

# CSC411: Advanced Networks

## Network Layer Overview

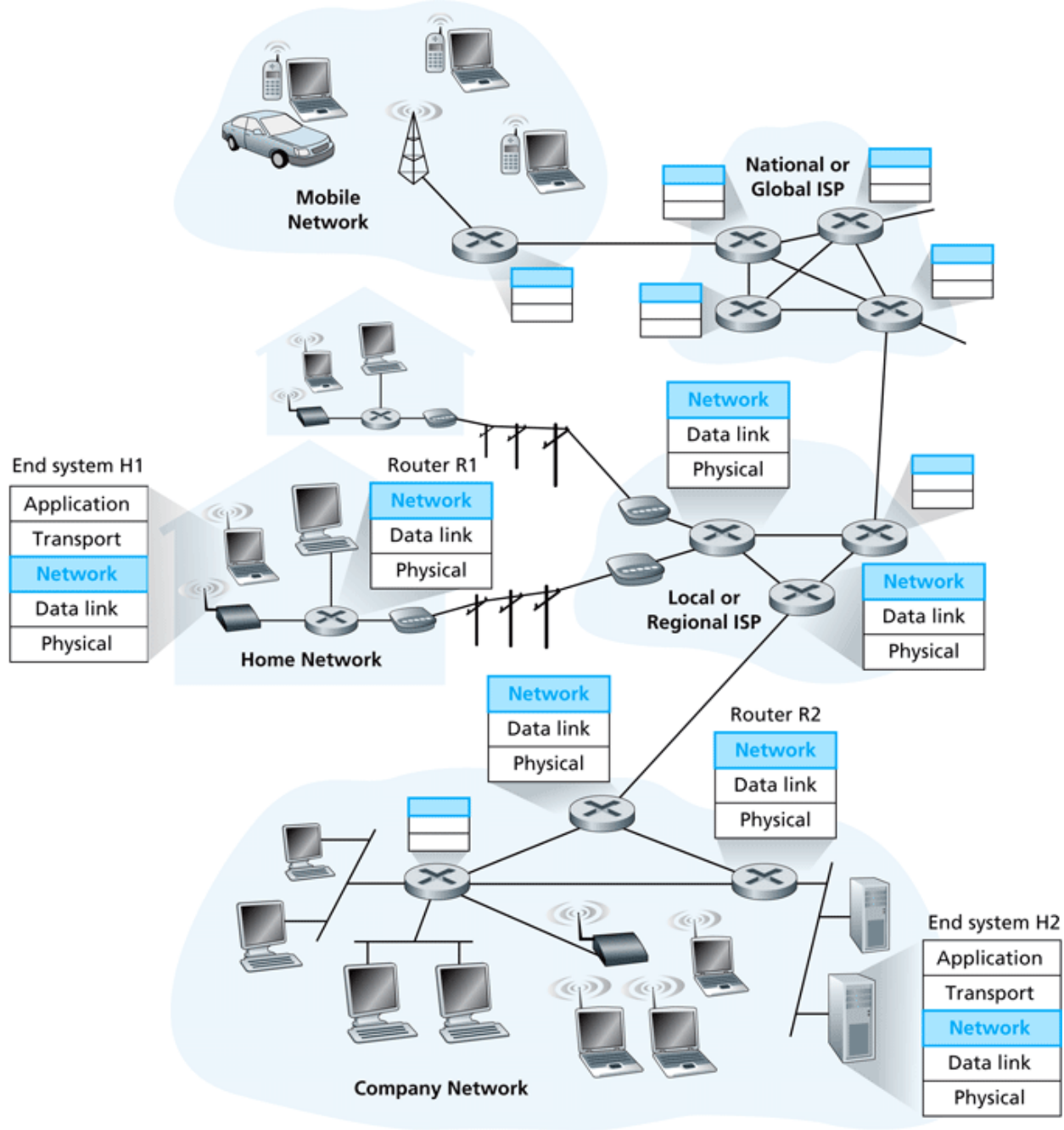
**Note: This class lecture will be recorded!**

If you do not consent to this recording, please do not ask questions via your video, audio or public chat; send your question to the instructor using the private chat.

