Recent Trends in Networking Including ATM and Its Traffic Management

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Overview

- Networking Trends
- Impact of Networking
- ATM Networks
- Competing technologies
- ATM Traffic Management

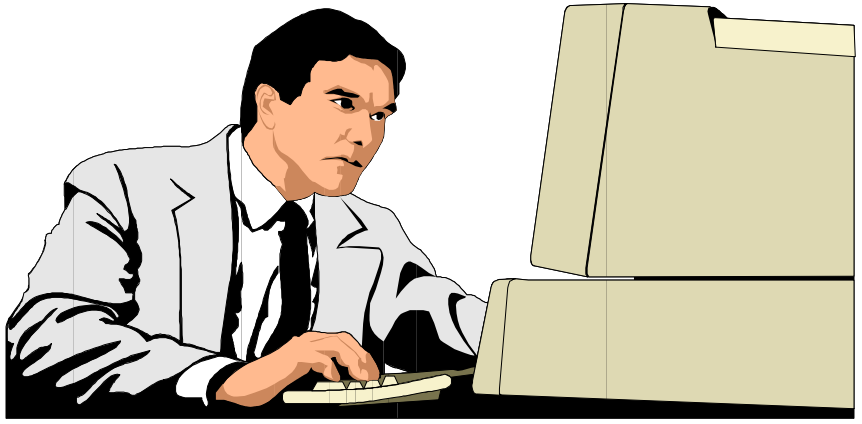
Trends

- Communication is more critical than computing
  - Greeting cards contain more computing power than all computers before 1950.
  - Genesis's game has more processing than 1976 Cray supercomputer.
- Internet: 0.3 M hosts in Jan 91 to 9.5 M by Jan 96
  $\Rightarrow$ More than 5 billion (world population) in 2003

Stone Age to Networking Age

- Microwave ovens, stereo, VCRs, had some effect. But, Stone, iron, …, automotive, electricity, telephone, jet plane,…, networks caused a fundamental change in our life style
- In 1994, 9% of households with PC had Internet link. By 1997, 26%. Soon 98% … like TV and telephone.
- URL is more important than a company's phone number. (54 URLs in first 20 pages of March'97 Good Housekeeping.)
- Email is faster than telegrams

Social Impact of Networking



- No need to get out for
  - Office
  - Shopping
  - Entertainment
  - Education
- Virtual Schools
- Virtual Cash
- Virtual Workplace

(55 Million US workers will work remotely by 2000)

