Today’s Lecture

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

Read Chapter 4.1 for Tuesday

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Switching and Forwarding

Outline
- Cell Switching
- Segmentation and Reassembly

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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.

Fixed Location - Lookup

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
  - Signalling → 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

UNI from earlier

Numbers are in bits

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

Encapsulation

Convergence Sublayer Protocol Data Unit

AAL 3/4

- Convergence Sublayer Protocol Data Unit (CS-PDU)

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

Path Aggregation