Switching and Forwarding

Outline
- Cell Switching
- Segmentation and Reassembly

Cell Switching (ATM)

- Connection-oriented packet-switched network
- Used in both WAN and LAN settings
- Signalling (connection setup) protocol: Q.2931
- Specified by ATM forum
- Packets are called *cells*
  - 5-byte header + 48-byte payload
- Commonly transmitted over SONET
  - other physical layers possible

Variable vs Fixed-Length Packets

- No optimal length
  - if small: high header-to-data overhead
  - if large: low utilization for small messages
- Fixed-length easier to switch in hardware
  - simpler
  - enables parallelism

Big vs Small Packets

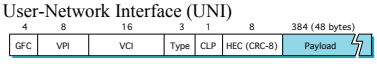
- Small improves queue behavior
  - finer-grained preemption point for scheduling link
    - maximum packet = 4KB
    - link speed = 100Mbps
    - transmission time = 4096 x 8/100 = 327.68us
    - high priority packet may sit in the queue 327.68us
    - in contrast, 53 x 8/100 = 4.24us for ATM
  - near cut-through behavior
    - two 4KB packets arrive at same time
    - link idle for 327.68us while both arrive
    - at end of 327.68us, still have 8KB to transmit
    - in contrast, can transmit first cell after 4.24us
    - at end of 327.68us, just over 4KB left in queue

Big vs Small

- Small improves latency (for voice)
  - voice digitally encoded at 64Kbps (8-bit samples at 8KHz)
  - need full cell's worth of samples before sending cell
  - example: 1000-byte cells implies 125ms per cell (too long)
  - smaller latency implies no need for echo cancelers
- ATM compromise: 48 bytes = (32+64)/2

Cell Format

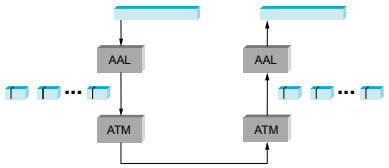
- User-Network Interface (UNI)



  - host-to-switch format
  - GFC: Generic Flow Control (still being defined)
  - VCI: Virtual Circuit Identifier
  - VPI: Virtual Path Identifier
  - Type: management, congestion control, AAL5 (later)
  - CLP: Cell Loss Priority
  - HEC: Header Error Check (CRC-8)
- Network-Network Interface (NNI)
  - switch-to-switch format
  - GFC becomes part of VPI field

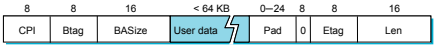
Segmentation and Reassembly

- ATM Adaptation Layer (AAL)
  - AAL 1 and 2 designed for applications that need guaranteed rate (e.g., voice, video)
  - AAL 3/4 designed for packet data
  - AAL 5 is an alternative standard for packet data



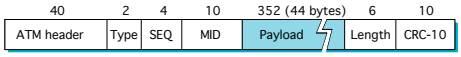
AAL 3/4

- Convergence Sublayer Protocol Data Unit (CS-PDU)



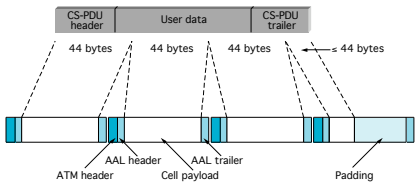
  - CPI: common part indicator (version field)
  - Btag/Etag: beginning and ending tag
  - BAsize: hint on amount of buffer space to allocate
  - Length: size of whole PDU

Cell Format



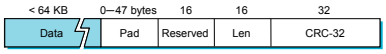
  - Type
    - BOM: beginning of message
    - COM: continuation of message
    - EOM: end of message
    - SSM: single-segment message
  - SEQ: sequence of number
  - MID: multiplexing id
  - Length: number of bytes of PDU in this cell

Encapsulation



AAL5

- CS-PDU Format



  - Pad: trailer always falls at end of ATM cell
  - Length: size of PDU (data only)
  - CRC-32
- Cell Format
  - End-of-PDU bit in Type field of ATM header

Virtual Paths

- 8-bit VPI and 16-bit VCI
- Two-level hierarchy of virtual connections