ATM Networks: An Overview and Applications

Raj Jain

Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/

- Trends: Why networking is critical?
- What is ATM?
- How and where can you use ATM?
- What are other competing technologies?
- How OSU is leading the research on ATM?

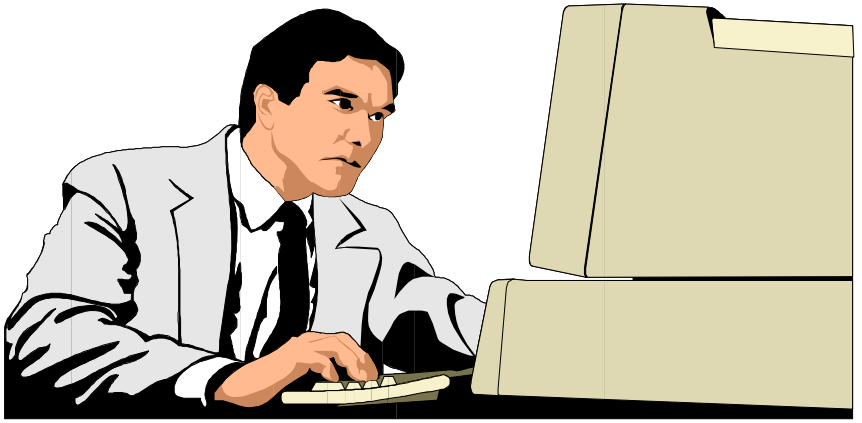
Trends

- 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.
- Last 10 years: Personal computing
  Next 10 years: Collaborative computing
- Past: Corporate networks (Intranets)
  Future: Intercorporate networks (Extranets)

Trends (Cont)

- Past: National Info Infrastructures (NII)
  Future: Global Info Infrastructures (GII)
- Internet: 0.3 M hosts in Jan 91 to 9.5 M by Jan 96
  $\Rightarrow$ More than 5 billion (world population) in 2003
- Networking is moving from specialists to masses $\Rightarrow$ Usability (plug & play), security
- Standards based networking $\Rightarrow$ Reduced cost
- URL is more important than a company's phone number
- Stone age to Networking Age

Social Impact of Networking

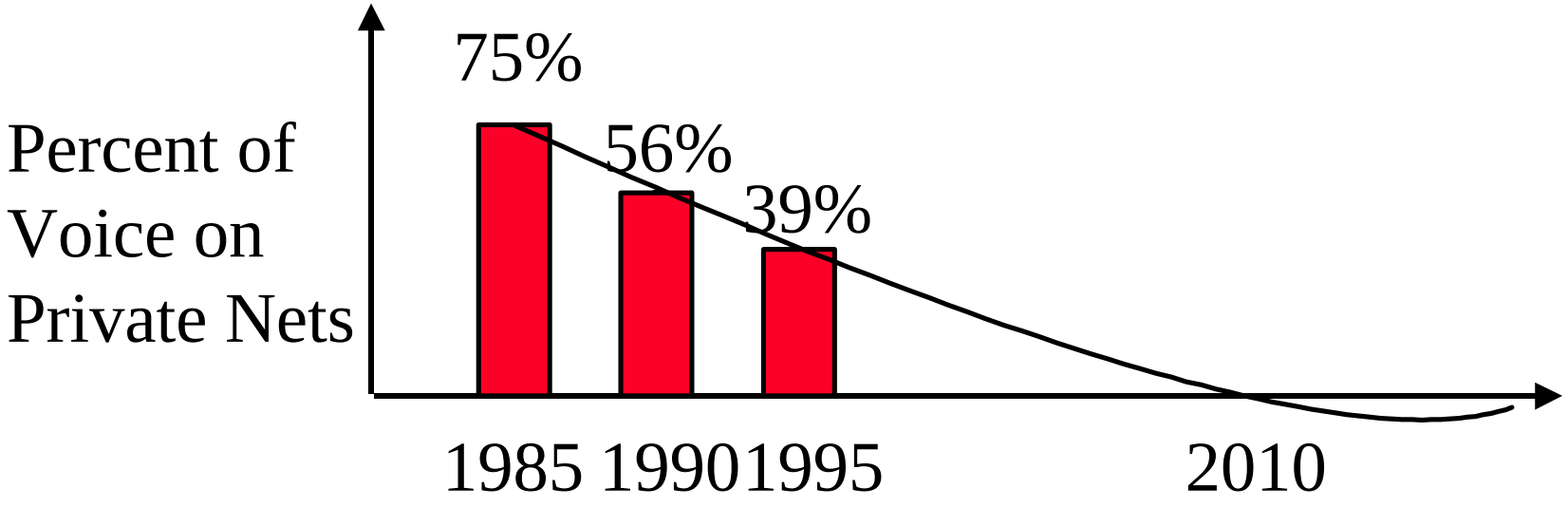


- No need to get out for
  - Office
  - Shopping
  - Entertainment
  - Education
- Virtual reality will satisfy your needs for
  - Sales
  - Training
  - Sex