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Kutztown University

# Review Questions

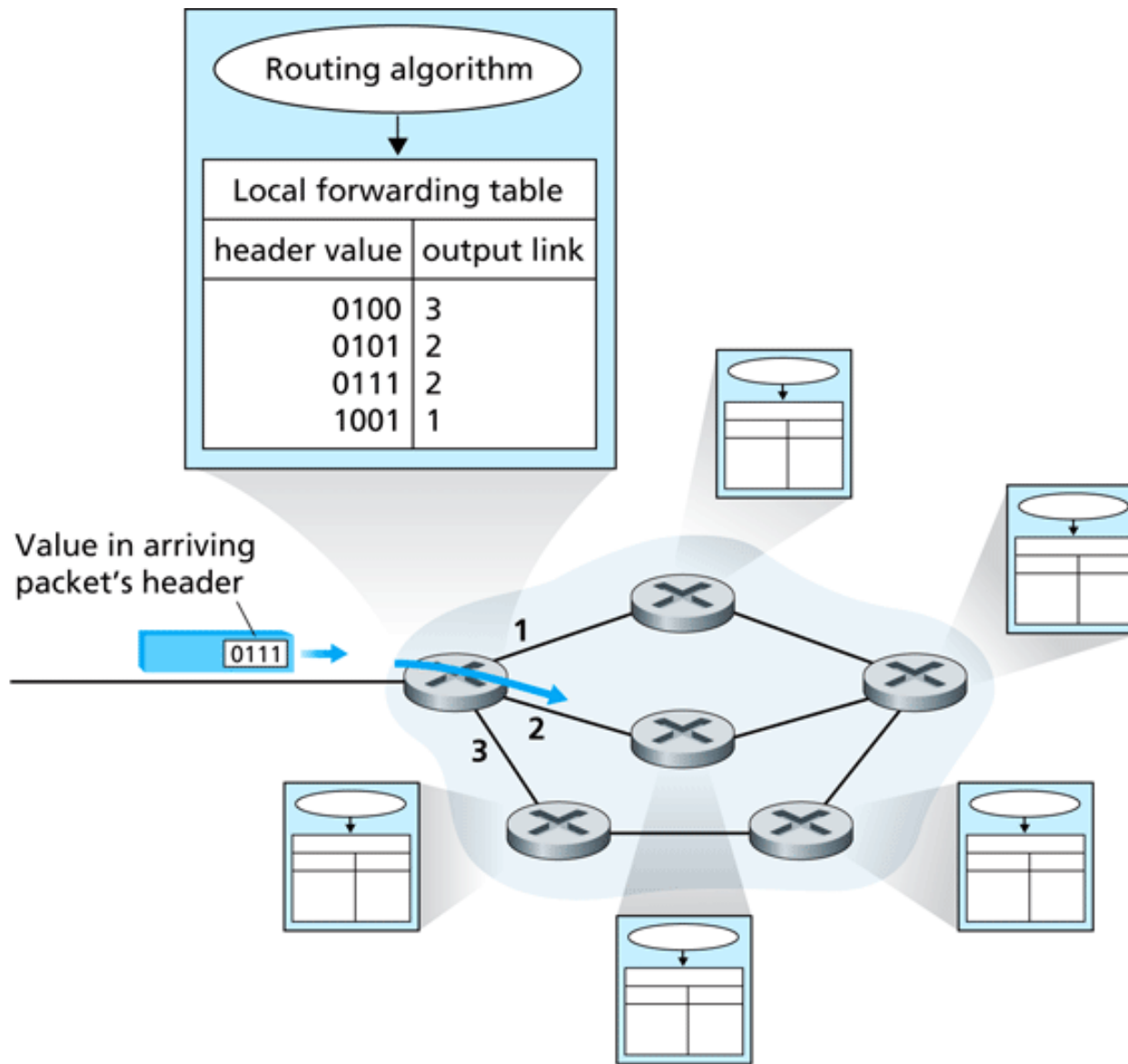
- ▶ What is the name of the network-layer PDU?
- ▶ Describe the difference between how a router and a layer-2 switch work.
- ▶ What is the difference between routing and forwarding?



