ATM Switch

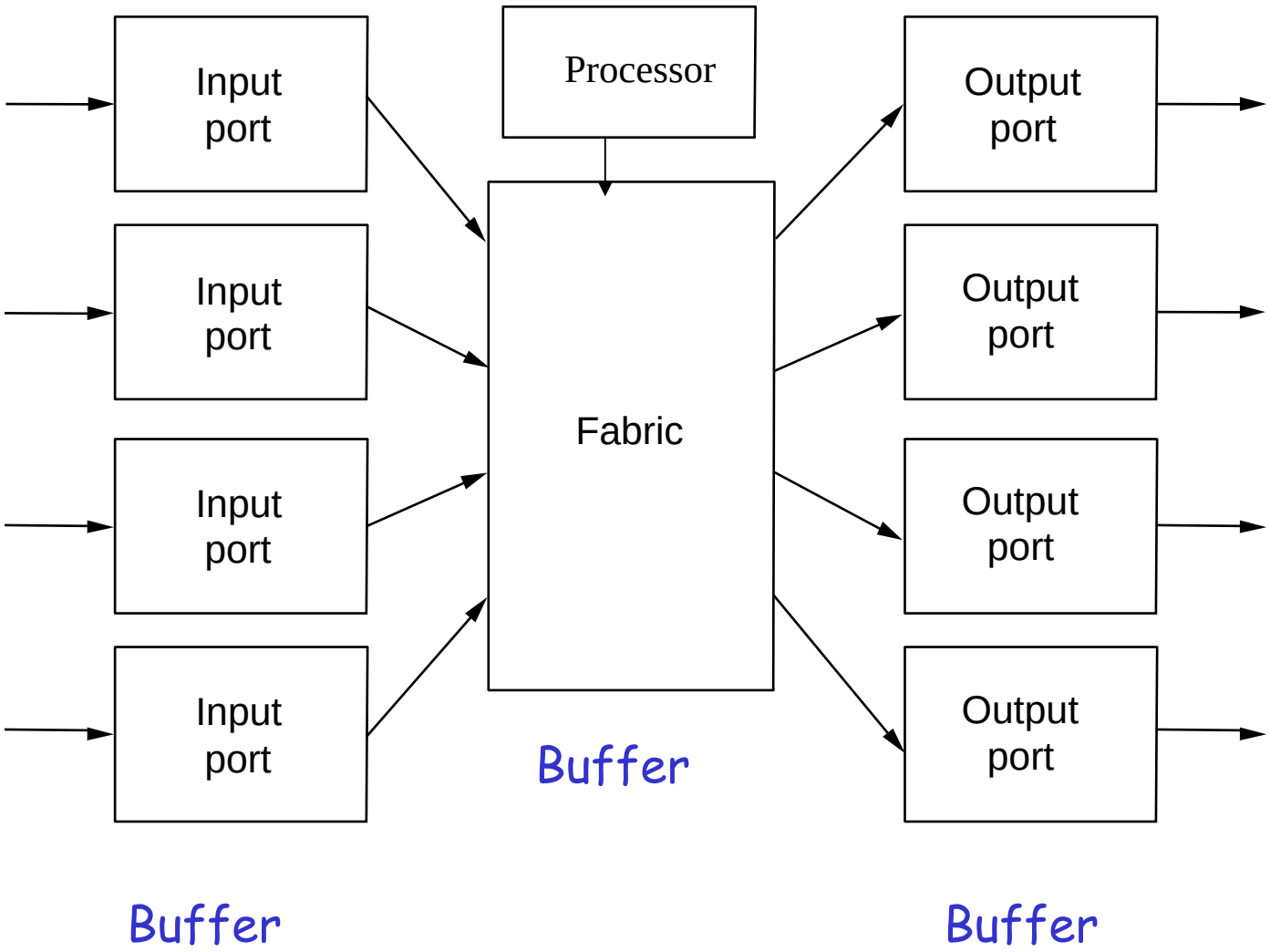
Class 7

Switch Design

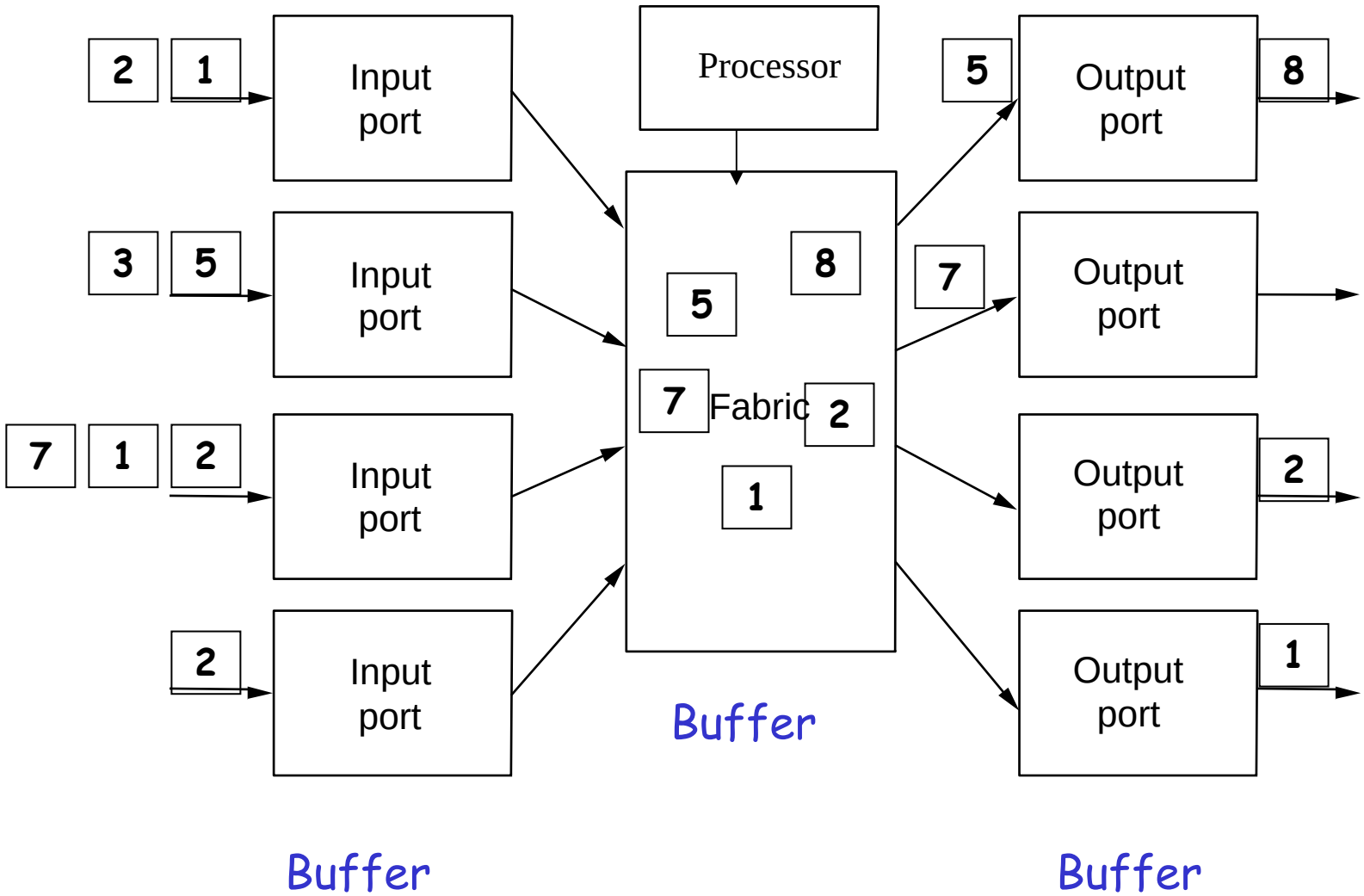
Switch Design Goals

- Throughput – performance advantage
  - Limited by contentions and variable packet sizes
  - Incorporation various Traffic models
- Size or scalability
  - With the goal of tens of thousands of ports
- Cost