Cavemen of 2050

Trends in Applications

- AT&T: 125 to 130 M calls/day
  @ 5 min/call 64 kbps
  = 28.8 Gbps = 1/1000 of one fiber
- 200 Million × 24 hr/day × 64 kbps = 12.8 Tbps



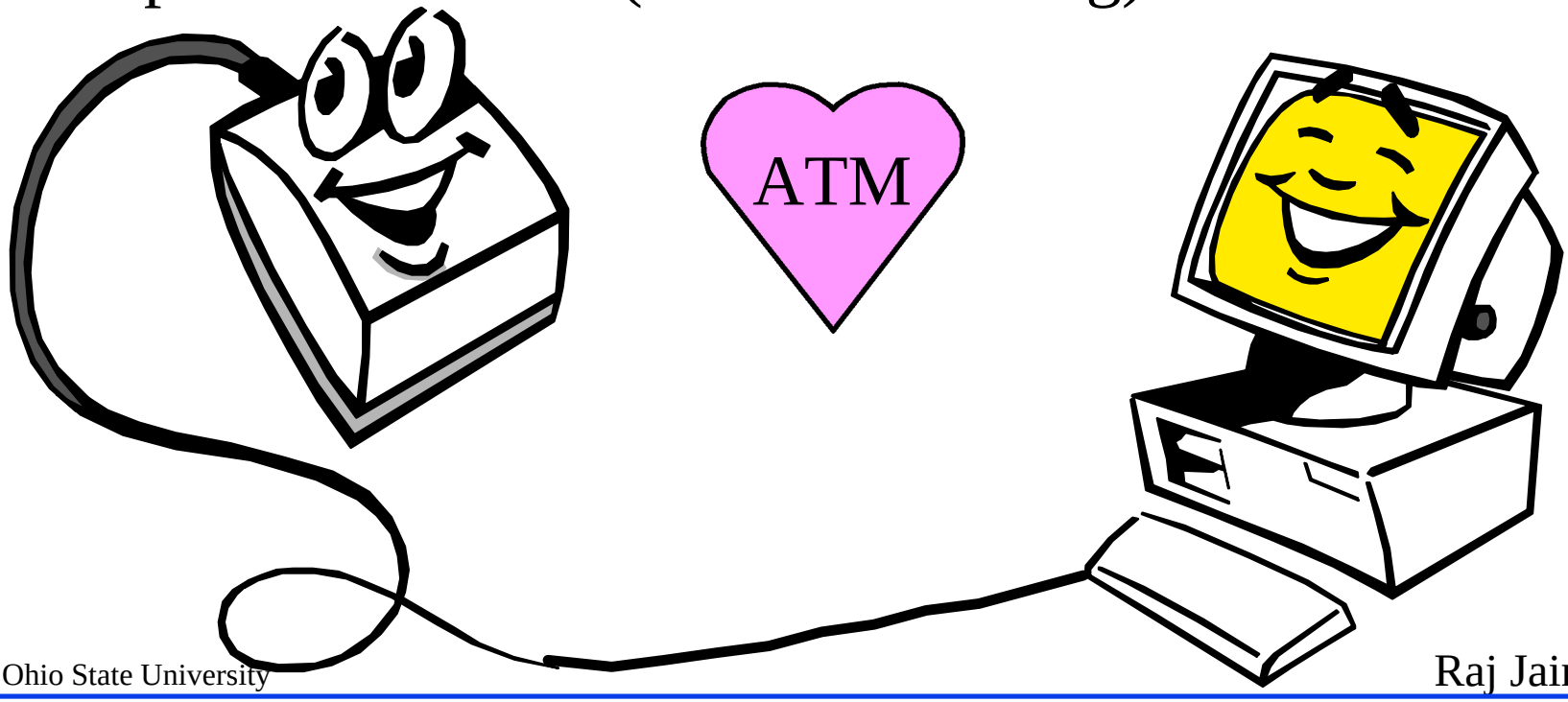
- Ref: IEEE Spectrum, August 1992, p 19.

What is ATM?

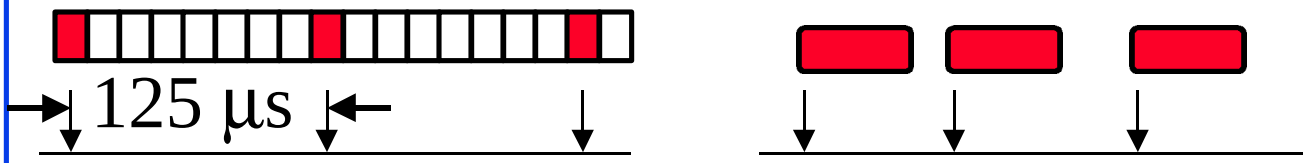
- Automatic Teller Machines
- Adobe Type Manager
- A Technical Mistake
- After The Millennium
- A Ton of Memory
- Asynchronous Transfer Mode