**Figure 4.1** ♦ The network layer

# Forwarding / Routing

- ▶ Forwarding
  - Input port to output port
  
- ▶ Routing
  - Determine path for packet

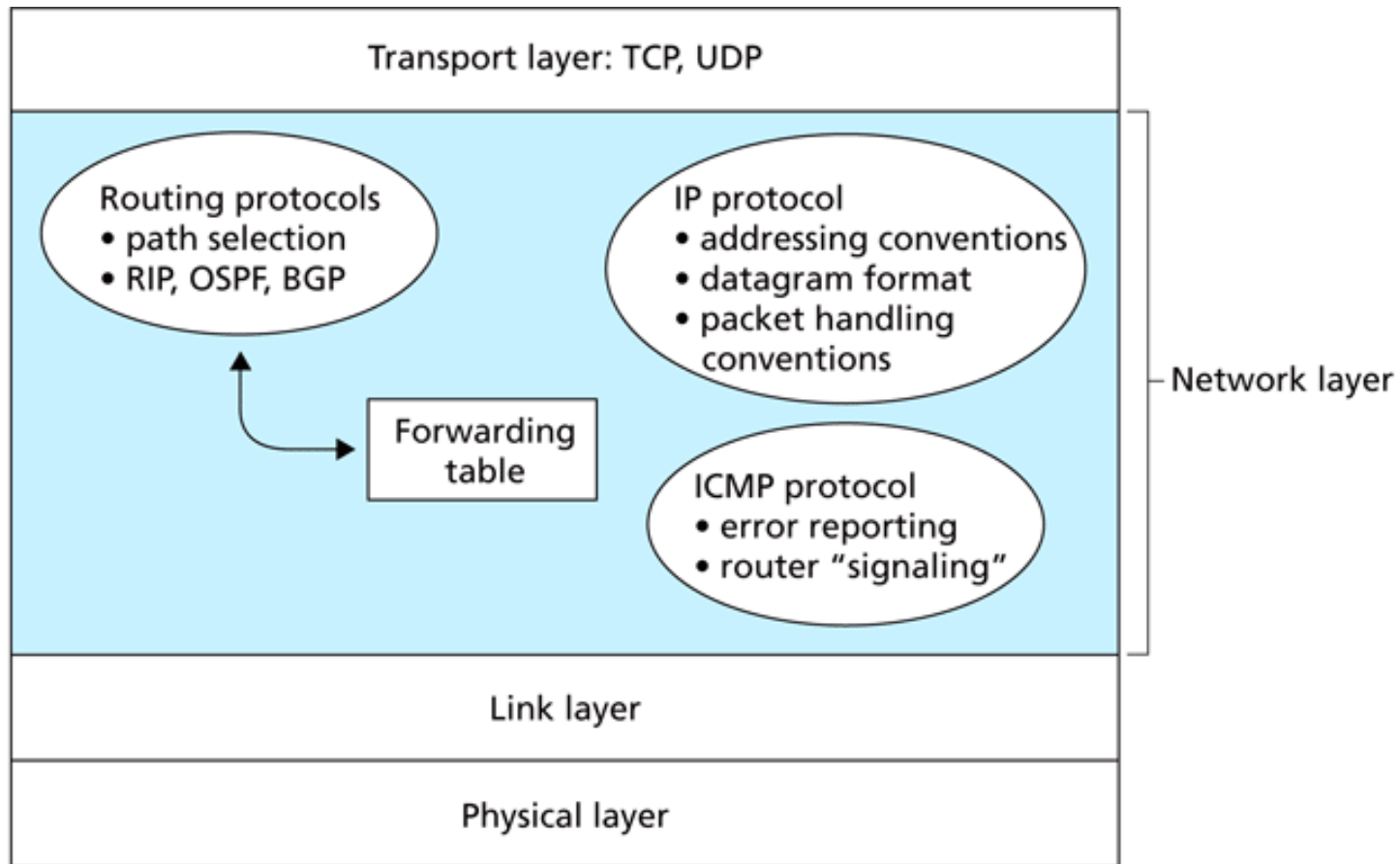


**Figure 4.2** ♦ Routing algorithms determine values in forwarding tables.

# Network Service Model

- ▶ Guaranteed delivery