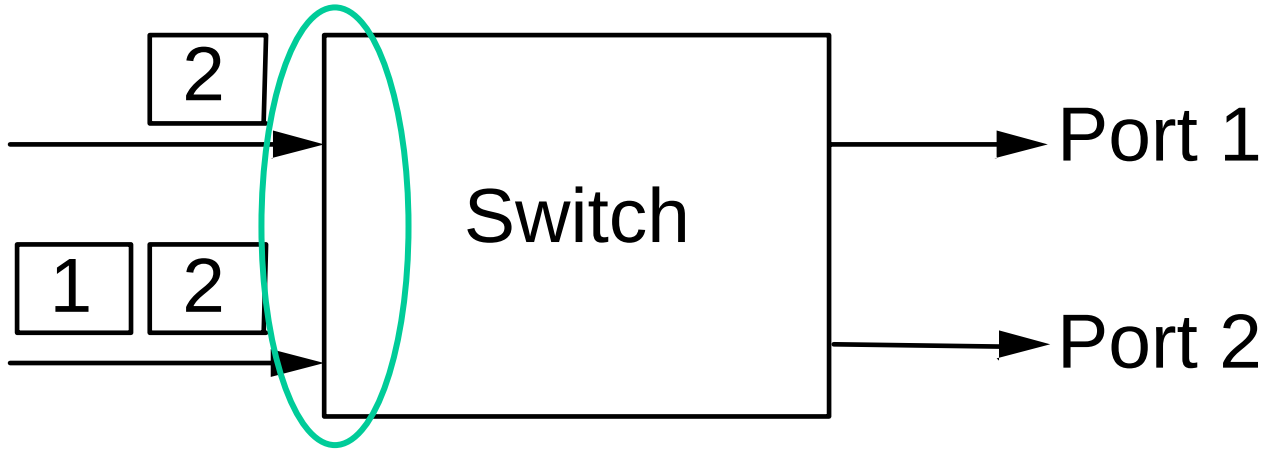
General Organization



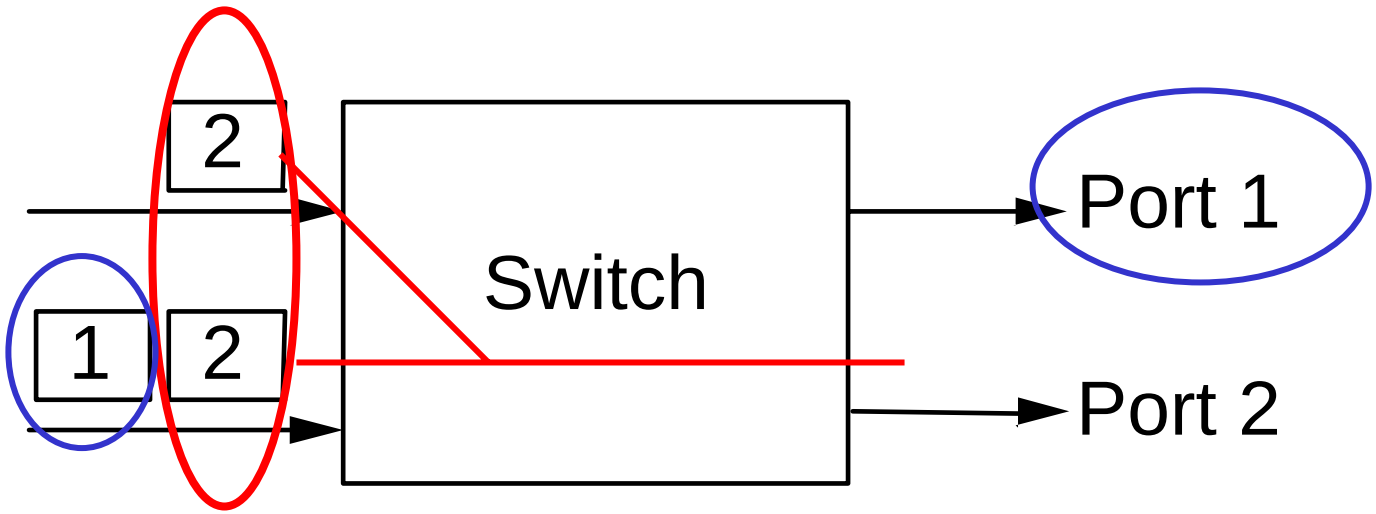
Packet Movement



Buffering at the Input Port



Head-of-Line Blocking



- For uniformly distributed traffic, throughput reduced to 59% of theoretical maximum (sum of the link BWs)
- So – use ***output*** or ***fabric*** *buffering*

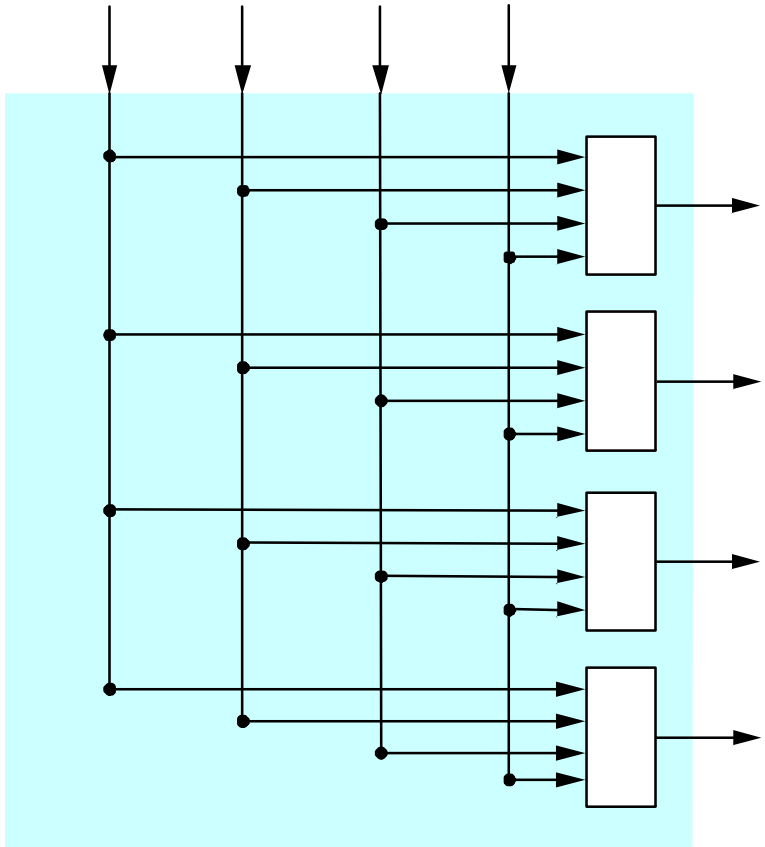
Design Options to Shift Buffering Point

- Shared bus
  - Bus bandwidth determines the throughput
  - So build special busses
- Shared memory
  - Memory BW determines throughput
  - Build special high-speed memory and memory bus
- Cross-bar
  - Each output port accepts packets from all input ports ***at once***
  - So each port has a BW = total switch throughput

