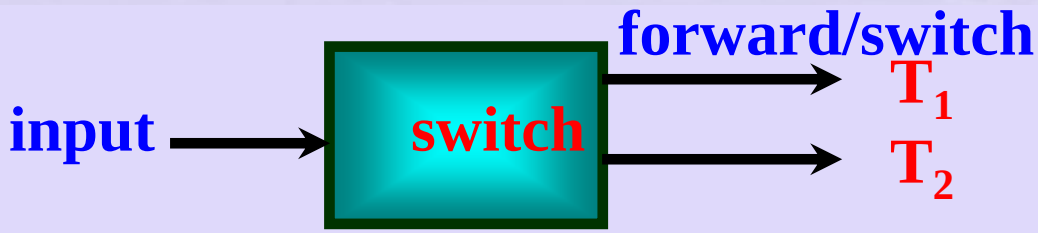
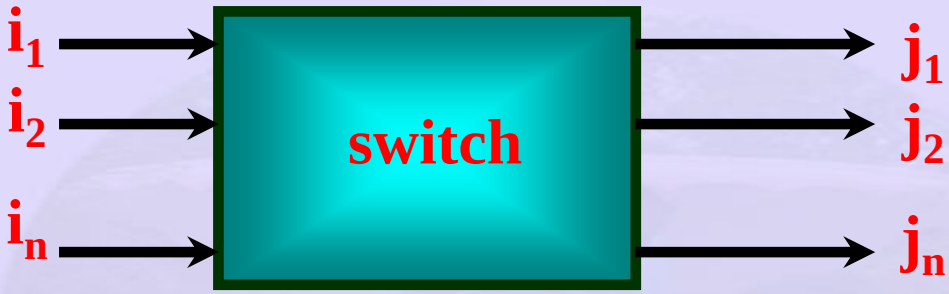
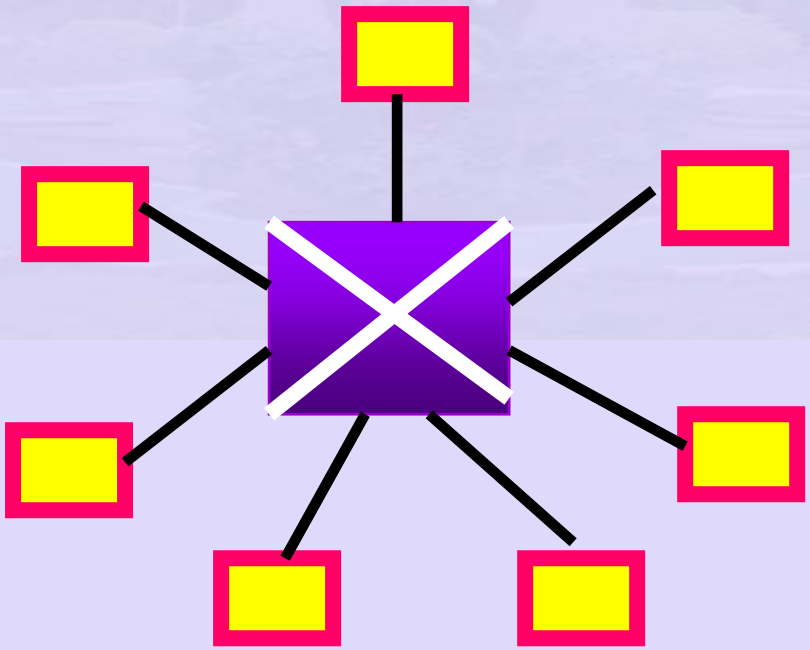
Packet Switching

- Not all nodes connected to each other
- Need Switches
  - Packet Switches
    - Enable packets to go from one host to another that is not directly connected



