

# ATM Networks

An Engineering Approach to Computer Networking

## Why ATM networks?

- Different information types require different qualities of service from the network
  - ◆ stock quotes vs. USENET
- Telephone networks support a single quality of service
  - ◆ and is expensive to boot
- Internet supports no quality of service
  - ◆ but is flexible and cheap
- ATM networks are meant to support a range of service qualities at a reasonable cost
  - ◆ potentially can subsume both the telephone network and the Internet

## Design goals

- Providing end-to-end quality of service
- High bandwidth
- Scalability
- Manageability
- Cost-effective

## How far along are we?

- Basic architecture has been defined
- But delays have resulted in ceding desktop to IP
- Also, little experience in traffic specification, multicast, and fault tolerance
- We may never see end-to-end ATM
  - ◆ but its ideas continue to powerfully influence design of next-generation Internet
  - ◆ Internet technology + ATM philosophy
- Note--two standardization bodies
  - ◆ ATM Forum
  - ◆ International Telecommunications Union-Telecommunications Standardization Sector (ITU-T)

## Concepts

1. Virtual circuits
2. Fixed-size packets (*cells*)
3. Small packet size
4. Statistical multiplexing
5. Integrated services

### Together

can carry *multiple* types of traffic  
with end-to-end quality of service

## 1. Virtual circuits

- Some background first
- Telephone network operates in *synchronous transmission mode*
  - ◆ the destination of a sample depends on where it comes from, and when it came
  - ◆ example--shared leased link
- Problems with STM
  - ◆ idle users consume bandwidth
  - ◆ links are shared with a fixed cyclical schedule => quantization of link capacity
    - can't 'dial' bandwidth

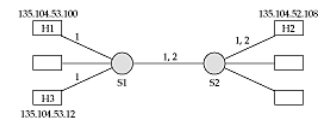
## Virtual circuits (contd.)

- STM is easy to overcome
  - ◆ use *packets*
  - ◆ metadata indicates destination =>arbitrary schedule and no wasted bandwidth
- Two ways to use packets
  - ◆ carry entire destination address in header
  - ◆ carry only an identifier



## Virtual circuits (contd.)

- Ids save on header space
- But need to be pre-established
- We also need to switch Ids at intermediate points (why?)
- Need *translation table* and *connection setup*



## Features of virtual circuits

- All packets must follow the same path (why?)
- Switches store per-VCI state
  - ◆ can store QoS information
- Signaling => separation of *data* and *control*
- Virtual circuits do not automatically guarantee reliability
- Small Ids can be looked up quickly in hardware
  - ◆ harder to do this with IP addresses
- Setup must precede data transfer
  - ◆ delays short messages
- Switched vs. Permanent virtual circuits

## More features

- Ways to reduce setup latency
  - ◆ preallocate a range of VCIs along a path
    - *Virtual Path*
  - ◆ send data cell along with setup packet
  - ◆ dedicate a VCI to carry datagrams, reassembled at each hop

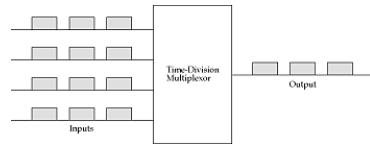
## 2. Fixed-size packets

- Pros
  - ◆ Simpler buffer hardware
    - packet arrival and departure requires us to manage fixed buffer sizes
  - ◆ Simpler line scheduling
    - each cell takes a constant chunk of bandwidth to transmit
  - ◆ Easier to build large parallel packet switches
- Cons
  - ◆ overhead for sending small amounts of data
  - ◆ segmentation and reassembly cost
  - ◆ last unfilled cell after segmentation wastes bandwidth

## 3. Small packet size

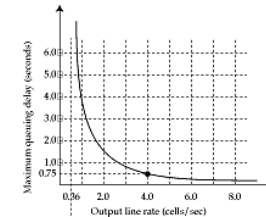
- At 8KHz, each byte is 125 microseconds
- The smaller the cell, the less an endpoint has to wait to fill it
  - ◆ *packetization delay*
- The smaller the packet, the larger the header overhead
- Standards body balanced the two to prescribe 48 bytes + 5 byte header = 53 bytes
  - ◆ => maximal efficiency of 90.57%

## 4. Statistical multiplexing



- Suppose cells arrive in bursts
  - ◆ each burst has 10 cells evenly spaced 1 second apart
  - ◆ gap between bursts = 100 seconds
- What should be service rate of output line?

## Statistical multiplexing



- We can trade off worst-case delay against speed of output trunk
- SMG = sum of peak input/output rate
- Whenever long term average rate differs from peak, we can trade off service rate for delay
  - ◆ key to building packet-switched networks with QoS

## 5. Integrated service

- Traditionally, voice, video, and data traffic on separate networks
- Integration
  - ◆ easier to manage
  - ◆ innovative new services
- How do ATM networks allow for integrated service?
  - ◆ lots of bandwidth: hardware-oriented switching
  - ◆ support for different traffic types
    - signaling
    - admission control
    - easier scheduling
    - resource reservation

## Challenges

- Quality of service
  - ◆ defined, but not used!
  - ◆ still needs research
- Scaling
  - ◆ little experience
- Competition from other LAN technologies
  - ◆ Fast Ethernet
  - ◆ FDDI
- Standardization
  - ◆ political
  - ◆ slow

## Challenges

- IP
  - ◆ a vast, fast-growing, non-ATM infrastructure
  - ◆ interoperation is a pain in the neck, because of fundamentally different design philosophies
    - connectionless vs. connection-oriented
    - resource reservation vs. best-effort
    - different ways of expressing QoS requirements
    - routing protocols differ