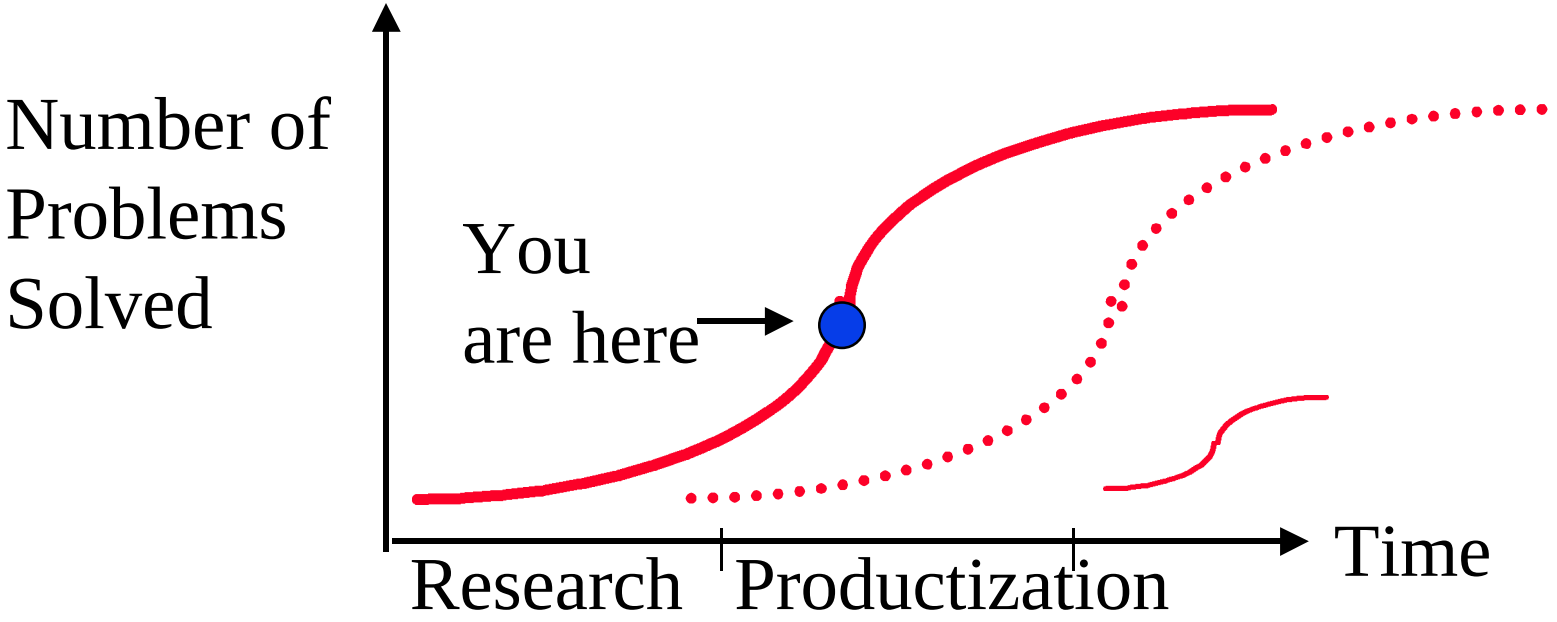
Impact on R&D

- Too much growth in one year
  $\Rightarrow$ Can't plan too much into long term
- Long term = 1_2 year or 10_2 years at most
- Products have life span of 1 year, 1 month, …
- Short product development cycles.
  Chrysler reduced new car design time
  from 6 years to 2.
- Distance between research and products has narrowed
  $\Rightarrow$ Collaboration between researchers and developers
  $\Rightarrow$ Academics need to participate in industry consortia

