COMP 790-088
Networked and Distributed Systems

Packet Switching

Jasleen Kaur

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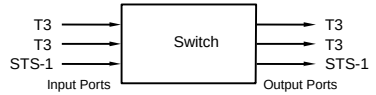
Packet Switching
What Issues Will We Focus On?

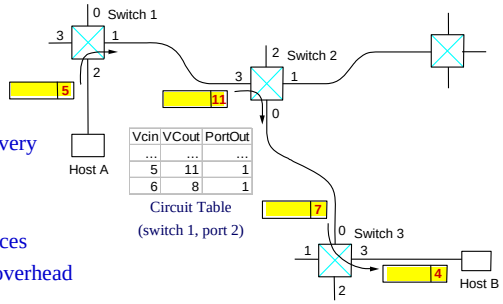
- Point-to-point links don't scale to large networks
  - » Limited geographical coverage, limited number of hosts (length constraints, limited ability to resolve access contention), too expensive to connect everyone in a clique.
- Switches:
  - » Enable communication between nodes that are not directly connected
    - ❖ Help create a "star" topology
  - » "Forward" packets from one link to another



- Issues we will look at:
  - » Forwarding approaches
    - ❖ How does a switch decide on which outgoing port to forward a packet?
  - » Selecting frame size

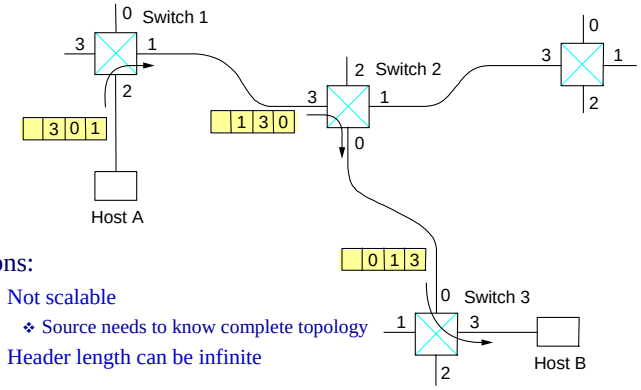
Virtual Circuit Switching
Connection-oriented Approach

- Done in two stages
  - » Connection set-up (in all switches): [VCI-in, Port-in, VCI-out, Port-out]
    - ❖ VCI: Virtual Circuit Identifier (link-local scope)
  - » Data transfer (all packets follow same circuit)
- Cons:
  - » set-up delay
  - » heavy failure-recovery
- Pros:
  - » Guaranteed resources
  - » Small per-packet overhead



Source Forwarding
Connection-less Approach

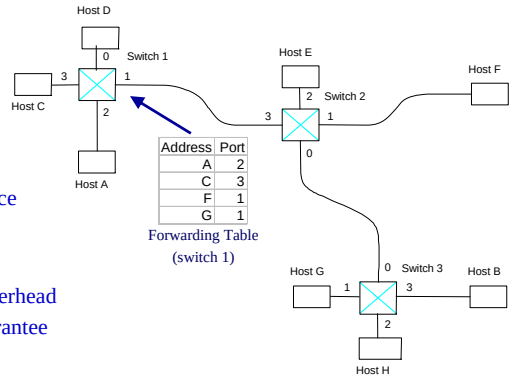
- Source specifies route to be taken (using headers)



- Cons:
  - » Not scalable
    - ❖ Source needs to know complete topology
  - » Header length can be infinite

Datagram Switching
Connection-less Approach

- Every packet has full destination address
  - » Switches maintain mapping of (destination → outgoing port)



- Pros:
  - » No setup delay
  - » Failure resistance
- Cons:
  - » High header overhead
  - » No service guarantee
  - » Reordering

Forwarding Approaches
Summary

- Issues that differentiate
  - » Signaling overhead
  - » Robustness to failure
- Ideas used:
  - » Less state
  - » Connection-less model
- What categories do the following fall in?
  - » Postal system?
  - » Phone system?

Packet Size: ATM as a Case Study
How Does Frame Size Matter?

- Variable length or fixed length?
  - » Variable length: since no optimal size for fixed length
    - If too large, low utilization for small messages (need padding)
    - If too small,
      - large header overhead
      - high processing cost (per-packet)
  - » Fixed length: facilitate fast, scalable hardware implementations
    - Simpler
    - Enables parallel processing implementations
- ATM networks: use fixed cell sizes

Packet Size: ATM as a Case Study
But What is the Right Size?

- Large cells:
  - » Better utilization
    - ☺: smaller header-to-payload ratio
    - ☹: Wastage due to cell padding
- Small cells:
  - » Improve queuing behavior
    - Fine-grained preemption for high-priority/latency-sensitive traffic
      - e.g.: 4 KB vs. 53 B on a 100Mbps link (327.68 μs vs. 4.24 μs)
    - Queues tend to be smaller
      - When 2 larger cells arrive simultaneously, time-averaged queue larger
  - » Improve packetization latency at source
    - Larger cells ⇒ wait longer before constructing and sending cell

Packet Sizes in the Internet

Optimality May Not Guide Practical Decisions

- Internet allows variable packet sizes
  - » Too much diversity in link-layer technologies (each with different frame sizes)
  - » Selecting a universal MSS might prohibit some link layers
- Basic Idea:
  - » No upper or lower limit on packet sizes
  - » If too large for a downstream link, break into smaller chunks & reassemble
    - ❖ Fragmentation and Reassembly (more later)
- Good example of:

  "simplicity" of the service model $\Longrightarrow$ generality / greater interoperability