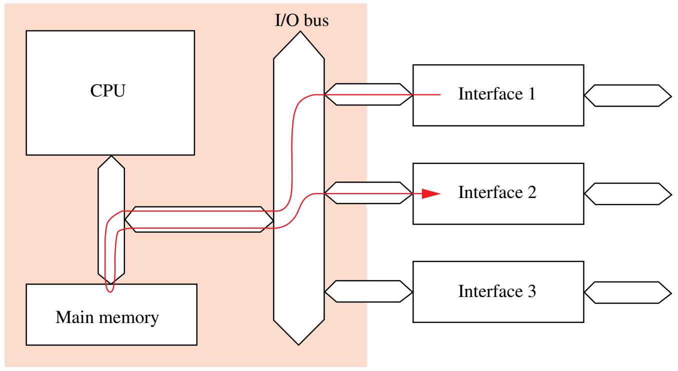
Router Design I

- Outline
  - Switching Fabrics
  - IP Routers

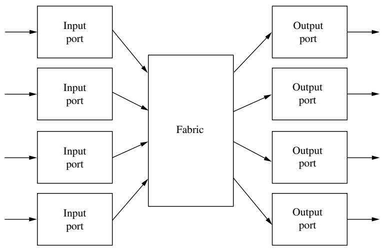
Workstation-Based



- Aggregate bandwidth
  - 1/2 of the I/O bus bandwidth
  - capacity is shared among all hosts connected to switch
  - example: 800Mbps bus can support 8 T3 ports
- Packets-per-second
  - must be able to switch small packets
  - 15,000 packets-per-second is an achievable number
  - example: 64-byte packets implies 7.69Mbps

Switching Hardware

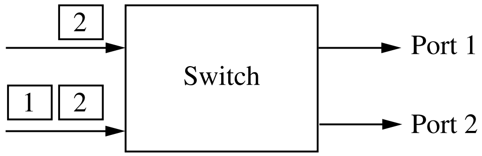
- Terminology: $n \times m$ switch has n inputs and m outputs
- Design Goals
  - throughput (depends on traffic model)
  - scalability (a function of n)
- Ports and Fabrics



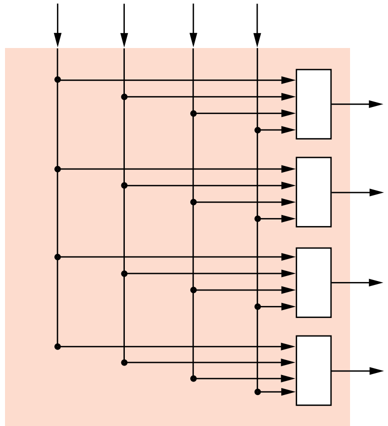
  - ports
    - ∗ circuit management (e.g., map VCIs, route datagrams)
    - ∗ buffering (input and/or output)
  - fabric
    - ∗ as simple as possible
    - ∗ sometimes do buffering (internal)

Buffering

- Wherever contention is possible
  - input port (contend for fabric)
  - internal (contend for output port)
  - output port (contend for link)
- Head-of-Line Blocking
  - input buffering