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



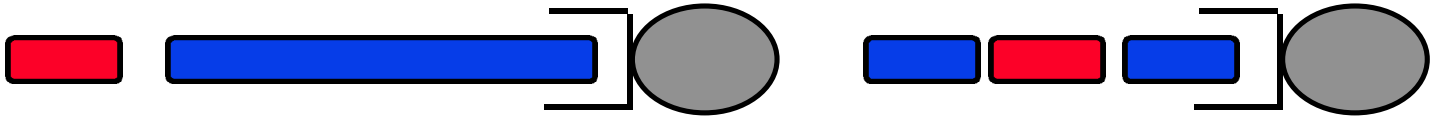
- Current phone networks are synchronous (periodic).
  ATM = Asynchronous Transfer Mode
- Phone networks use circuit switching.
  ATM networks use "Packet" Switching
- In phone networks, all rates are multiple of 8 kbps.
  With ATM service, you can get any rate.
  You can vary your rate with time.
-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

ATM vs Data Networks

- Internet Protocol (IP) is connectionless.
  You cannot reserve bandwidth in advance.
  ATM is connection-oriented.
  You declare your needs before using the network.
- Routers cannot guarantee bandwidth or delay.
  ATM networks reserve bandwidth and buffers.
- In IP, each packet is addressed and processed individually. Inefficient for continuous media like voice and video.

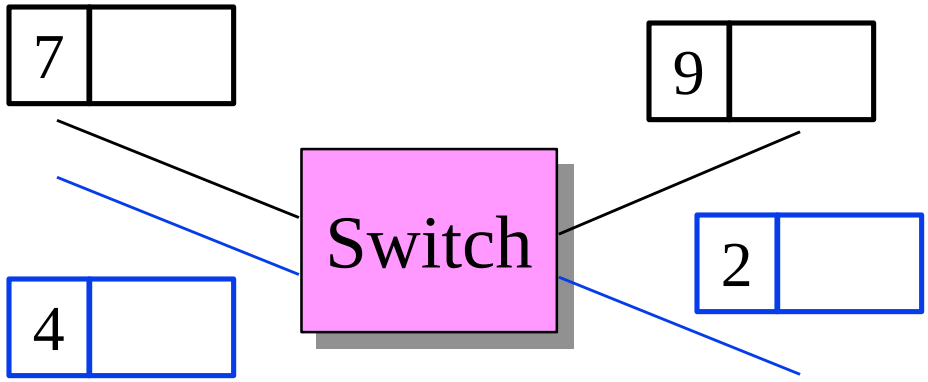
ATM vs Data Nets (Cont)

- IP has no traffic management.
  (TCP does have traffic management
  but it is 1984 technology.)
  ATM has 1996 traffic management technology.
  Required for high-speed and variable demands.
- IP uses variable size packets.
  ATM uses fixed size cells.
  Less variance in delay ⇒ Good for voice.
  (However, at high speeds, variance with variable size packets is not significant.)



ATM vs Data Nets (Cont)

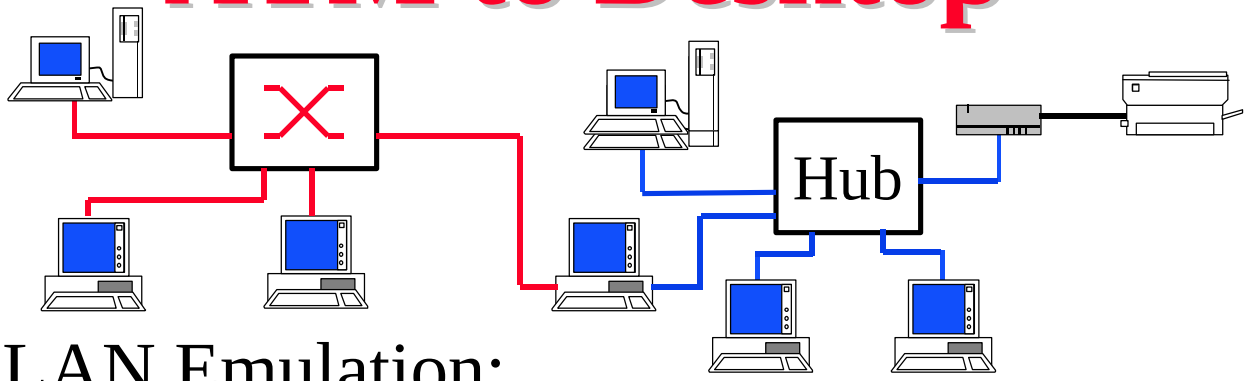
- Current IP uses 4-byte addresses.
  (e.g., 123.45.65.89)
  Not enough IP addresses for global communication.
  (Next Generation of IP will use 16-byte addresses)
  ATM uses 20-byte addresses.
- IP has to match addresses for routing each packet.
  ATM indexes circuit numbers for switching ⇒ Fast.



Where to Use ATM?