  - ▶ Guaranteed delivery with bounded delay
  - ▶ In-order packet delivery
  - ▶ Guaranteed minimal bandwidth
  - ▶ Guaranteed maximum jitter
  - ▶ Security Services
- 
- ▶ Best-Effort Service

# Network Layer Overview



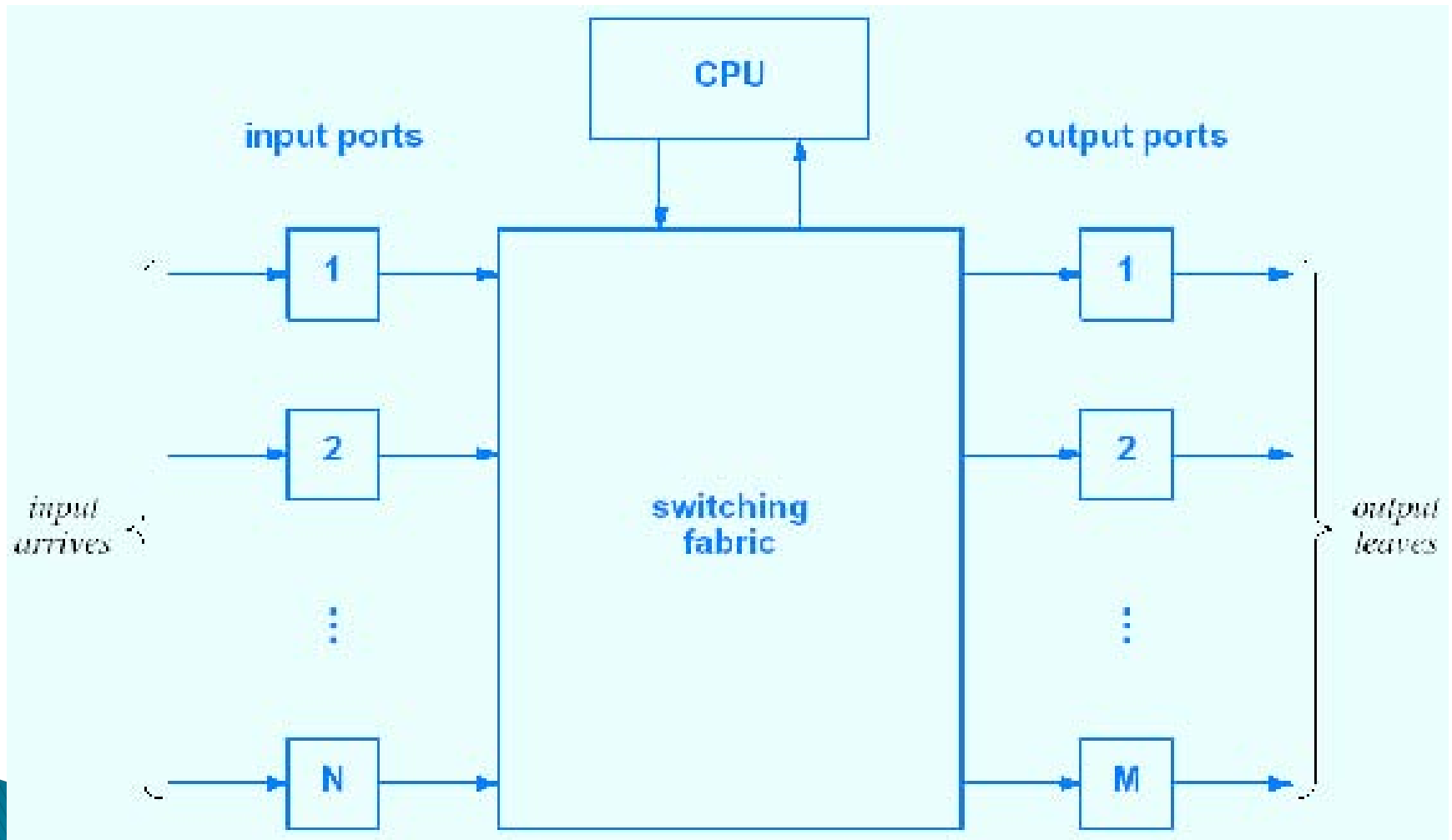
**Figure 4.12** ♦ A look inside the Internet's network layer

