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 resulting 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

	Data	*Sample*
VCI		Data	*ATM cell*
Addr.		Data	*Datagram*
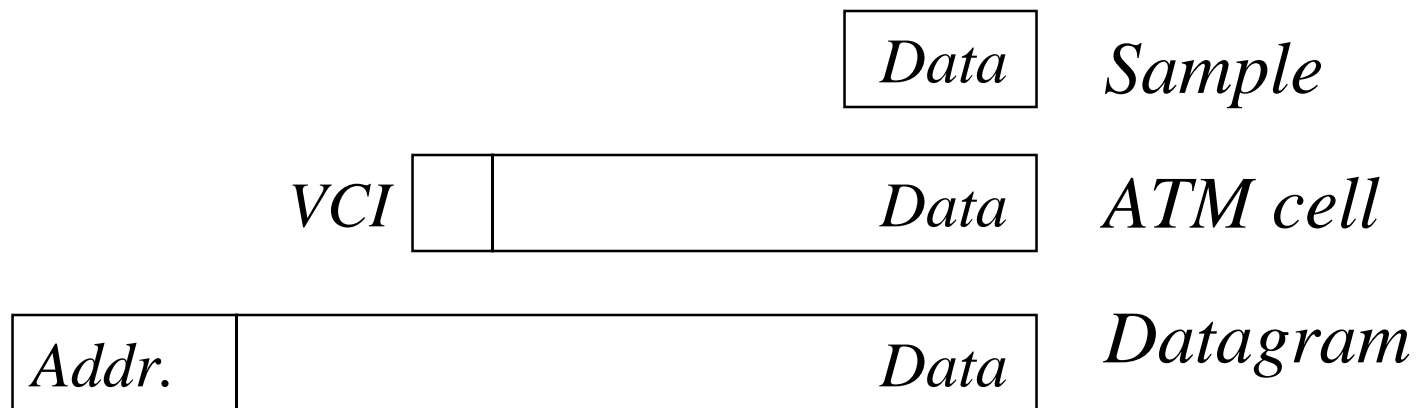
Virtual circuits (contd.)

- 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*
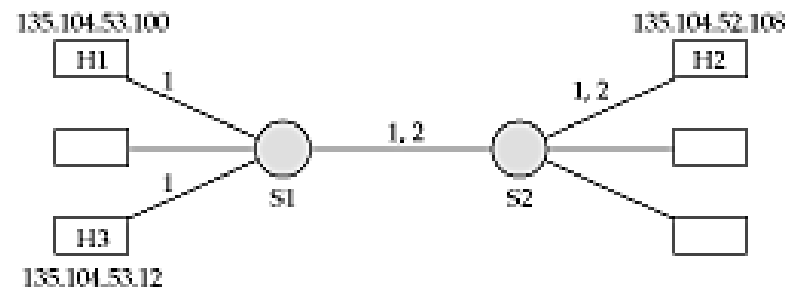
Features of virtual circuits

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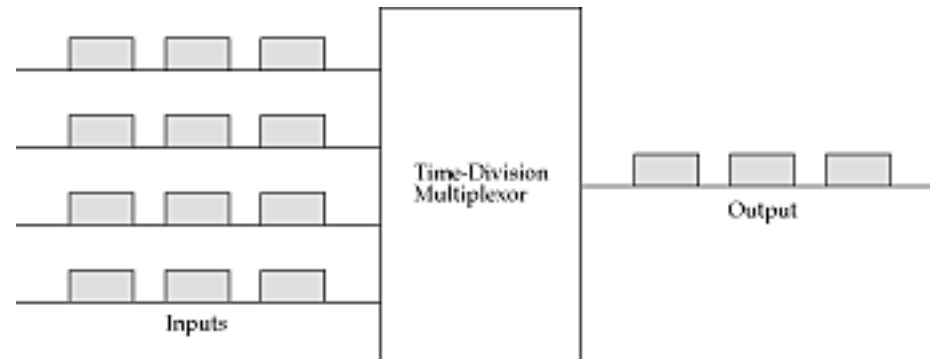
- Suppose cells arrive in bursts
    - each burst has 10 cells evenly spaced 1 second apart
    - gap between bursts = 100 seconds
- What should be service rate of output line?

Statistical multiplexing
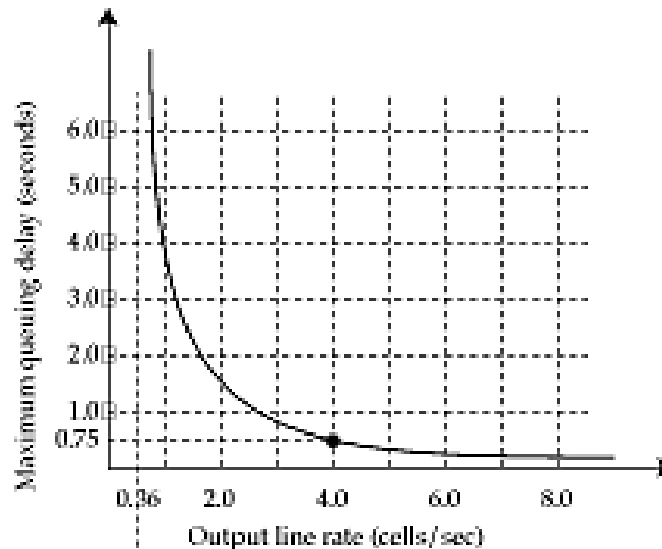
- We can trade off worst-case delay against speed of output trunk

- 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