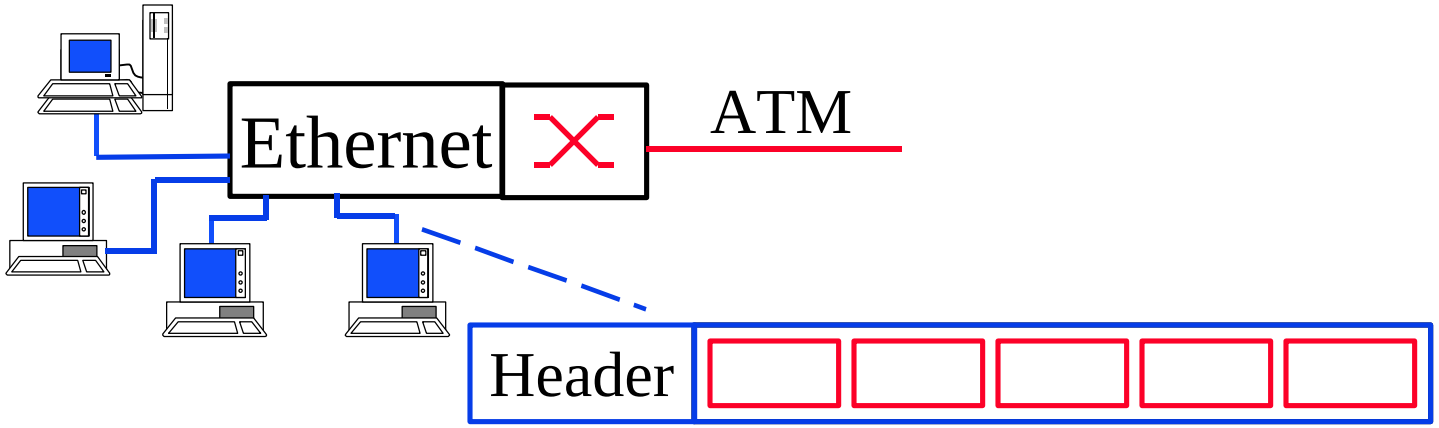
- Desktop
- Campus backbone
- Wide area networks
- Inside a carrier's network

ATM to Desktop



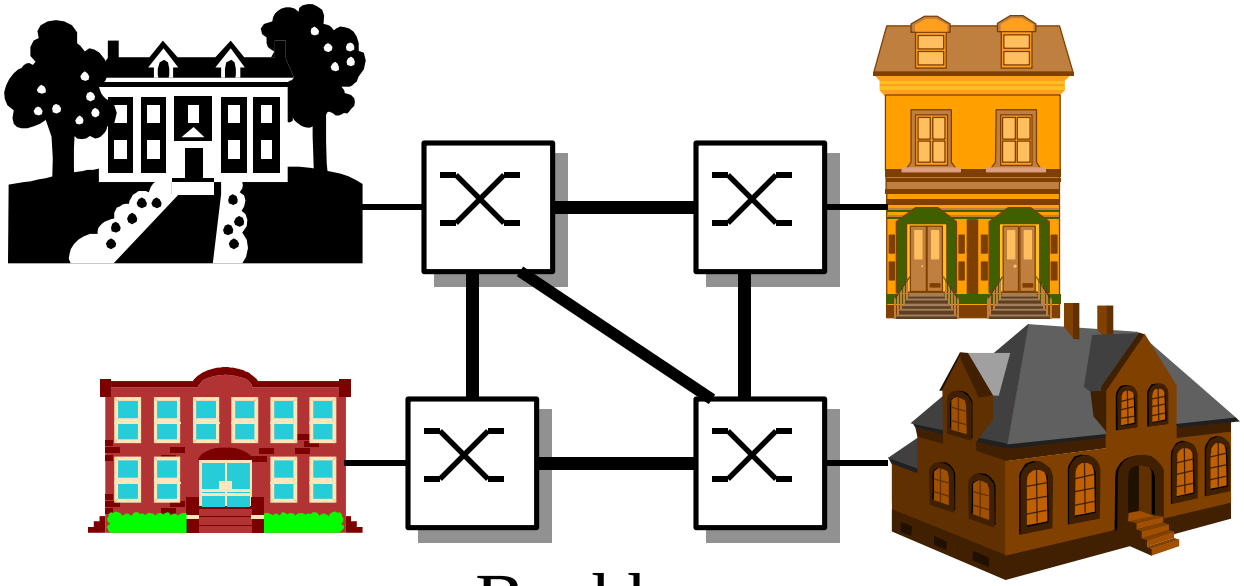
- LAN Emulation:
  - Software driver allows ATM network to look like an Ethernet (or token ring)
  - All current data applications will run on ATM
  - ATM stations can talk to non-ATM stations
  - One ATM LAN can be multiple virtual LANs
    You can logically divide people into workgroups
- Winsock 2 will allow new ATM (video) applications

ATM to Desktop (Cont)