Crossbar

- Cost
- Memory B/W requirement

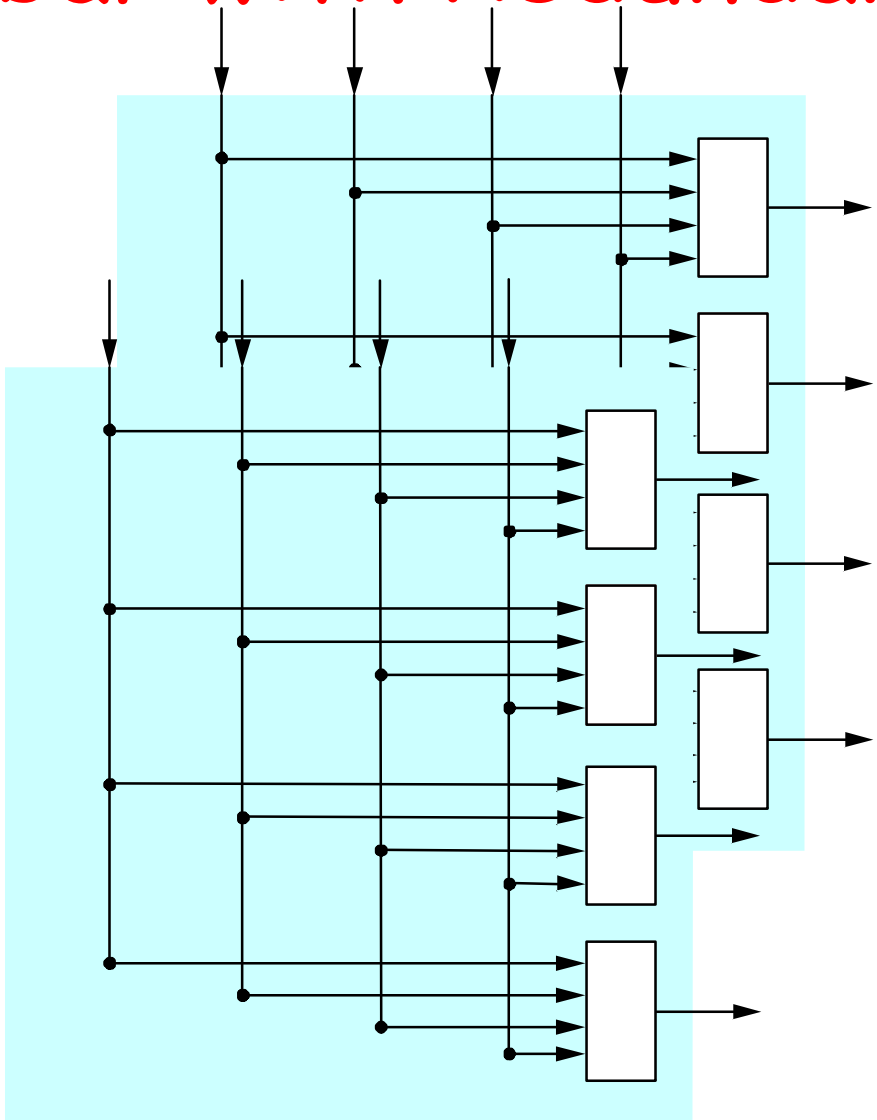
➔ non-blocking design



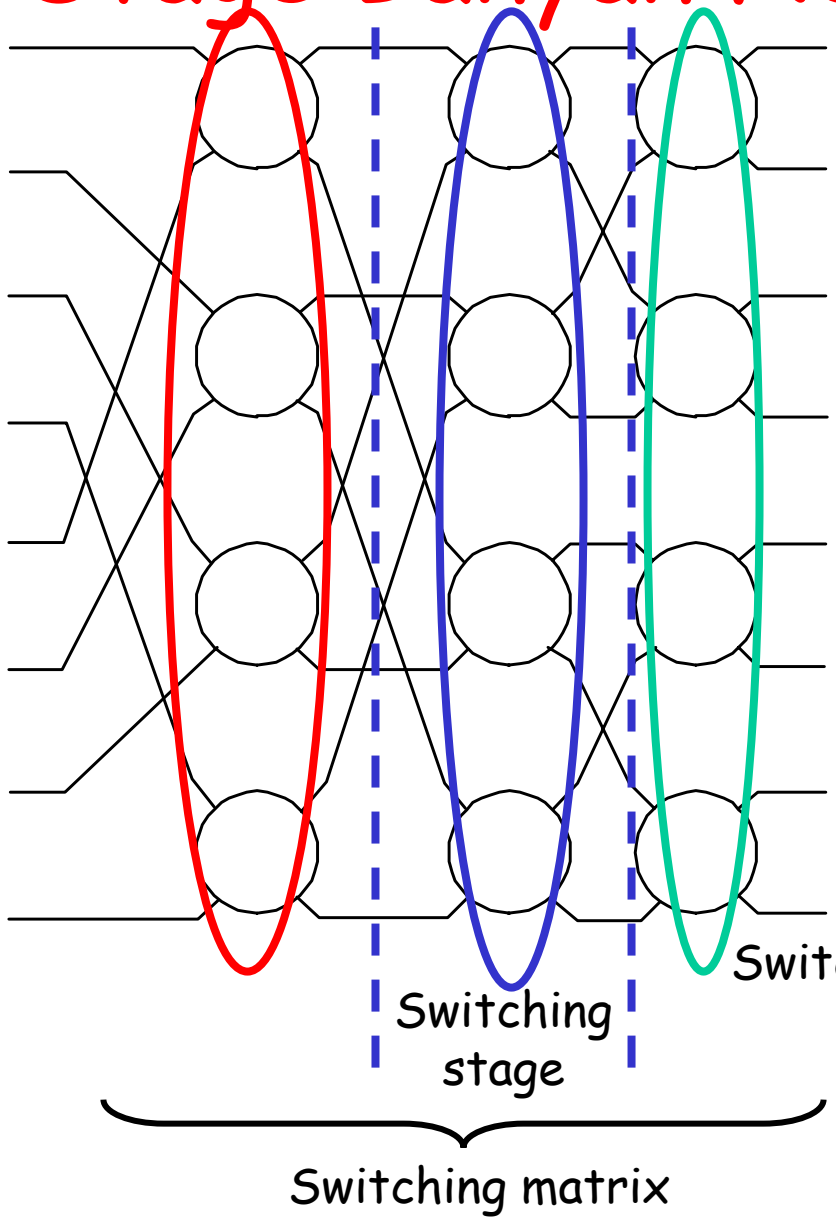
Crossbar with Redundancy

- Every-port is duplicated

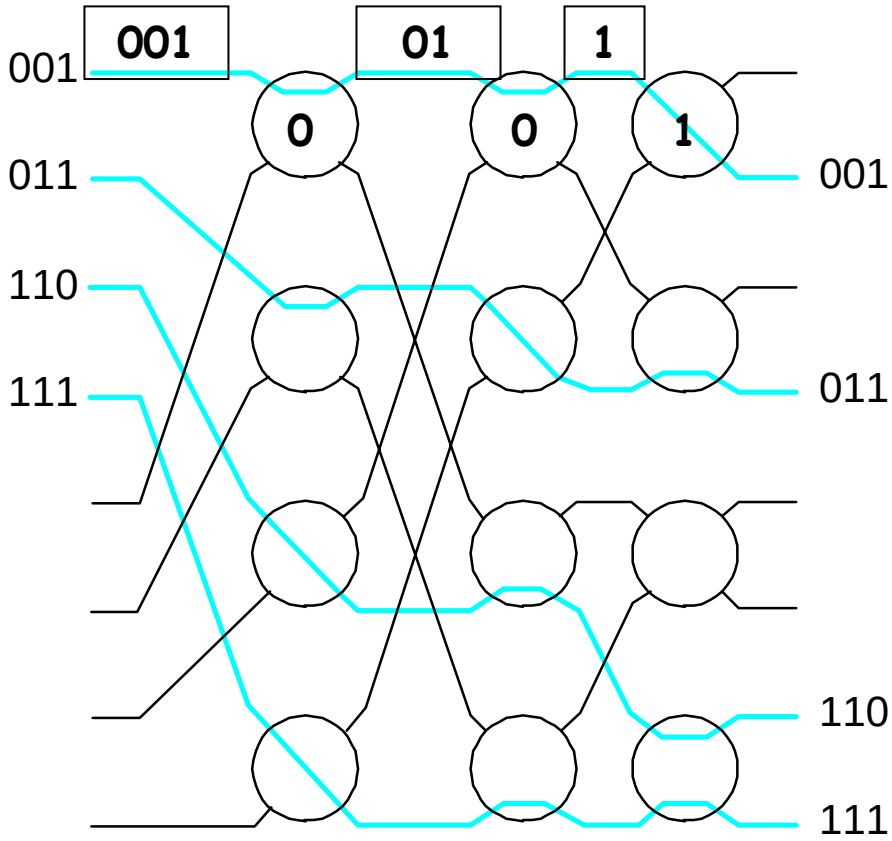
➔ Hence the design is robust but costly



Multi-Stage Banyan Network



