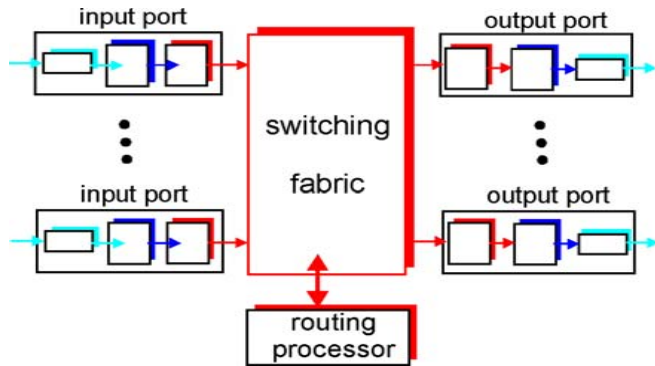


## Router Architecture Overview

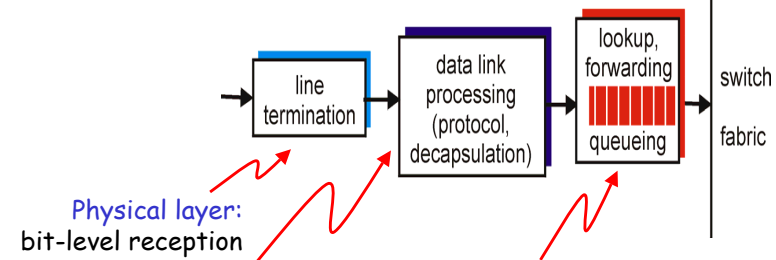
Two key router functions:

- run routing algorithms/protocol (RIP, OSPF, BGP)
- *switching* datagrams from incoming to outgoing link



4: Network Layer 4b-21

## Input Port Functions



Physical layer:  
bit-level reception

Data link layer:  
e.g., Ethernet  
see chapter 5

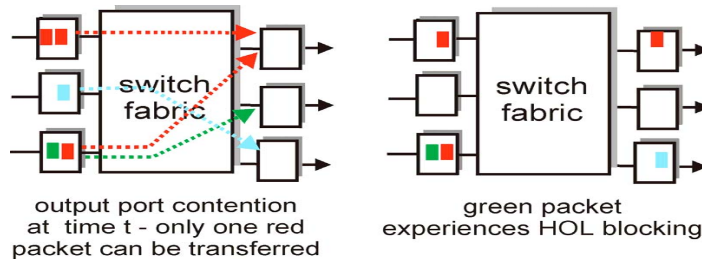
### Decentralized switching:

- given datagram dest., lookup output port using routing table in input port memory
- goal: complete input port processing at 'line speed'
- queueing: if datagrams arrive faster than forwarding rate into switch fabric

4: Network Layer 4b-22

## Input Port Queuing

- Fabric slower than input ports combined → queuing may occur at input queues
- **Head-of-the-Line (HOL) blocking:** queued datagram at front of queue prevents others in queue from moving forward
- *queueing delay and loss due to input buffer overflow!*

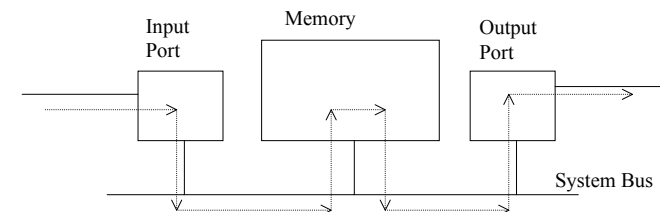


4: Network Layer 4b-23

## Switching Via Memory

### First generation routers:

- packet copied by system's (single) CPU
- speed limited by memory bandwidth (2 bus crossings per datagram)

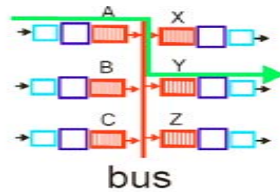


### Modern routers:

- input port processor performs lookup, copy into memory
- Example: Cisco Catalyst 8500

4: Network Layer 4b-24

## Switching Via Bus



- datagram from input port memory to output port memory via a shared bus
- **bus contention**: switching speed limited by bus bandwidth
- 1 Gbps bus, (example: Cisco 1900): sufficient speed for access and enterprise routers (not regional or backbone)

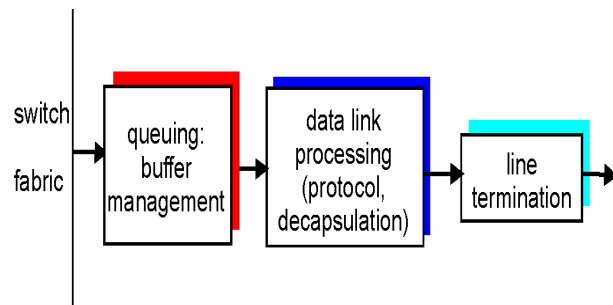
4: Network Layer 4b-25

## Switching Via An Interconnection Network

- overcome bus bandwidth limitations
- Banyan networks, other interconnection nets initially developed to connect processors in multiprocessor
- Advanced design: fragmenting datagram into fixed length cells, switch cells through the fabric.
- Example: Cisco 12000: switches Gbps through the interconnection network

4: Network Layer 4b-26

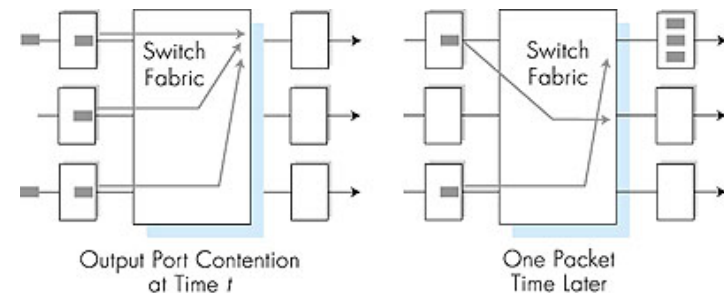
## Output Ports



- **Buffering** required when datagrams arrive from fabric faster than the transmission rate
- **Scheduling discipline** chooses among queued datagrams for transmission

4: Network Layer 4b-27

## Output port queueing



- buffering when arrival rate via switch exceeds output line speed
- **queueing (delay) and loss due to output port buffer overflow!**

4: Network Layer 4b-28

# Three types of switching fabrics

