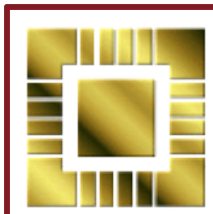

Electronics and Computer Science
University of Southampton

CM214-COMP2008
Data Communications and Networks

Switch Problems & Design

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Objectives

- The Hardware of Packet Switching
  - Why specialised hardware is needed

- (Peterson & Davie 2nd Ed., Section 3.1, 3.2, 3.4)
- (Peterson & Davie 3rd Ed., Section 3.4)

Review

- In the previous units we looked at
  - Ethernet bridges
  - Ethernet switches
  - Routing methods
  - Routing tables and algorithms

- Recall switches (next two slides)

Switch Characteristics

- Ideally, we would like our switch to:
  - Provide multi-way connections
    - To avoid expense & complexity of linking every network with every other by a point-to-point link
  - Be able to connect to other switches
    - For redundancy and scalability
  - Not impose too much of a performance limitation on traffic
    - Keep all the (expensive) p-t-p links busy

Switch Actions

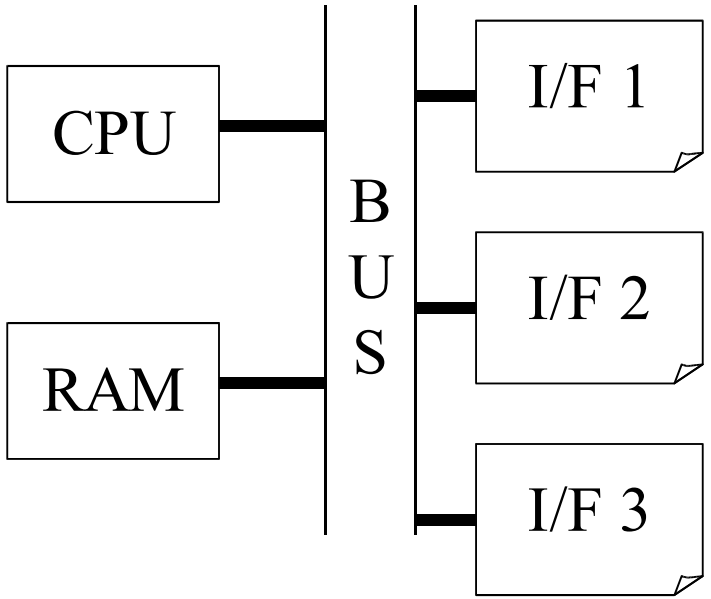
- Receive packets on inbound links
- Send packets on outbound links
- Route packets between links
  - Datagram routing
  - Virtual circuit routing
  - (Source routing – now usually ignored as security risk)

Switch Congestion

- Switches need to buffer packets
  - Because packets may arrive faster than they can be sent out - Why?
    - May have different speeds on each port
    - > 1 inbound port may have packets for same outbound port
  - Buffers may fill up – Possible solutions
    - Virtual circuits can pre-allocate buffer space
    - Throw packets away
    - Share buffer space between ports

PCs as Switches - 1

- Can we use a PC or workstation as a switch?
- On receipt of packet
  - CPU gets interrupt
  - DMA data into RAM
  - Read & decode header
  - Place in output queue



PCs as Switches - 2

- To send the output packet:
  - output I/F interrupts CPU when ready
  - CPU programs DMA transfer to I/F
  - Packet is sent
- Limitation is either memory or I/O (bus) bandwidth
- Most PCs / workstations designed to support a single I/F
  - Typical bandwidth 50-100Mb/s TOTAL

PCs as Switches - 3

- Recall, optical links run from 50Mb/s to 2.48Gb/s (& ever higher)
- For maximum we want to keep each link full of data
- Therefore, most ports will be operating near capacity
- PC architecture does not support necessary bus bandwidth

Switch Performance

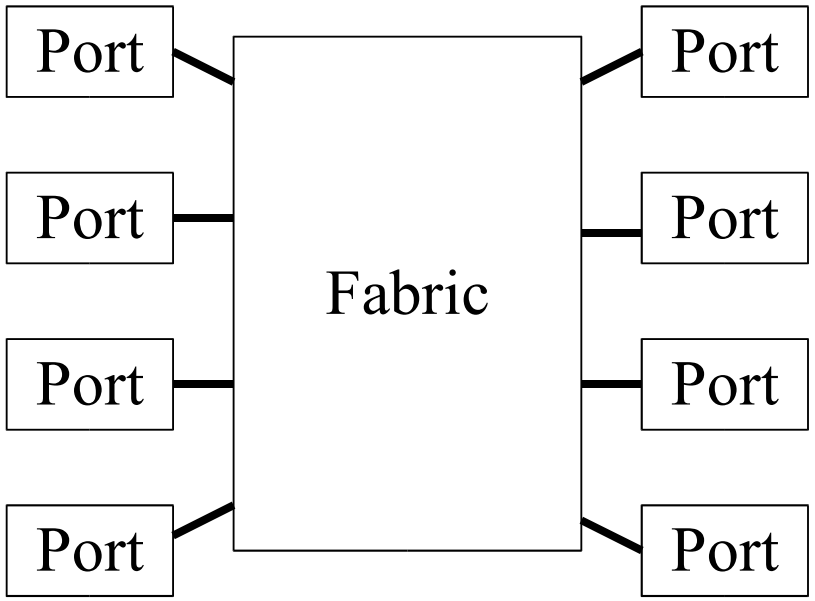
- What are we trying to achieve?
  - Throughput
    - Lots of packets switched per second
  - Scalability
    - Lots of ports (interfaces)
  - Cost
    - Minimise costs of manufacture
    - Minimise costs of operation

Switch Throughput

- Depends on the type of traffic
- E.g. Contention for a single output port will limit performance to the speed of that port
- Size of packets
- Packet arrival times
  - Steady or “bursty”

Switch Design

- How is necessary throughput achieved?
  - Complicated ports
  - Simple (and hence FAST) fabric



Port Implemenation

- Usually no input buffering
  - Due to “head of line blocking”
- Must do the mapping to the output port

- Output buffering
- Implements QOS guarantees

Fabrics – Crossbar

- Connect inputs to all outputs
- Ports setup control logic for multiplexors appropriately

- Does not scale well
- Output buffer must deal with contention

Fabrics – Shared Media

- Modified PC architecture, dedicated HW
- Big pool of shared buffers in RAM
- Very wide memory access to give sufficient bandwidth (wide bus)

- Limitation probably speed of control logic

Fabrics – Banyan / Batchers

- Self routing network within fabric
- Makes small, simple (fast!) decisions
  - Net result is correct output port
- Banyan network routes packet through set of nodes without collisions provided packets sorted in numerical order
- Batcher is hardware to sort packets in numerical order of output port

Banyan Limitations

- Does not solve problem of contention
  - Output ports must still buffer
- Solution
  - Use multiple banyans
  - Don’t drop packets on contention
  - Delay them and re-inject into banyan network

Summary

- Switches are specialised hardware devices
- General purpose computers (PCs, workstations) do not make good switches