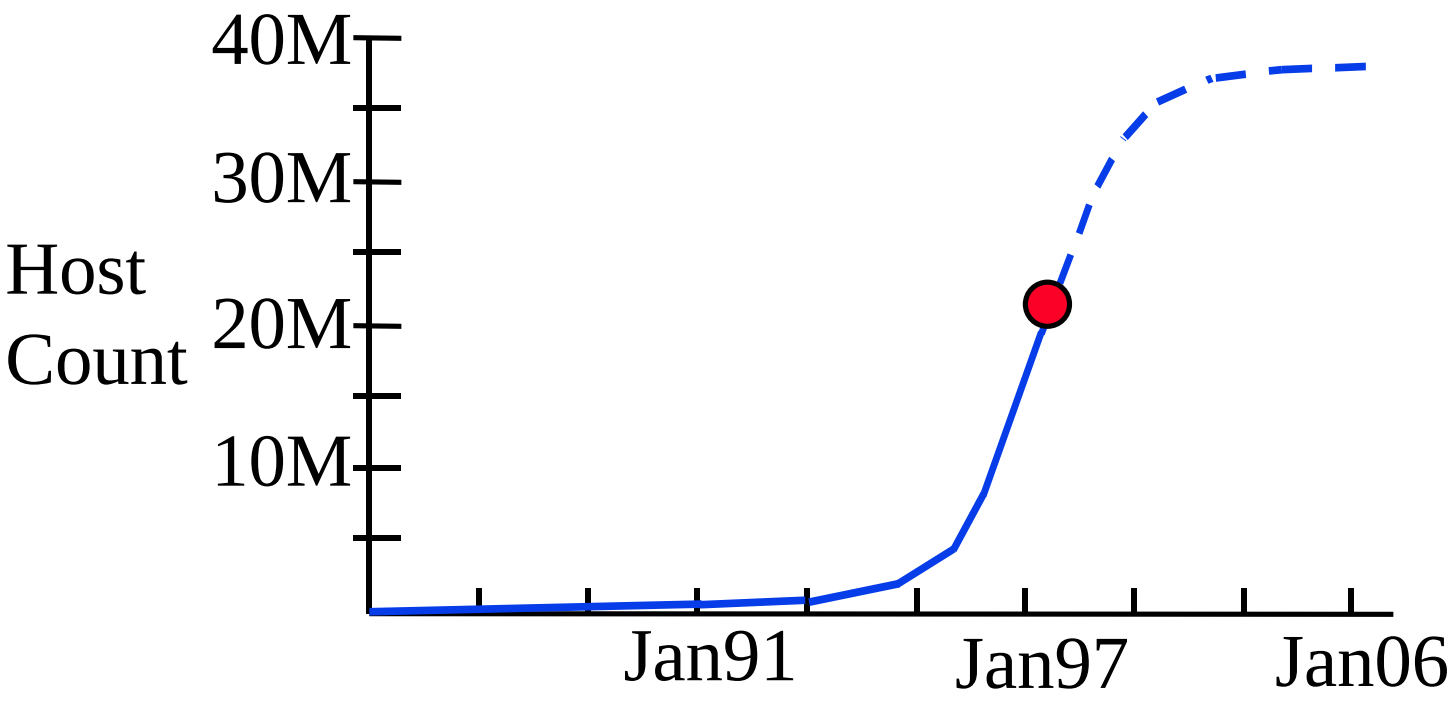
Garden Path to I-Way

- Plain Old Telephone System (POTS) = 64 kbps = 3 ft garden path
- ISDN = 128 kbps = 6 ft sidewalk
- T1 Links to Businesses = 1.544 Mbps = 72 ft = 4 Lane roadway
- Cable Modem Service to Homes: = 10 Mbps = 470 ft = 26 Lane Driveway
- OC3 = 155 Mbps = 1 Mile wide superhighway
- OC48 = 2.4 Gbps = 16 Mile wide superhighway