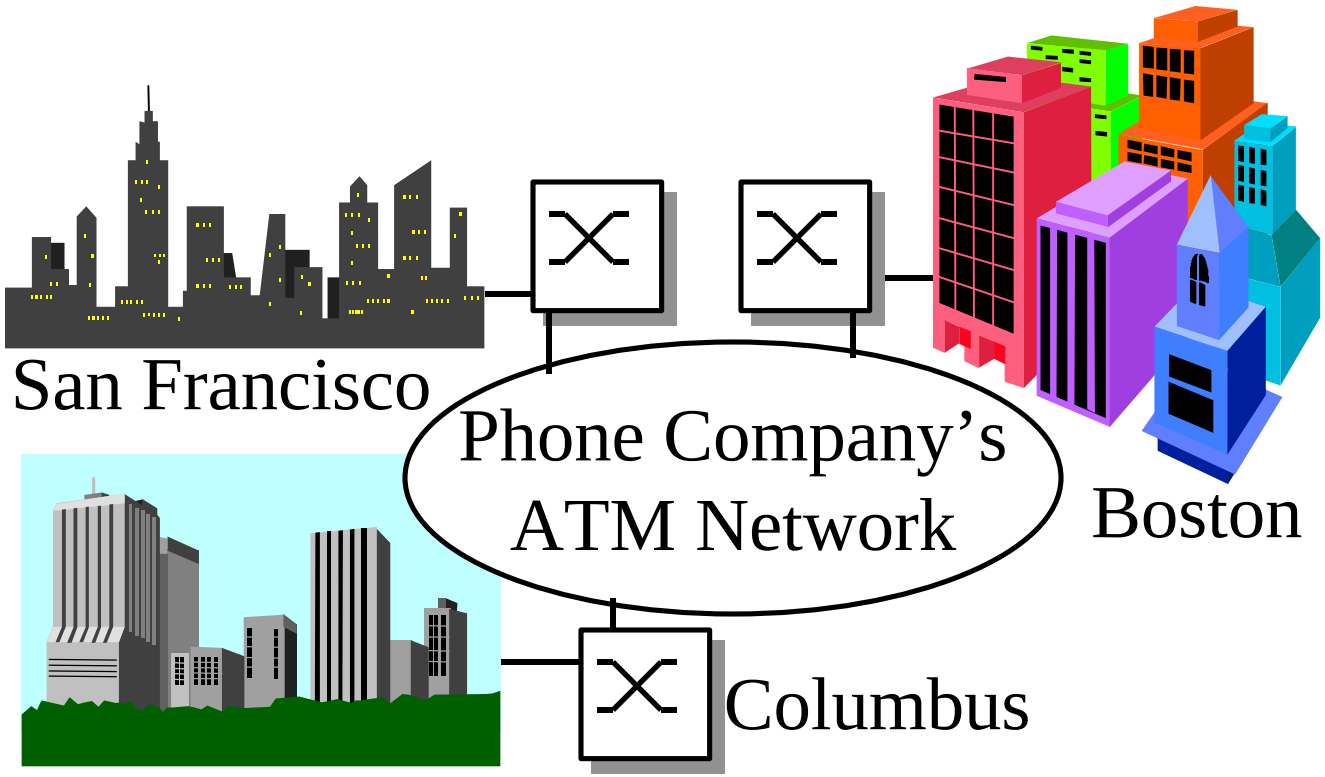
- ATM Emulation:
  - Software driver packs ATM cells into Ethernet frames
  - Leave current Ethernet interface cards in hosts. Replace hubs with "Cells in Frame Attachment Device (CIF-AD)".

Campus Backbone



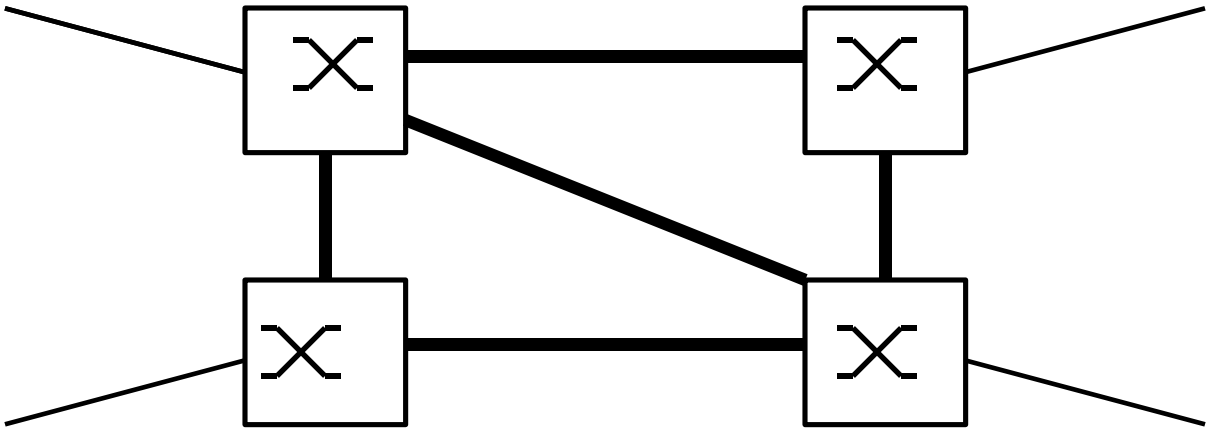
- Interconnect backbone routers via ATM switches