# Interconnection

- ▶ Physical interconnection
- ▶ Logical interconnection



# Routers



# Switching Fabric

- ▶ Connect input ports to output ports
- ▶ Decentralized hardware design
  - Bottleneck – moving packets among interfaces
- ▶ System Backplane
- ▶ Switching fabric

# Switching Fabric Properties

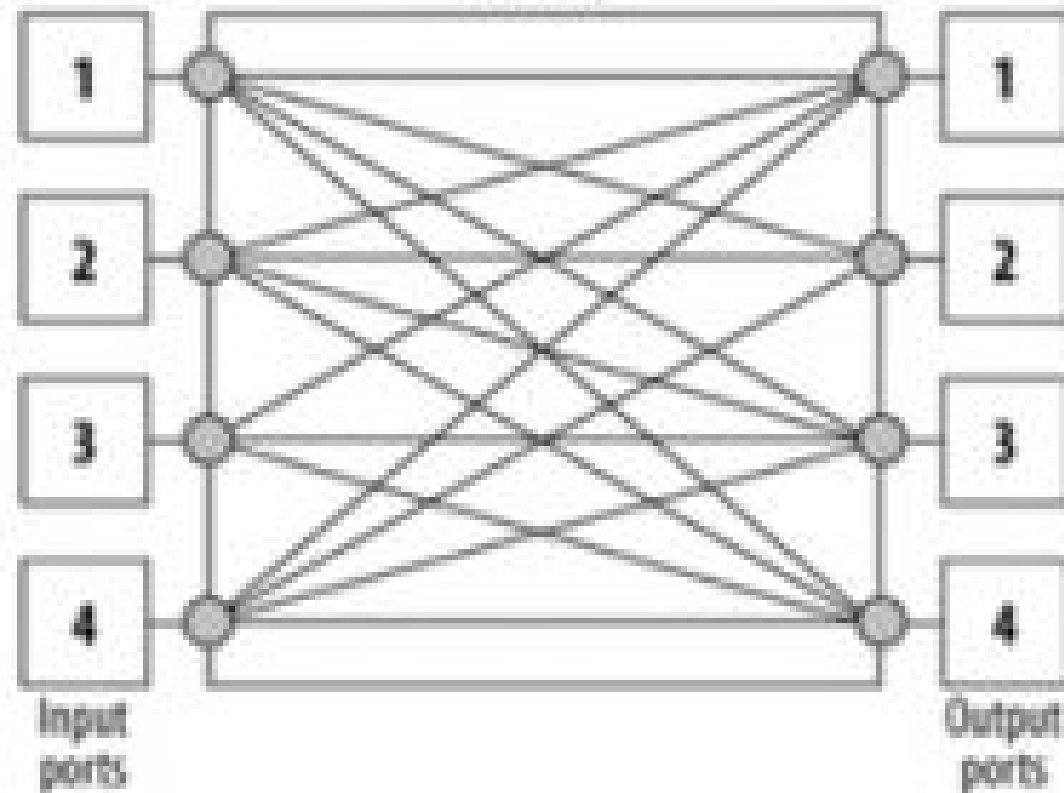
- ▶ Designed for use inside a single network system
- ▶ Provides interconnection among the CPU and smart I/O ports
- ▶ Supports the transfer of unicast, multicast, and broadcast packets
- ▶ Scales to handle an arbitrary data rate on any input or output port
- ▶ Scales to handle an arbitrary packet rate on any input or output port
- ▶ Scales to handle an arbitrary number of input or output ports
- ▶ Has low overhead
- ▶ Has low cost

# Switching Fabric Classifications

- ▶ Synchronous
  - ▶ Asynchronous
- 
- ▶ Time division approach
  - ▶ Space division approach

