Today’s Lecture

- Project 1
  - Reference Client
- Switching and Forwarding
  - Chapter 3.2

Read Chapter 4.1 for Tuesday

Project 1

- Reference Client
Switching and Forwarding

Outline
- Cell Switching
- Segmentation and Reassembly

Frame / Packet Length
- How long should your frame be?
  - Similar to THT concept
- Is it a fixed size or variable?
  - Consistency?
- Frame is the atomic unit of the network
  - Cannot pre-empt it
  - Medium becomes free after block is finished being transferred

Variable vs Fixed Length Packets
- No optimal length
  - Small
    - High header-to-data overhead
  - Large
    - Low utilization for small messages
- Fixed-length easier to switch in hardware
  - Simpler
  - Enables parallelism
  - Each packet means more overhead
Variable Location - Lookup

Look in the first two bytes of the message from the client

Big vs Small Packets

- Small improves flexibility
  - Finer-grained scheduling
  - Share capacity easier between flows
  - Less time waiting to forward
  - Can send when whole packet is there

- Example
  - Maximum packet = 4KB, Link speed=100 Mb/s
  - Transmission time = 4096 x 8/100 = 327.68us
  - High priority packet may sit in the queue 327.68us
  - Maximum packet = 48 bytes + Overhead, same link speed
  - Transmission time = 53 x 8/100 = 4.24us for ATM
ATM – Asynchronous Transfer Mode
• Evolved from phone network
  – Predictable
  – Deterministic
• Connection-oriented
  – Setup / teardown of virtual circuits
  – Quality of Service (QoS)

Cell Switching (ATM)
• Used in both WAN and LAN settings
• Specifications
  – ATM Forum
  – Signaling \( \rightarrow \) Q.2931
• Packets are called cells
  – 5-byte header + 48-byte payload
• Commonly transmitted over SONET
  – Other physical layers possible

Big vs Small Redux
• 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

Numbers are in bits

- **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
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

  ![Segmentation and Reassembly Diagram]

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

  ![AAL 3/4 Diagram]

AAL 5

- 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

  ![AAL 5 Diagram]
Virtual Paths

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

Path Aggregation

VPI 0, VCI 17
VPI 0, VCI 25
VPI 0, VCI 3089
VPI 25
VPI 0, VCI 17
VPI 0, VCI 25
VPI 0, VCI 3089
VPI 0, VCI 3089