Self Routing

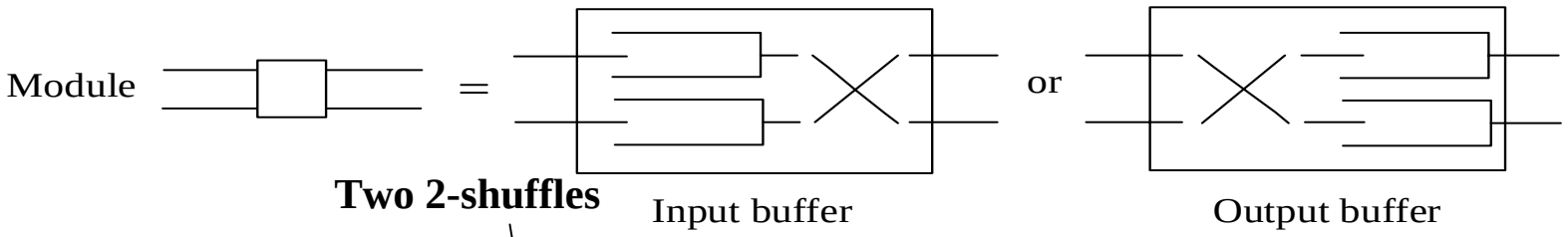


The self-routing is internal to the switch – it is used to minimize contention of ports

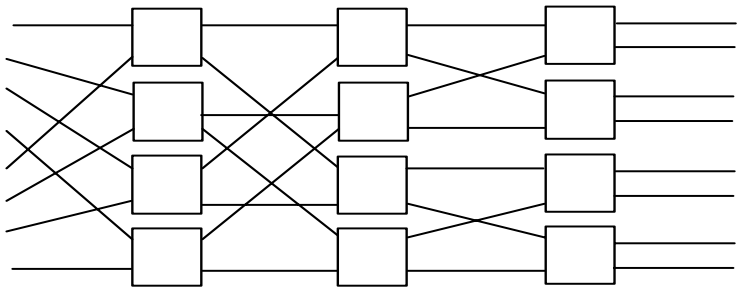
Blocking in Multi-Stage Switches

- When multiple connections going to the same output port
  - Buffer
  - Increase switching speed