Life Cycles of Technologies



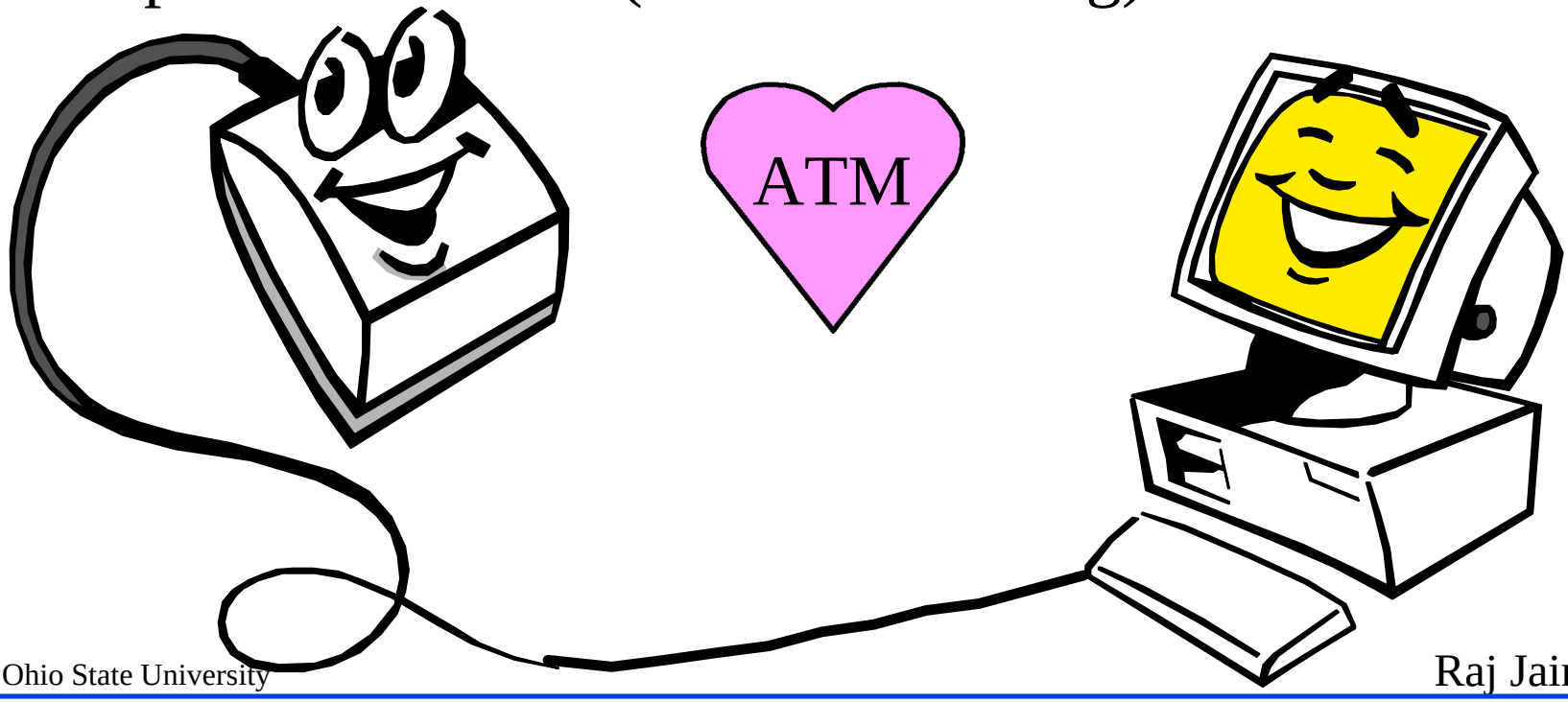
Internet Technology



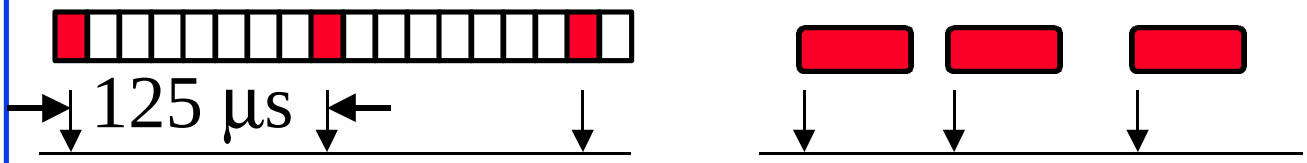
- **New Challenges**: Exponential growth in number of users. Exponential growth in bandwidth per user. Traffic management, Security, Usability, ...

ATM

- ATM Net = Data Net + Phone Net
- Combination of Internet method of communication (packet switching) and phone companies' method (circuit switching)



ATM vs Phone Networks

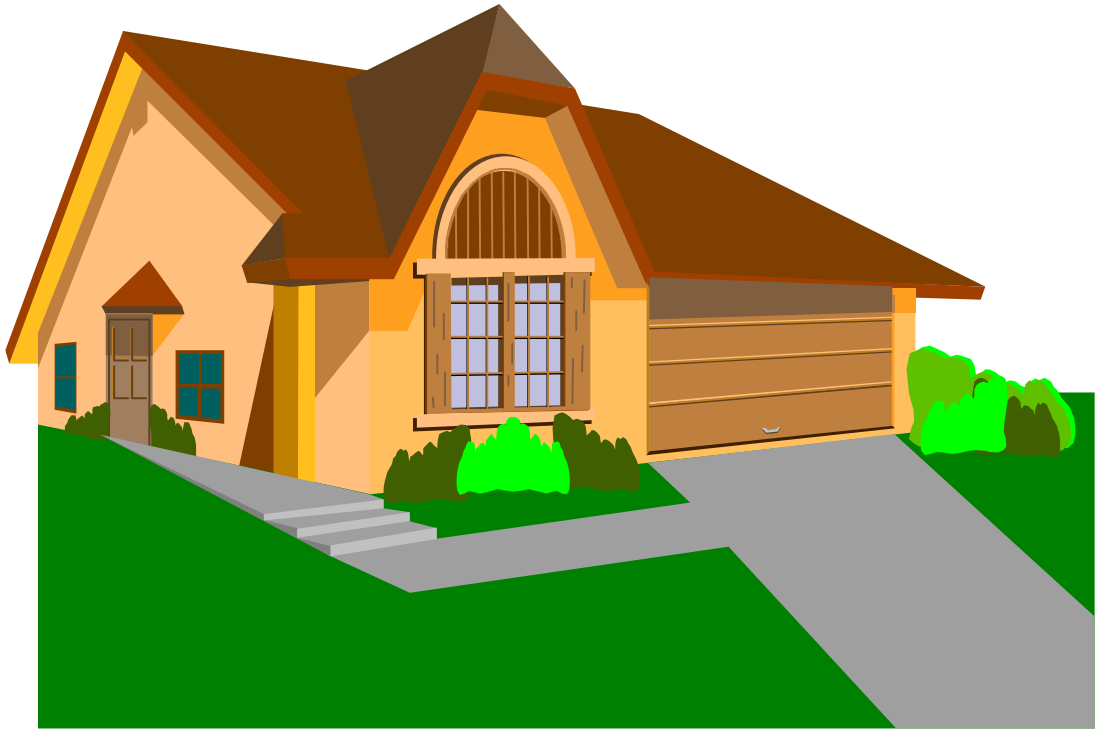


- Current phone networks are synchronous (periodic).
  ATM = Asynchronous Transfer Mode
- Phone networks use circuit switching.
  ATM networks use "Packet" Switching
- In phone networks, all rates are multiple of 8 kbps.
  With ATM service, you can get any rate.
  You can vary your rate with time.
- With current phone networks, all high speed circuits are manually setup. ATM allows dialing any speed.