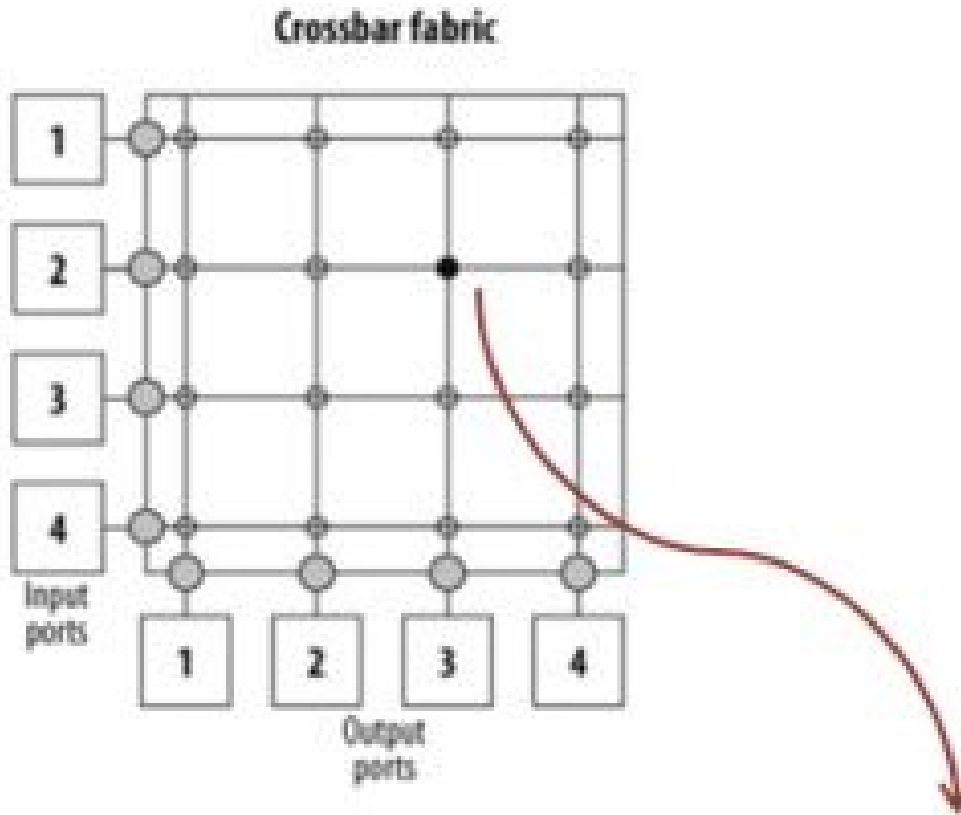
# Switching Fabric Illustration

Fully interconnected fabric



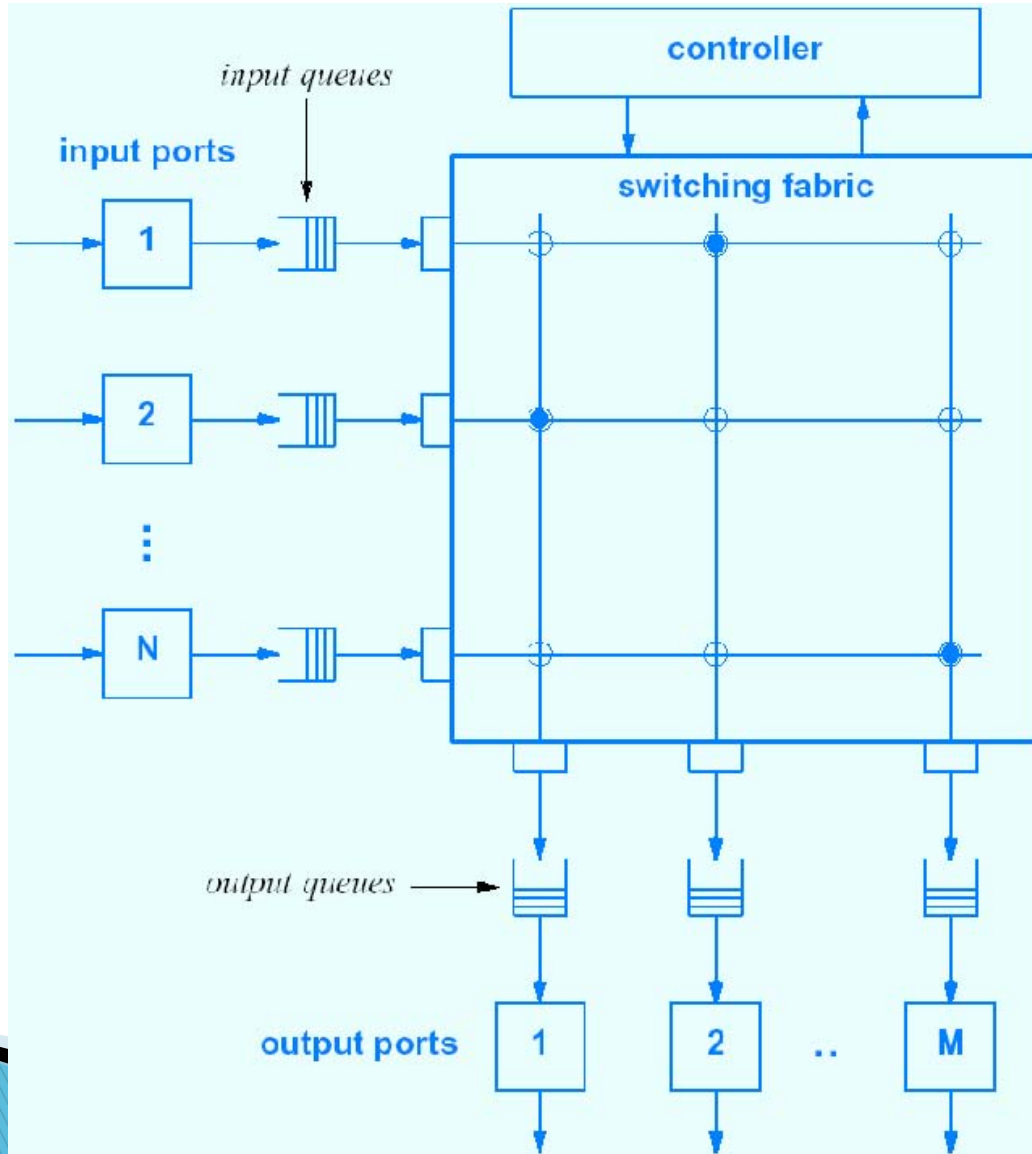
- ▶ Any problems with this type?
- ▶ Big disadvantage?