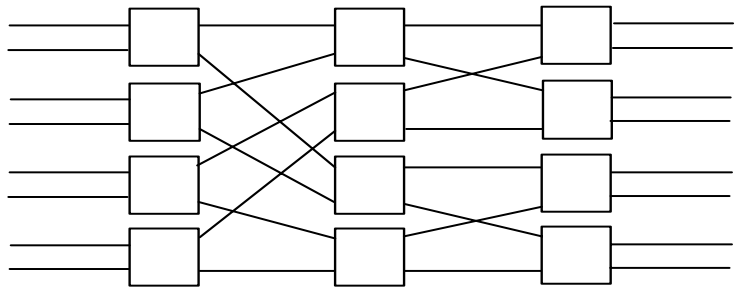
Attempts to Minimize Blocking

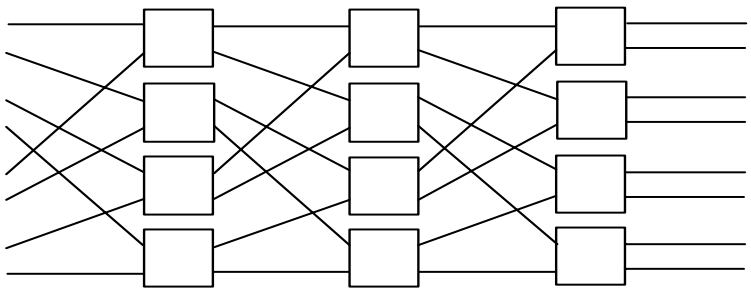


Banyan

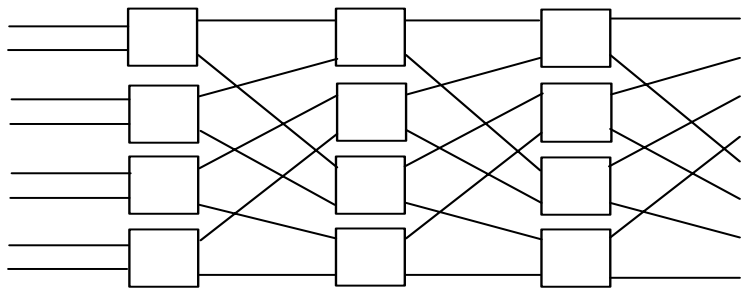


Baseline





Omega



Flip

A Banyan Network

Blocking occurs if two incoming packets want to go to the same output terminal

- Solution, include buffer in every switching element ➔ *expensive*
- To avoid packet loss, buffer size must be large enough to hold the worst case pattern

Since buffering is an expensive solution first try to minimize ***hot spots*** (contention points)

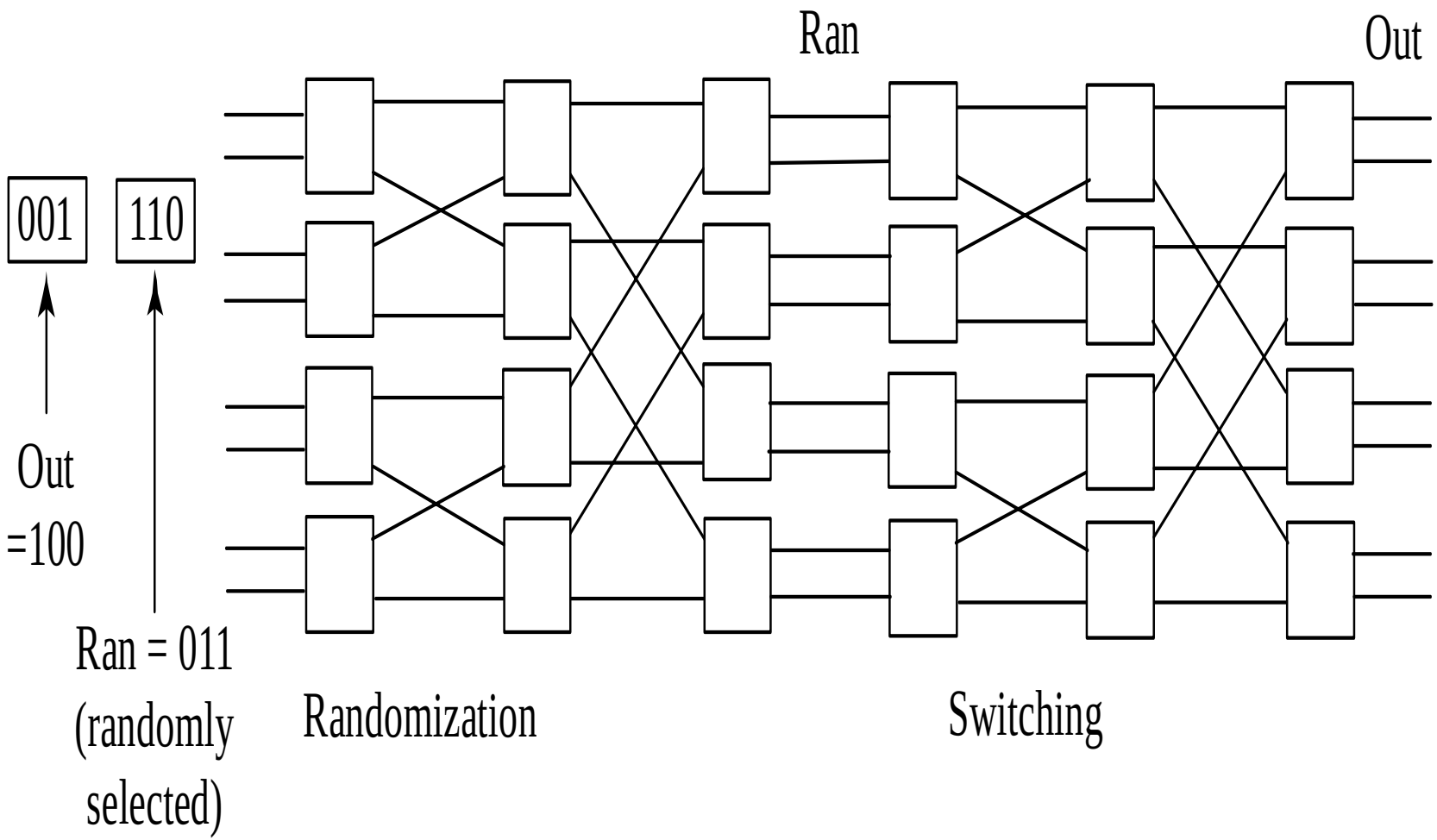
Two techniques:

1. Use of ***randomization*** stage in ***front*** of Banyan switch
2. Use of ***sorting*** network in ***front*** of Banyan switch

Use of Randomization Stage

- Additional banyan switch is added in front – called the randomization stage.
  - When a cell arrives at an input port, its destination port
  - Is replaced by another (Random) destination port
- On leaving the randomization stage, each packet's original destination is restored
- Since randomization is statistical
  - this technique does not completely eliminate all hot spots
  - thus, buffers at each stage will still be required – but less expensive versions

Randomized Banyan Network



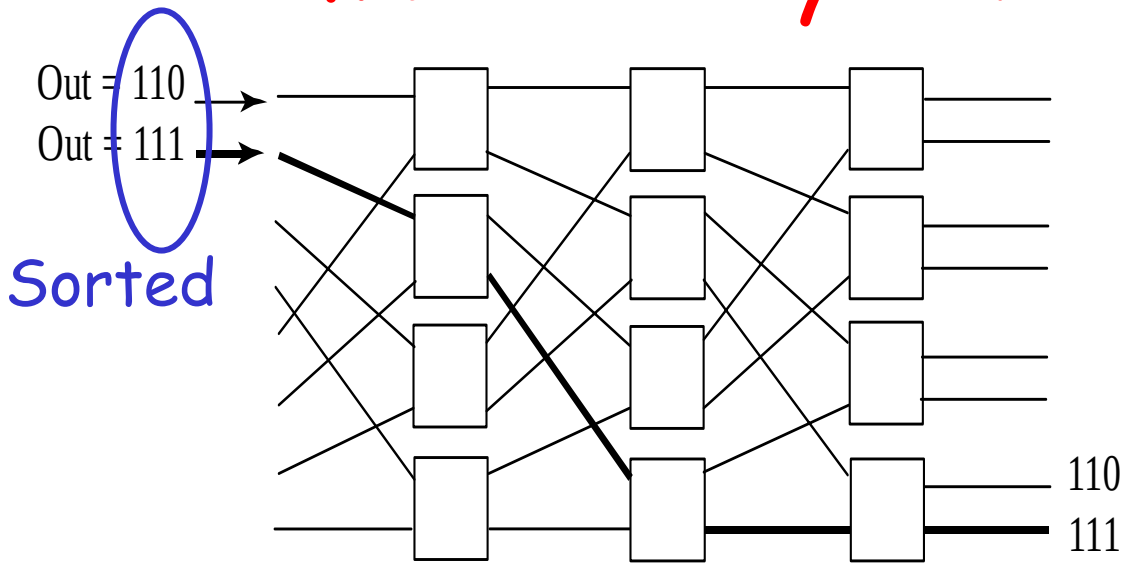
Sorting – Batcher Banyan Network

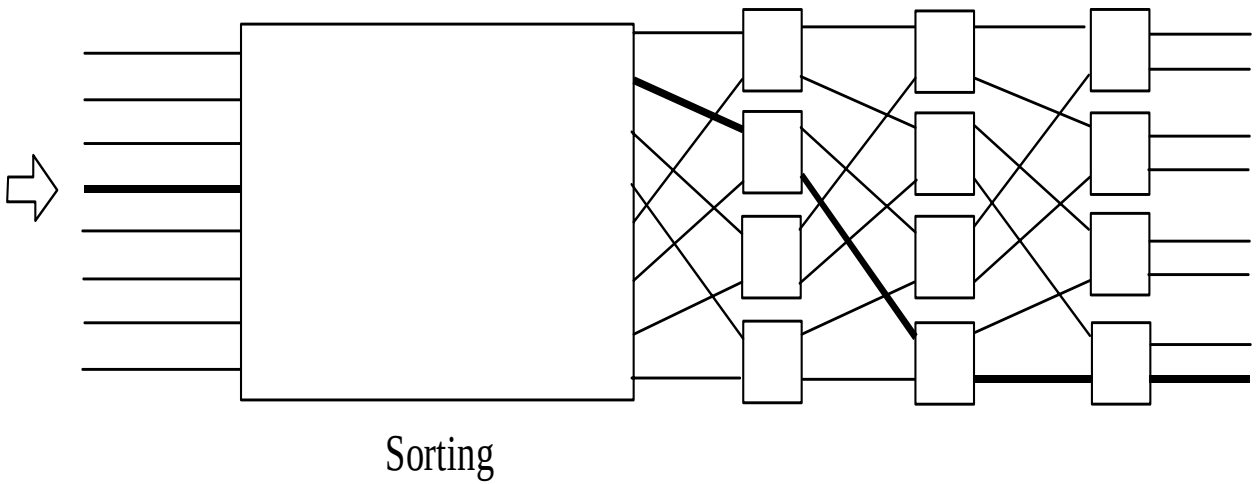
- The technique is based on the observation that if the destination N Routing-vector is sorted (in increasing order) by output port, the corresponding N routes will be disjoint