ATM vs Data Networks

- Signaling: Internet Protocol (IP) is connectionless.
  You cannot reserve bandwidth in advance.
  ATM is connection-oriented.
  You declare your needs before using the network.
- PNNI: Path based on quality of service (QoS)
- Switching: In IP, each packet is addressed and processed individually.
- Traffic Management: Loss based in IP.
  ATM has 1996 traffic management technology.
  Required for high-speed and variable demands.
- Cells: Fixed size or small size is not important

Old House vs New House

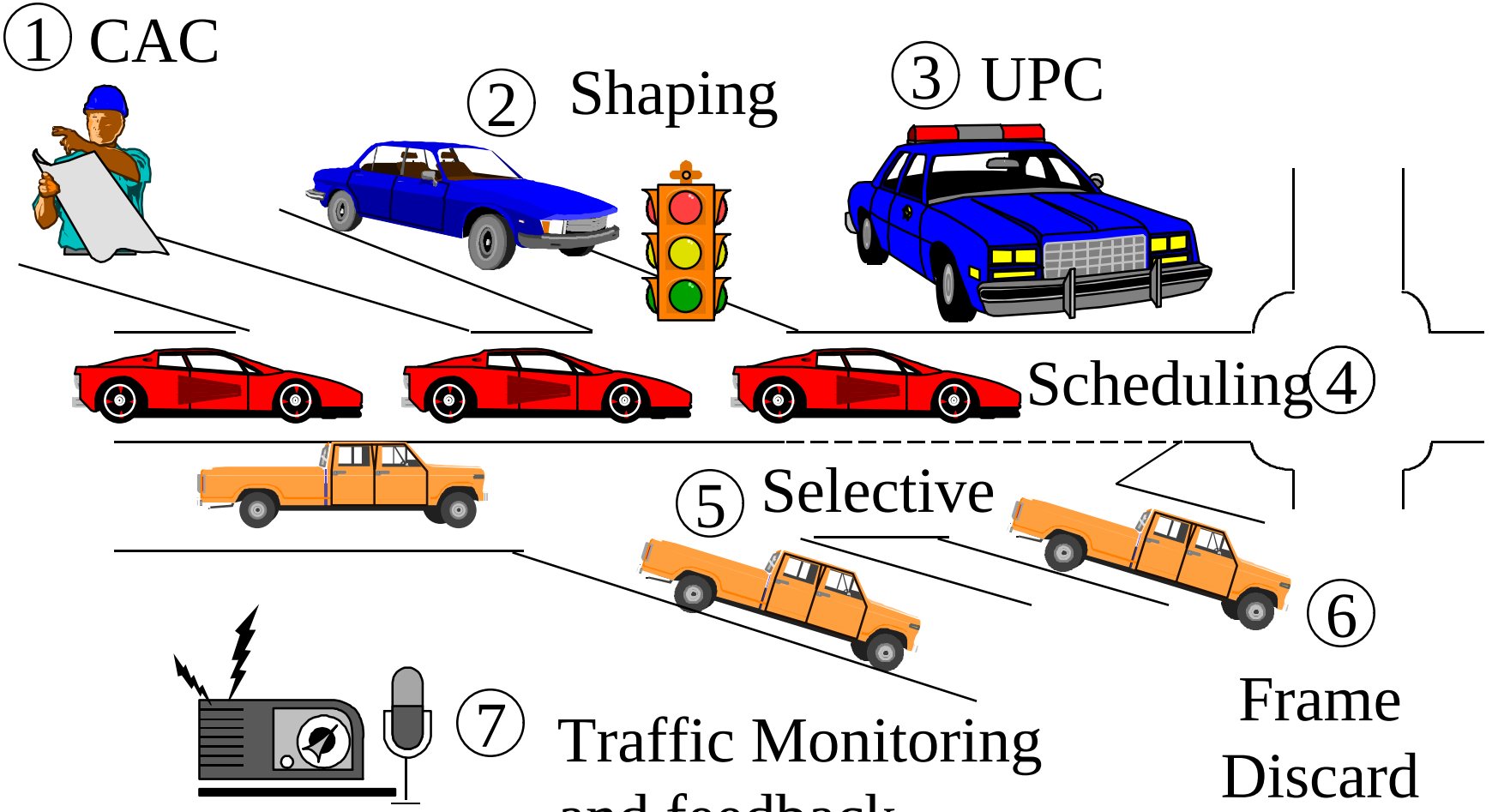


- New needs:

  Solution 1: Fix the old house (cheaper initially)

  Solution 2: Buy a new house (pays off over a long run)

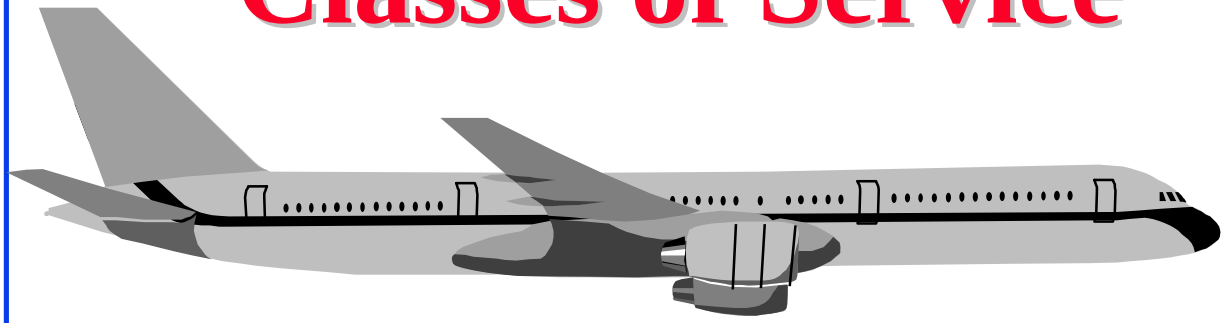
Traffic Management on the Info Superhighway



Traffic Mgmt Functions

- Connection Admission Control (CAC):
  Can quality of service 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.