Wide-Area Networks



- *n* connection vs *n(n-1)/2* leased lines. Good for ISPs.
- Bandwidth on demand. Add voice on same network.
- If no ATM service, ATM cells can be sent over T1/T3

Inside Carrier Networks

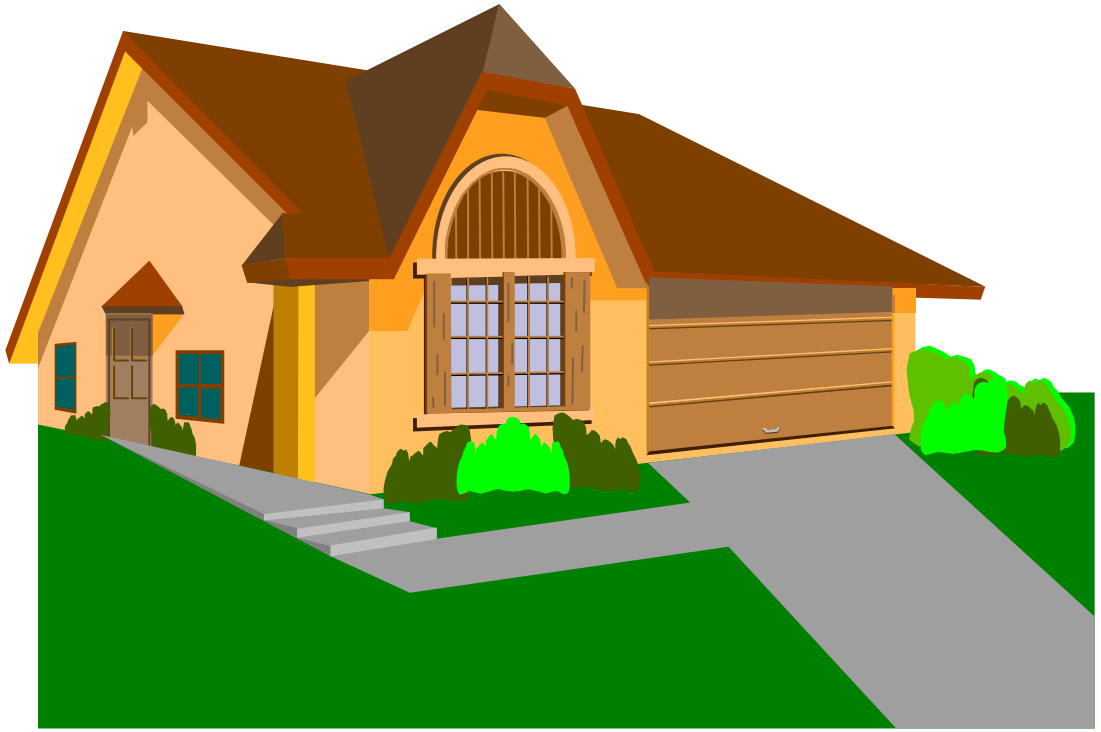


- Frame relay or leased line services on ATM
- Silence suppression: Unused bandwidth for data
- LAN emulation and data services
- Bandwidth added on demand
- Traffic management ⇒ Divert overload to other links

Competing Technologies

- Fast Ethernet to the desktop
  Gigabit Ethernet for the campus backbone
  - No traffic management. No priority. (Being added)
- Frame-Relay for Wide-area networking
  - Lower speed only (1.5 Mbps - 10 Mbps)
  - No support for quality of service (for video/voice)
- IP over SONET
  - No signaling ⇒ Fixed bandwidth. Can't dial in.
  - No traffic management ⇒ Unused bandwidth wasted.

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)

Key Challenge: Economy of Scale

- Technology is far ahead of the applications. Invention is becoming the mother of necessity. We have high speed fibers, but not enough video traffic.
- Low-cost is the primary motivator. Not necessity. $\Rightarrow$ Buyer's market (Like $99 airline tickets to Bahamas.) Why? vs Why not?
- Parallel computing, not supercomputing
- Ethernet was and still is cheaper than 10 one-Mbps links.

Challenge: Tariff

- Phone company's goal: How to keep the voice business and get into data too?
- Customer's goal: How to transmit the voice/video/data cheaper?
- Tariff Today:
  - 64 kbps voice line = $300/year
  - 45 Mbps line ($45/mile/month)
    Coast to coast = $180 k-240 k/year
    $\Rightarrow$ 155 Mbps line = $540 k - $720 k/year
- Tomorrow: 155 Mbps = $1k/month+ $28/G cells
  $\Rightarrow$ $13k - $45k/year

Case Studies

- AGIS - Forth largest ISP. ISP's ISP.
  Offers three quality of services.
  Store and forward, Interactive, Guaranteed.
- Chrysler installed a 3000 node network in Detroit area
- McDonald has implemented an ATM backbone for 150 subnets
- World Health Organization is installing 2000-desktop ATM network in Geneva.
- Home Depot, Texaco, Amoco, Fuji Bank of Japan, Malaysian Bank, Royal Bank of Canada, Florida Power and Light, Allegheny Hospital, ...