# Crossbar Architecture



port 2 is in communication with port 3

# Crossbar Fabric with Queuing

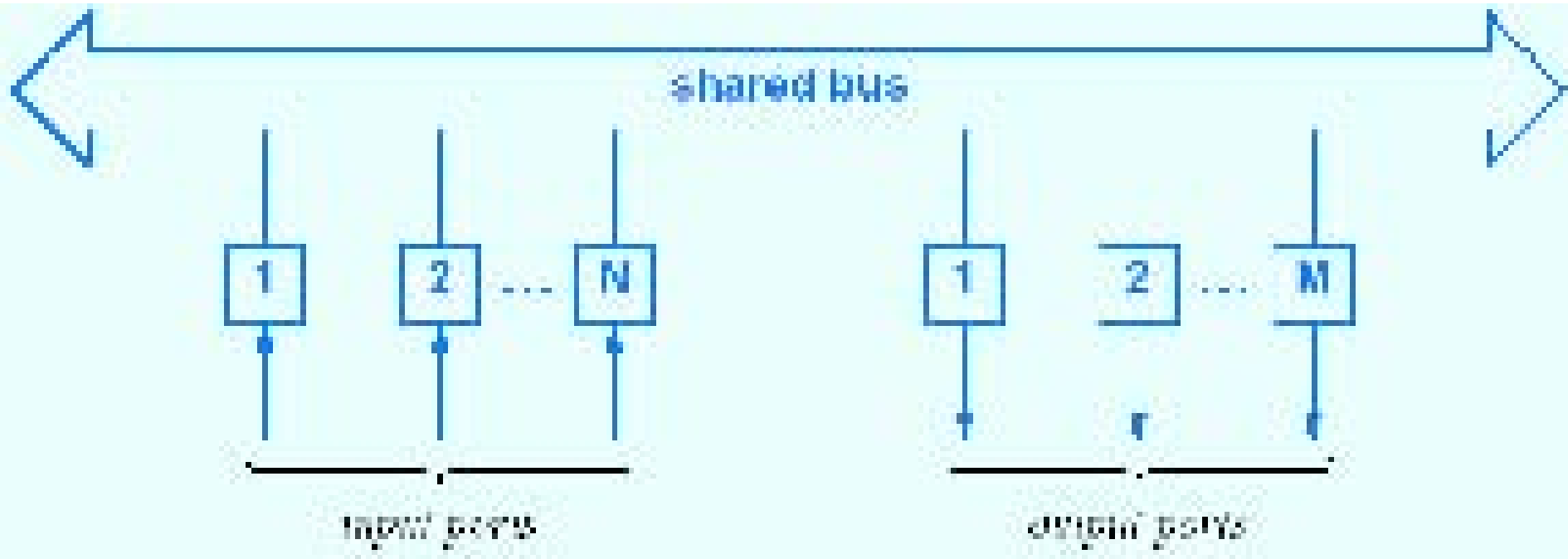


# Time-Division Fabrics

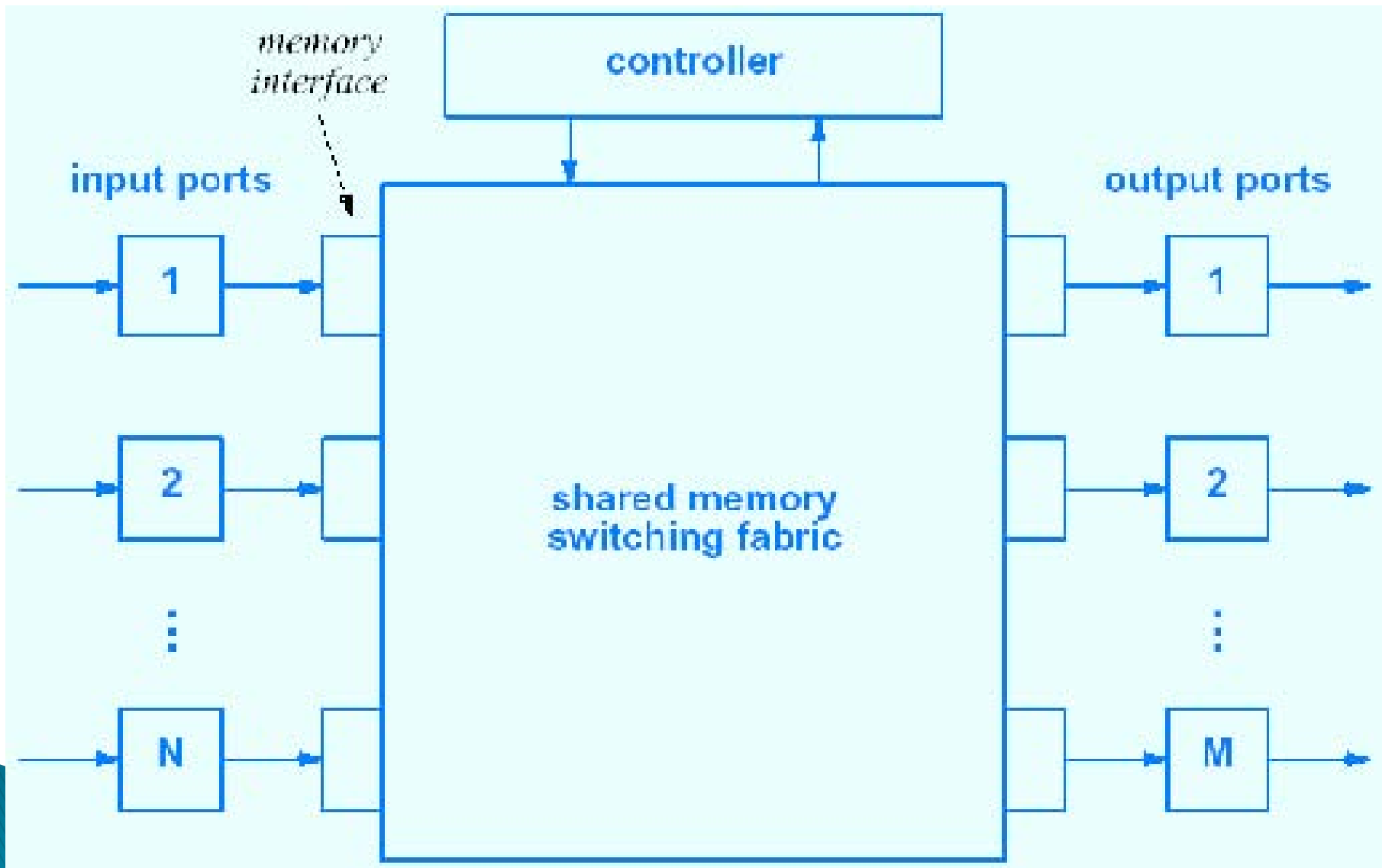
- ▶ Share communication paths
- ▶ Advantage - lower cost
- ▶ Disadvantage - lower aggregate throughput
- ▶ Operational Granularities
  - Packet
  - Cell
  - Block