Classes of Service



Standby

Guaranteed

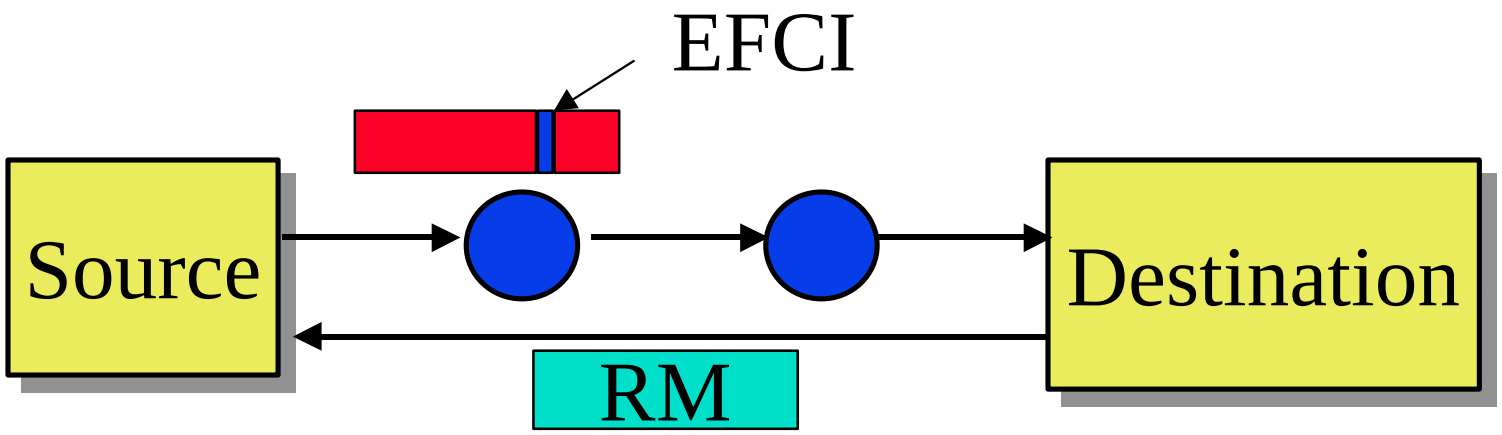
Joy Riders

Confirmed

Classes of Service

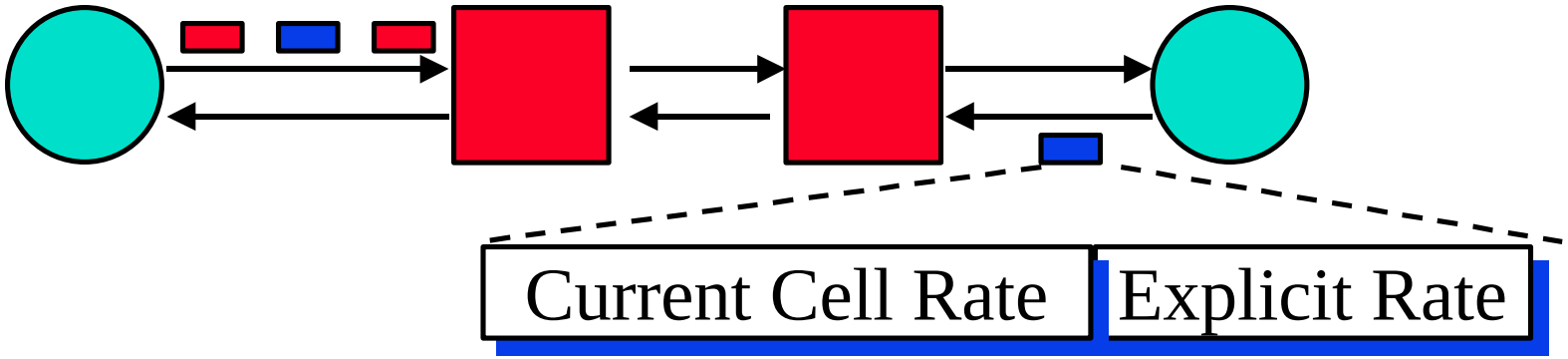
- ABR (Available bit rate):
  Source follows network feedback.
  Max throughput with minimum loss.
- UBR (Unspecified bit rate):
  User sends whenever it wants. No feedback. No guarantee. Cells may be dropped during congestion.
- CBR (Constant bit rate): User declares required rate. Throughput, delay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

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

The Explicit Rate Scheme

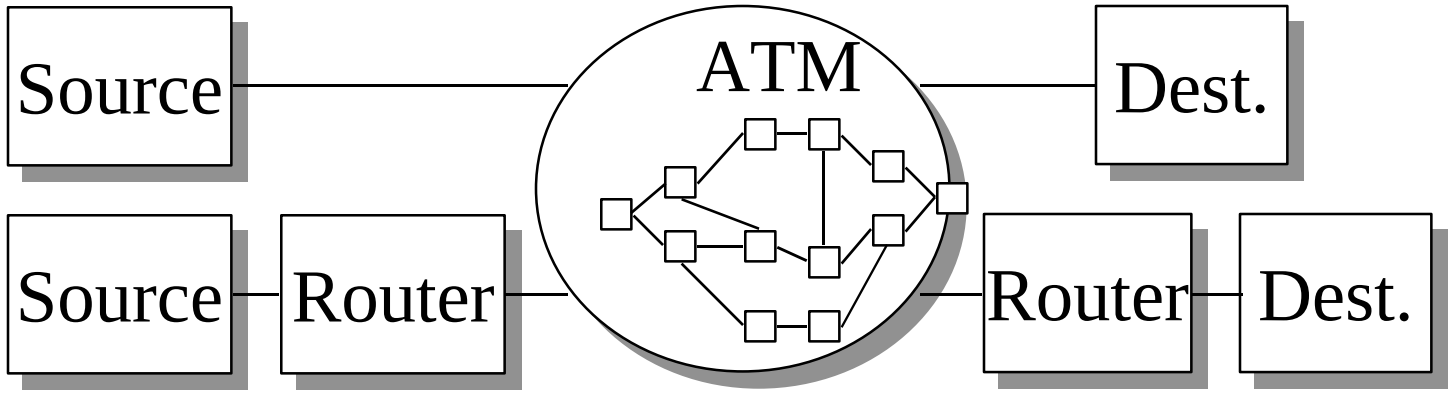


- Sources send one RM cell every n cells
- The RM cells contain "Explicit rate"
- Destination returns the RM cell to the source
- The switches adjust the rate down
- Source adjusts to the specified rate

ATM Research at OSU

- Traffic Management:
  - Explicit Rate Approach
  - ERICA+ Switch Algorithm
  - Internet Protocols over ATM
  - Point to Multipoint ABR
  - Multipoint to Point ABR
  - Multi-class Scheduling
- Voice/Video over ATM
- Performance Testing
- ATM Test bed: OCARnet