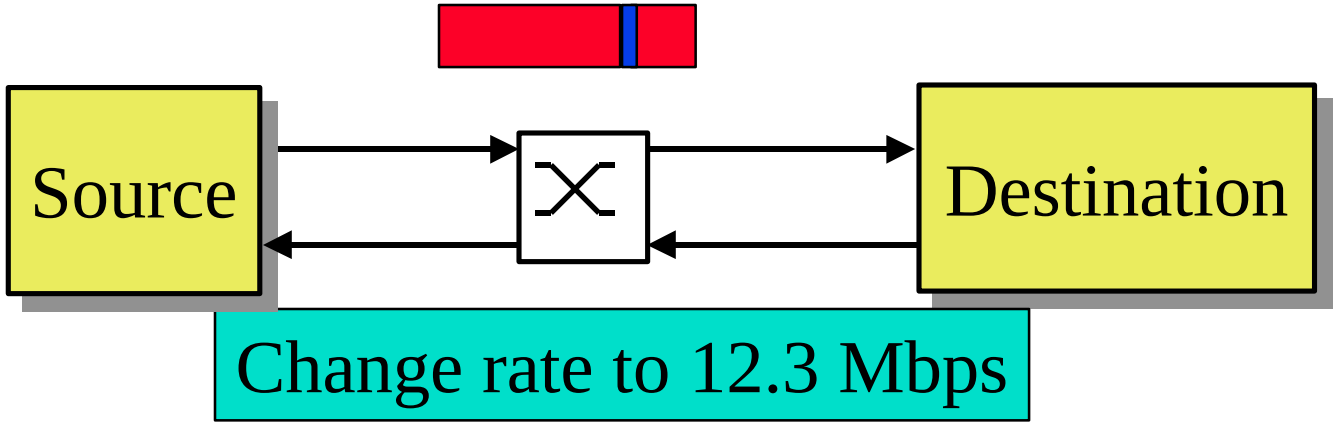
Who Can Benefit from ATM?

- Large enterprises with large WANs
  - Scalable: 1.5 to 622 Mbps
  - Multiple quality of services
  - Integration of voice, data
  - Standard
- Internet Service Providers
- Carriers
- Any one with a need for high-quality multimedia

ATM Research at OSU

- Traffic Management
- Performance Testing
- Voice/Video over ATM
- ATM Test beds: OCARnet and CATnet
- Networking Seminar Series

Traffic Management



- Invented DECbit scheme in 1986: Bit ⇒ Go up/Down
  - Used now in Frame Relay (FECN)
  - Used in ATM (EFCI)
- In July 1994, we proposed Explicit Rate Approach. Current standard.
- Two patents. Collaboration with industry.

OSU National ATM Benchmarking Lab

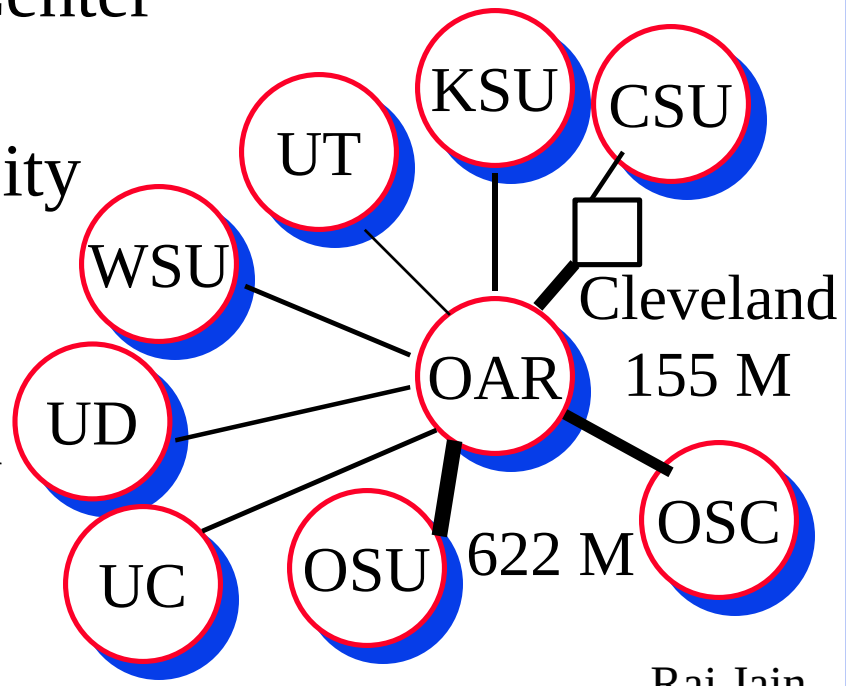
- Started a new effort at ATM Forum in October 1995
- Defining a new standard for performance metrics and measurement methodologies
- We have a measurement lab with the latest ATM testing equipment. Funded by NSF and State of Ohio.
- The benchmark scripts can be run by any manufacturer/user in our lab or theirs.
- Modeled after Harvard benchmarking lab for routers