- With sorting the two routes have no links in common
  - so both cells can be transmitted simultaneously
  - there will be no contention or need for buffers within elements

- Thus the Banyan network is preceded by a sorting network
- However, if two input cells with the *same* destination output port appear at the Batcher network, there will be contention.
  - So one of those cells cannot be allowed to enter the network and must be buffered.
  - Thus a Batcher-banyan switch also must be equipped with buffer

Randomized Banyan Network





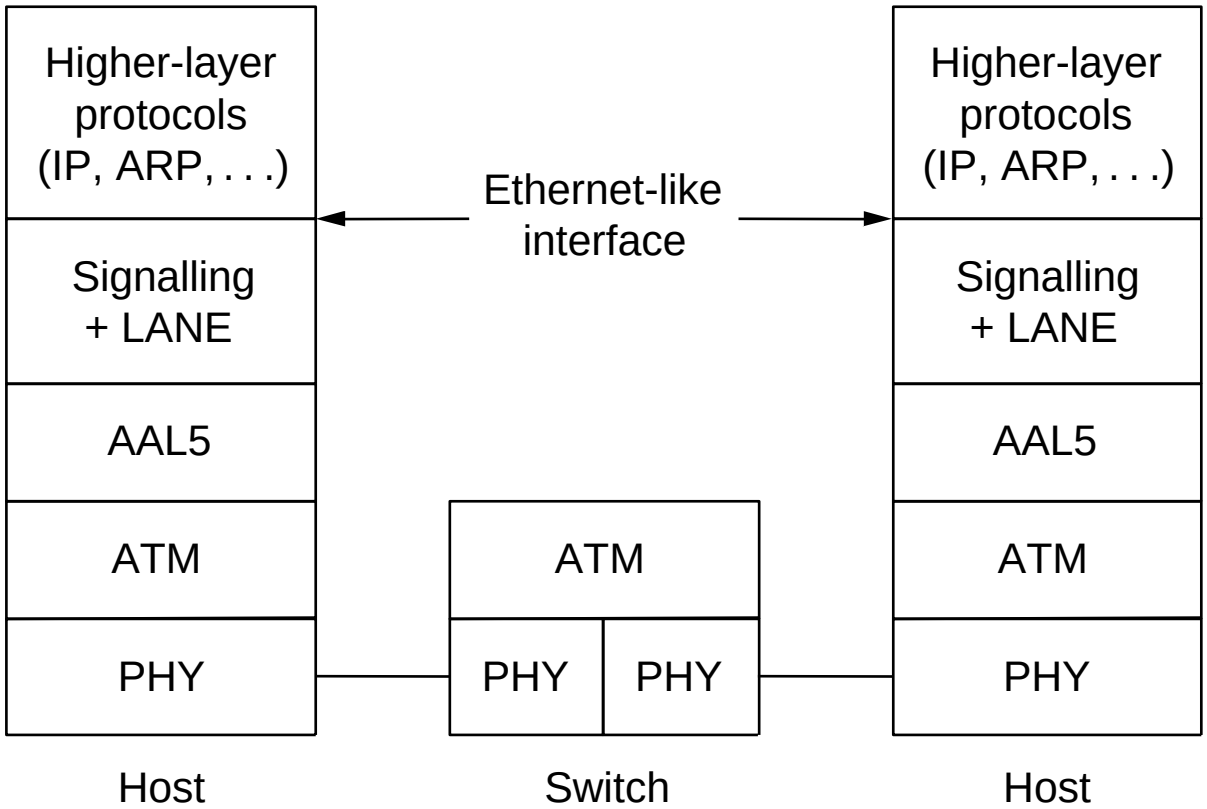
ATM LANs

LAN Emulation

ATM in LAN

- As backbone
- Interworking with other LANS
  - ATM not a broadcast technology
  - ATMARP and LAN Emulation

Protocol Stack for LAN Emulation



Emulation Components

- LE clients
- Servers
  - Configuration servers (LECS)
  - Emulation Server (LES)
  - Broadcast and Unknown Server (BUS)