# Time-Division Fabric (Shared Bus)



# Time-Division Fabric (Shared Memory)



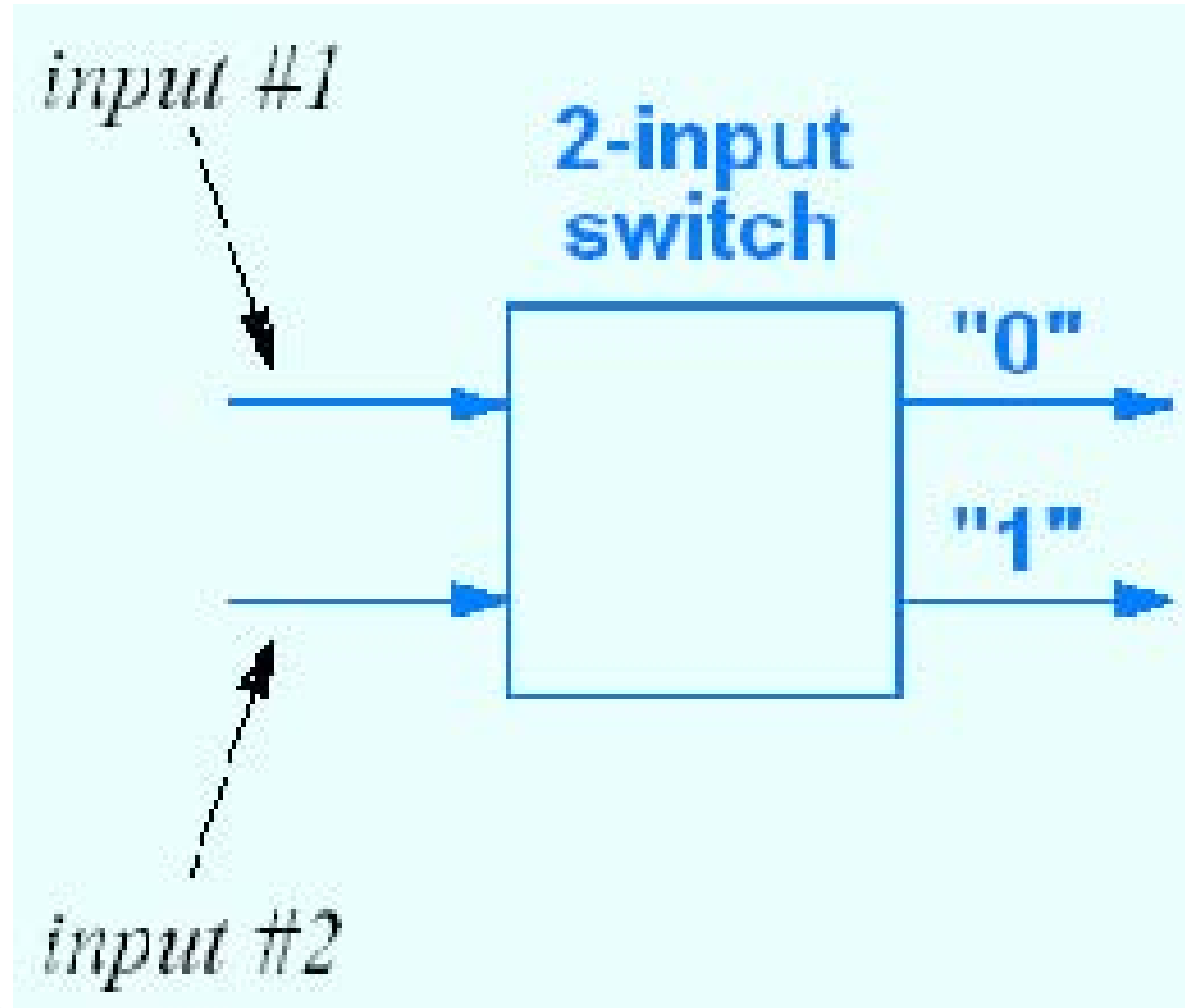
# Multi-Stage Fabrics

- ▶ Compromise performance and cost
- ▶ Compromise between time-division and space-division
  - Time-division: lower cost
  - Space-division: higher performance

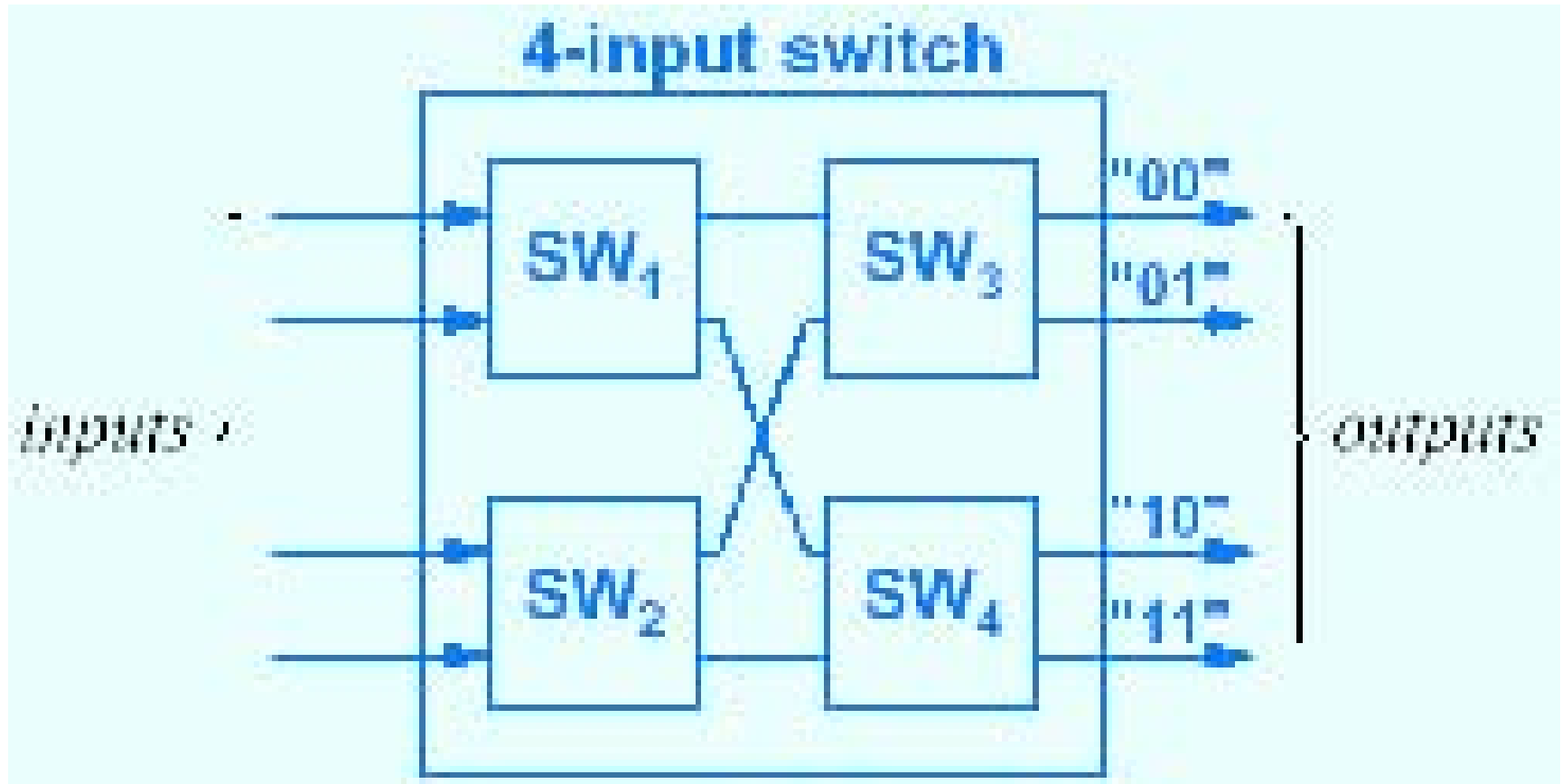
# Banyan Fabric

- ▶ Scalable
- ▶ Self routing
- ▶ Internal packet queues allowed (not required)

# Banyan Fabric



# 4-Input Banyan Fabric



# 8-Input Banyan Fabric

