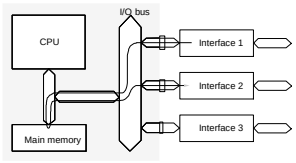
Router Construction

Outline

- Switched Fabrics
- IP Routers
- Extensible (Active) Routers

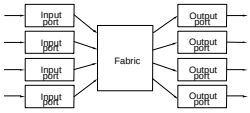
Workstation-Based

- Aggregate bandwidth
  - 1/2 of the I/O bus bandwidth
  - capacity 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
  - 100,000 packets-per-second is achievable
  - e.g., 64-byte packets implies 51.2Mbps



Switching Hardware

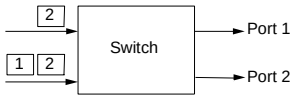
- Design Goals
  - throughput (depends on traffic model)
  - scalability (a function of *n*)



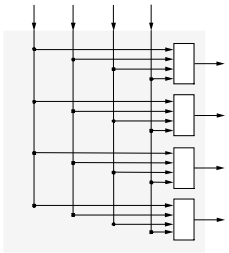
- Ports
  - circuit management (e.g., map VCIs, route datagrams)
  - buffering (input and/or output)
- Fabric
  - as simple as possible
  - sometimes do buffering (internal)

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

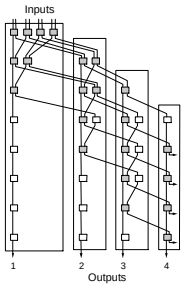


Crossbar Switches



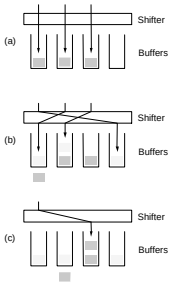
Knockout Switch

- Example crossbar
- Concentrator
  - select l of n packets
- Complexity: n^2



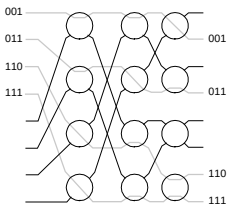
Knockout Switch (cont)

- Output Buffer



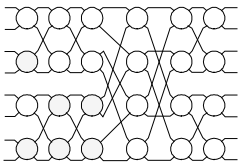
Self-Routing Fabrics

- Banyan Network
  - constructed from simple 2 x 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: $n \log_2 n$



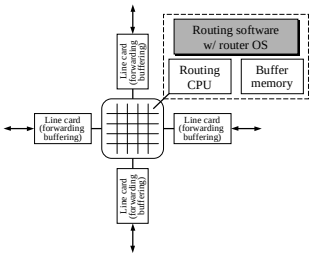
Self-Routing Fabrics (cont)

- 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 Switch

High-Speed 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

High-Speed Router