Switch: Multi-input Multi-output





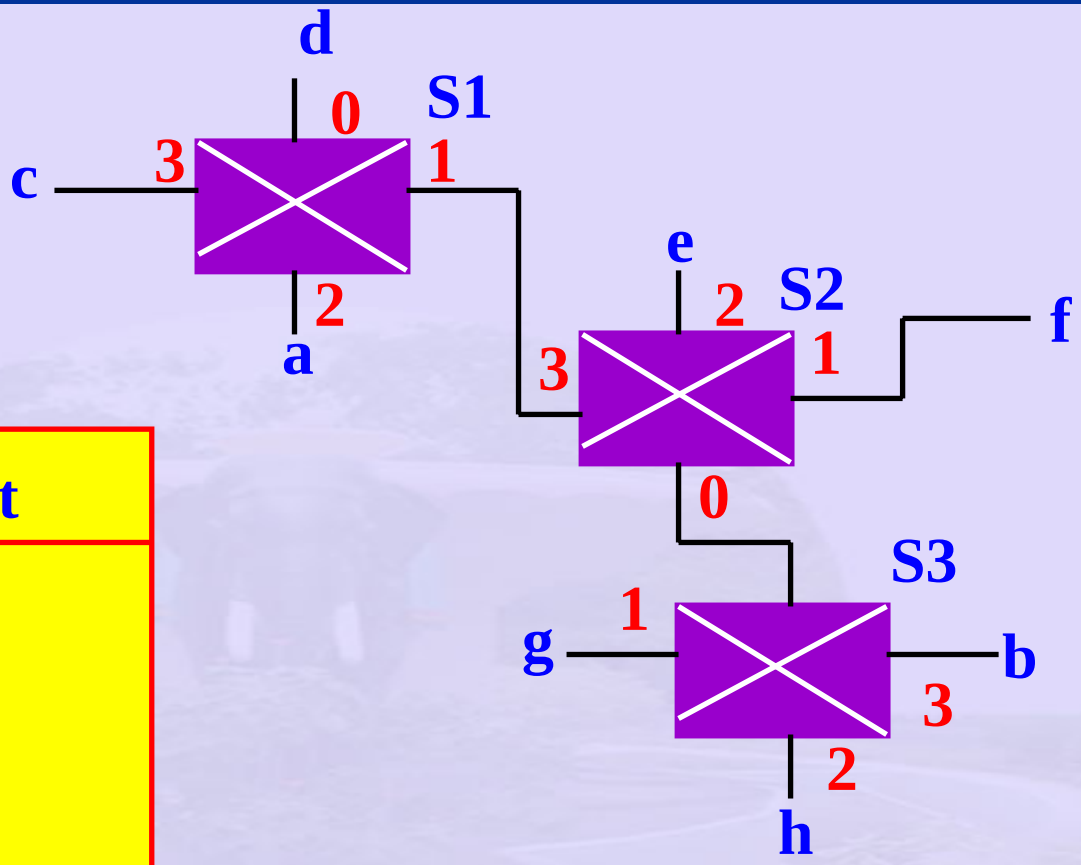
Switches: Functions

- Receive incoming packets on incoming ports
- Forward on to outgoing ports
- Not forward all traffic
- Switch must have aggregate capacity
- Help build large networks

Switches: Functions

- Switching
  - Connectionless (datagram)
    - Using destination address in packet consult forwarding table to decide how to forward packet
  - Connection oriented (virtual circuit)
    - First establish a circuit from source to destination
    - Then forward packets on this circuit