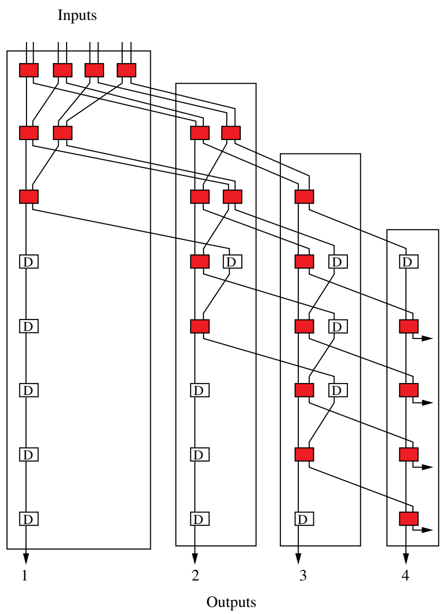


Crossbar Switches



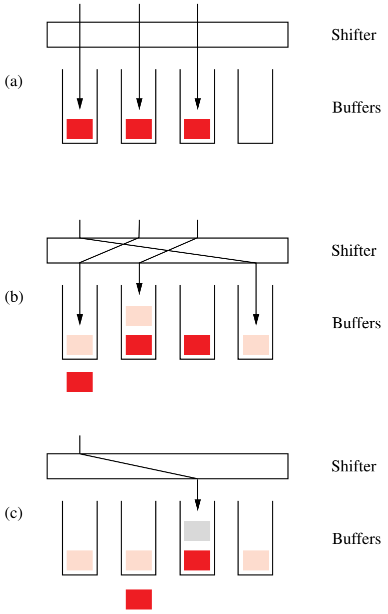
Knockout Switch

- Example of Crossbar
- Concentrator: select l of n packets



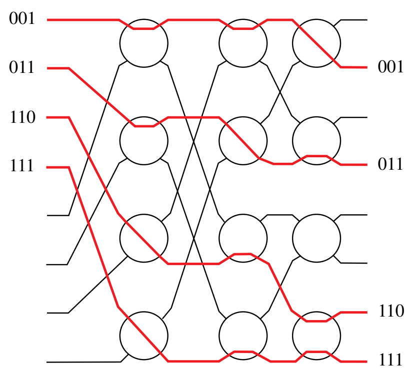
- Complexity: n^2

- Output Buffer

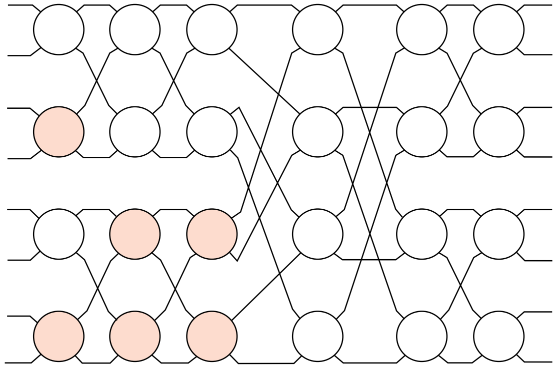


Self-Routing Fabrics

- Banyan Network
  - constructed from simple 2×2 switching elements
  - self-routing header attached to each packet
  - elements arranged to route based on this header
  - no collisions if input packets sorted into ascending order
  - complexity: $n \log_2 n$



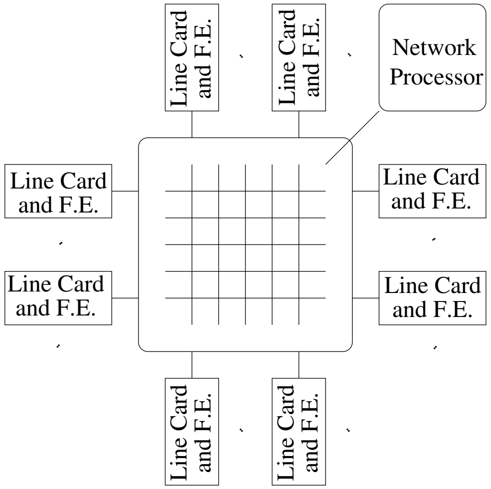
- Batcher Network
  - switching elements sort two numbers
    - ∗ some elements sort into ascending (clear)
    - ∗ some elements sort into descending (shaded)
  - elements arranged to implement merge sort
  - complexity: $n \log_2^2 n$



- Common Design: Batcher-Banyan Switching Fabric

Traditional IP Router

- Switch (possibly ATM)
- Line Cards + Forwarding Engines
  - link interface
  - router lookup (input)
  - common IP path (input)
  - packet queue (output)
- Network Processor
  - routing protocol(s)
  - exceptional cases



Supplemental Slides

- Tag Switching
- Extensible Routers and Active Network