Voice/Video over ATM

- Speech suppression
  ⇒ Unused bandwidth can be used by data
- Hierarchical compression of Video
  Different users can see different bandwidth video
- Our course was broadcast over the Internet
  ⇒ Experimental Video Lab

OCARnet

- Ohio Computing and Communications ATM Research Network
- Nine-Institution consortium lead by OSU
  - Ohio State University
  - Ohio Super Computer Center
  - OARnet
  - Cleveland State University
  - Kent State University
  - University of Dayton
  - University of Cincinnati
  - Wright State University
  - University of Toledo



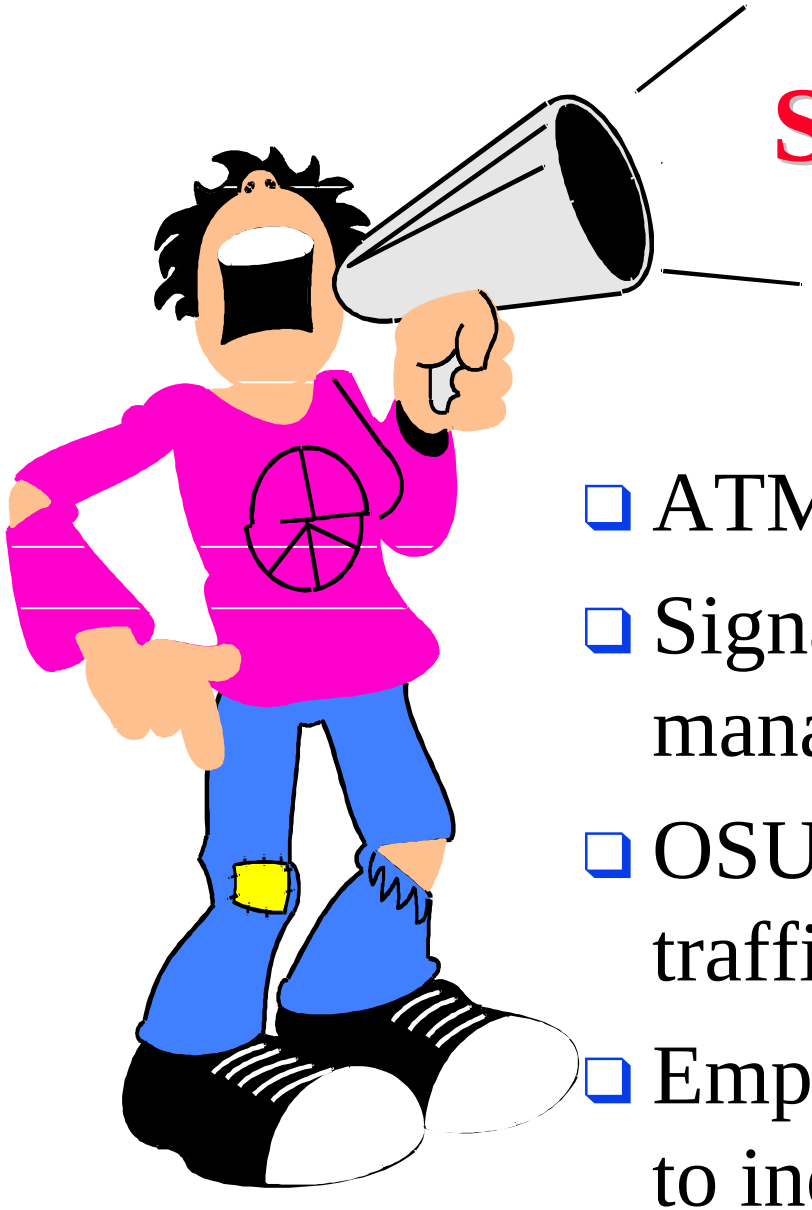
CATNet

- Columbus ATM Network
- Lead by Industry and Technology Council of Columbus
- Technology leadership provided by OSU
- Fiber links provided by Metricom
- Starting with 8 major Columbus companies

Seminar Series

- Recent Advances in Networking and Telecommunications
- Why?
  - Technology is advancing too fast.
  - Engineers, managers, planners need to keep up
  - Columbus is the headquarter of several networking and telecommunication companies
- 1995 Series sponsored by AT&T
- Need a 1997 Sponsor in Columbus
  - Topics: Gigabit Ethernet, Residential broadband, Virtual LANs

Summary



- ATM Net = Phone + Data
- Signaling and traffic management
- OSU is a world leader in ATM traffic and performance mgmt
- Emphasizing topics of interest to industry

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"
- C. Gadecki and C. Heckart, "ATM for Dummies," IDG Books, 1996 (non-Technical)
- G. Sackett and C. Y. Metz, "ATM and Multiprotocol Networking," McGraw-Hill, 1997 (Technical).
- ATM Forum, http://www.atmforum.com