ABR vs UBR

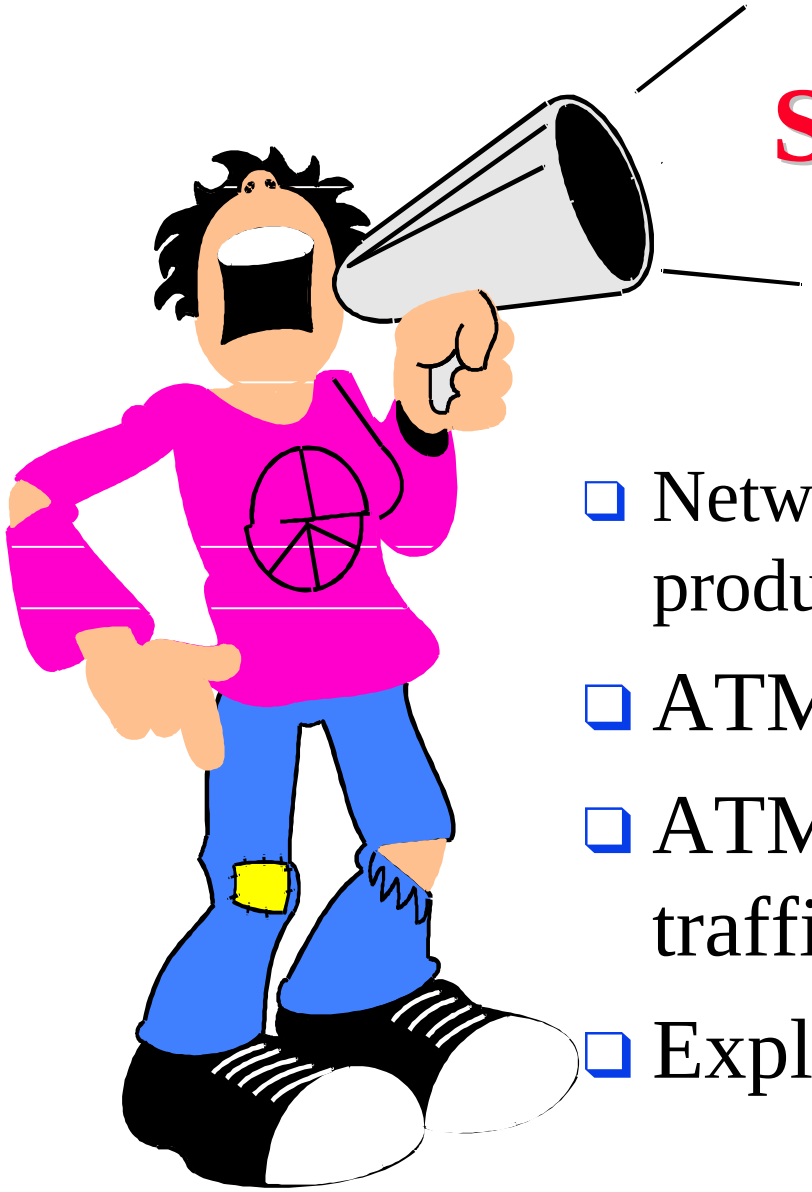


ABR	UBR
Queue in the source	Queue in the network
Pushes congestion to edges	No backpressure
Good if end-to-end ATM	Same end-to-end or backbone
Fair	Generally unfair
Good for the provider	Simple for user

Real-Time ABR

- Compressed video is VBR.
  VBR is subject to connection denial.
- Compression parameters can be adjusted dynamically
- In situations, where reduced service is preferable over connection denial, such as in tactical environments, Video over ABR is preferable over no Video.
- ABR divides the available bandwidth fairly among contending connections
- By proper control, ABR can be designed to reduce delay $\Rightarrow$ Real-time ABR

Summary



- Networking is the key to productivity
- ATM Net = Phone + Data
- ATM vs IP: Signaling and traffic management
- Explicit Rate Approach

References

- All our ATM Forum contributions and papers are available on-line at *http://www.cis.ohio-state.edu/~jain/*
  Specially see “Recent Hot Papers” and “References on Recent Advances in Networking”
- D. Tapscott, "The Digital Economy: Promise and Peril in the Age of Networked Intelligence," McGraw-Hill, 1995.
- G. Sackett and C. Y. Metz, “ATM and Multiprotocol Networking,” McGraw-Hill, 1997 (Technical).