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

What happened?

- Basic architecture was defined by
  - ATM Forum
  - International Telecommunications Union-Telecommunications Standardization Sector (ITU-T)
- But delays resulted in ceding desktop to IP
  - Overly complex initial standards
  - Often no technical solution known to defined traffic specification, multicast, and fault tolerance requirements
- We will never see the dream of end-to-end ATM
  - but its ideas continue to powerfully influence design of next-generation Internet
  - Internet technology + ATM philosophy
  - ATM is widely deployed in ADSL…

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

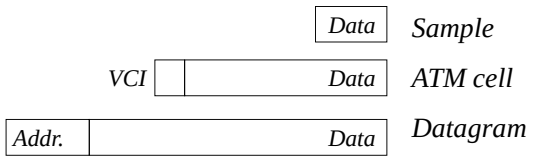
with end-to-end quality of service

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

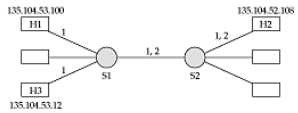
Virtual circuits (contd.)

- 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

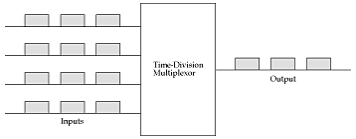
2. Fixed-size packets

- 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

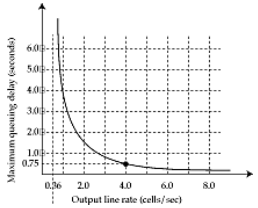
- At 8KHz, each byte is 125 microseconds
- The smaller the cell, the less an endpoint has to wait to fill it
  - *packetization delay*
- The smaller the packet, the larger the header overhead
- Standards body balanced the two to prescribe 48 bytes + 5 byte header = 53 bytes
  - => maximal efficiency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