Modeling, Analysis and Design of Communication Links and Networks, McLean, VA, October 20, 1996.

- S. Kalyanaraman, R. Jain, S. Fahmy, R. Goyal and S. Kim, "Buffer Requirements For TCP/IP Over ABR," Proc. IEEE ATM'96 Workshop, San Francisco, August 23-24, 1996.
- S. Kalyanaraman, R. Jain, S. Fahmy, R. Goyal, F. Lu and S. Srinidhi, ``Performance of TCP/IP over ABR," To appear Globecom'96, London, November 1996.
- R. Jain, S. Kalyanaraman, R. Goyal, S. Fahmy, "Source Behavior for ATM ABR Traffic Management: An Explanation," To appear in IEEE Communications Magazine, November 1996.
- R. Jain, S. Kalyanaraman and R. Viswanathan, ``The OSU Scheme for Congestion Avoidance in ATM Networks: Lessons Learnt and Extensions," To appear in Performance Evaluation Journal, submitted May 1, 1996.

- R. Jain, S. Kalyanaraman, R. Viswanathan, "The OSU Scheme for Congestion Avoidance in ATM networks Using Explicit Rate Indication," Proceedings WATM'95 First Workshop on ATM Traffic Management, Paris, December 1995 (proceedings also to appear in book form).
- R. Jain, "ABR Service on ATM Networks: What is it?" Network World, June 24, 1995.
- A. Charny, D. Clark, R. Jain, "Congestion Control with Explicit Rate Indication," Proc. ICC'95, June 1995, 10 pp.
- K. Siu and R. Jain, "A Brief Overview of ATM: Protocol Layers, LAN Emulation, and Traffic Management," Computer Communications Review (ACM SIGCOMM), April 1995.
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- R. Jain, R. Goyal, S. Kalyanaraman, S. Fahmy, "Performance of TCP over UBR and buffer requirements," ATM Forum/96-0518, April 1996.
- ATM Forum/96-1172: ERICA Switch Algorithm: A Complete Description (August 1996)