Table lookup for switching



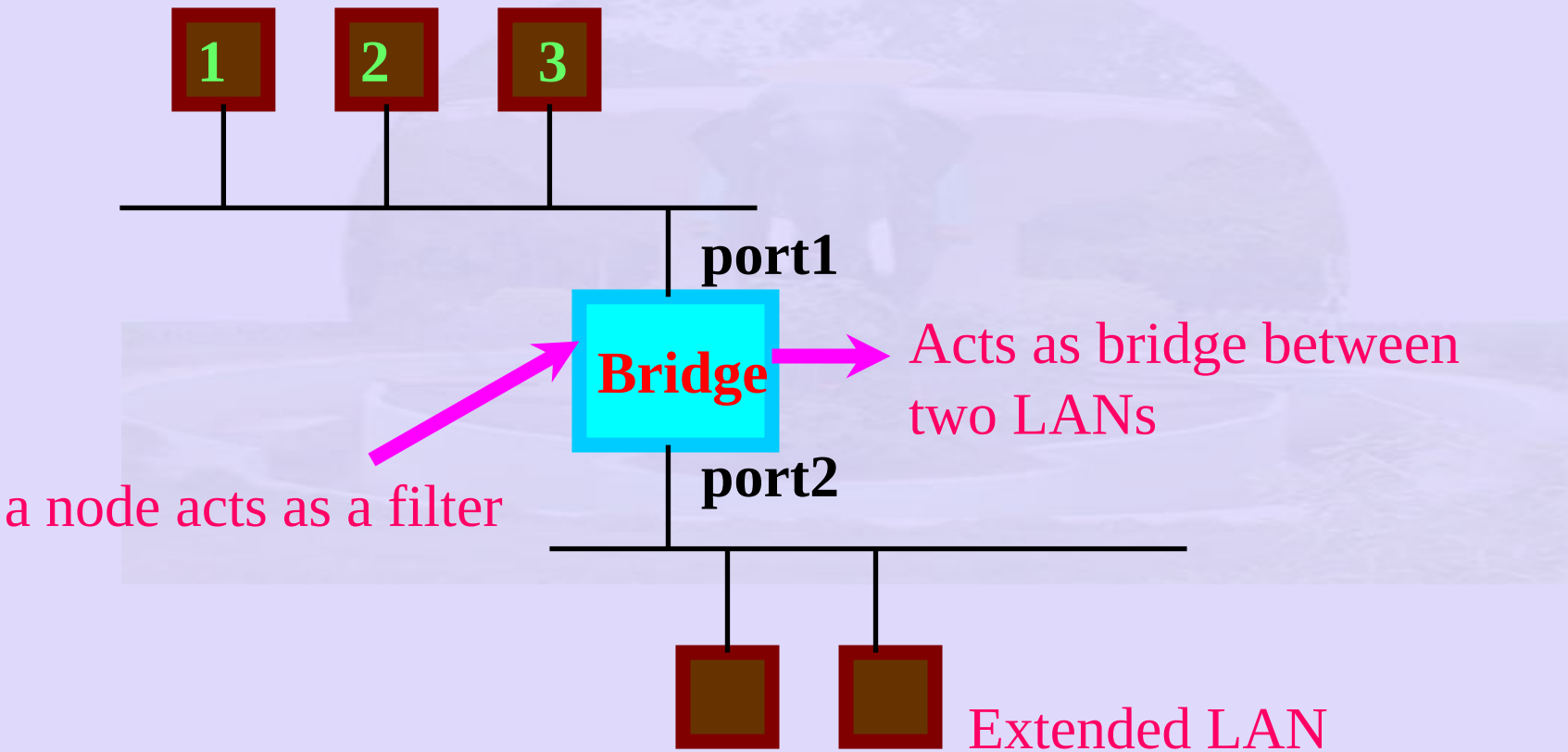
Switch 2

Destination	Port
a	3
b	0
c	3
d	3
e	2
f	1
g	0
h	0

Easy when entire map of network is Available

Configured at the time of network setup

Bridges and LAN Switches

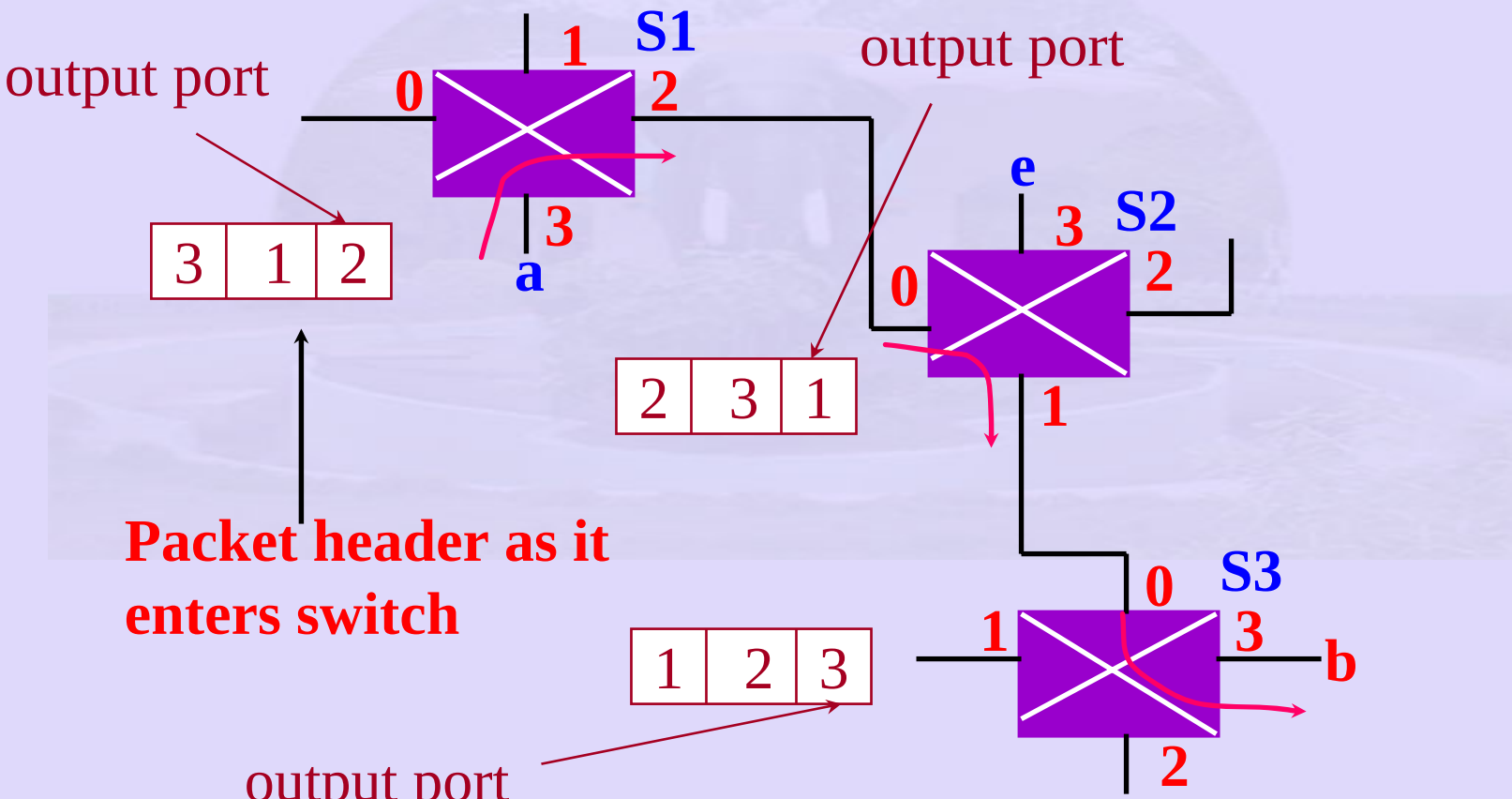


- **Bridge is also a switch**

Source Routing Bridges

- Sender knows the location of destination address
  - LAN number, Bridge number
  - Example:
  - H11 on LAN1 wants to talk to H21 on LAN3
  - Route packets LAN1, B3, LAN2, B4
  - Each LAN has a unique number and each bridge on a LAN has a unique number

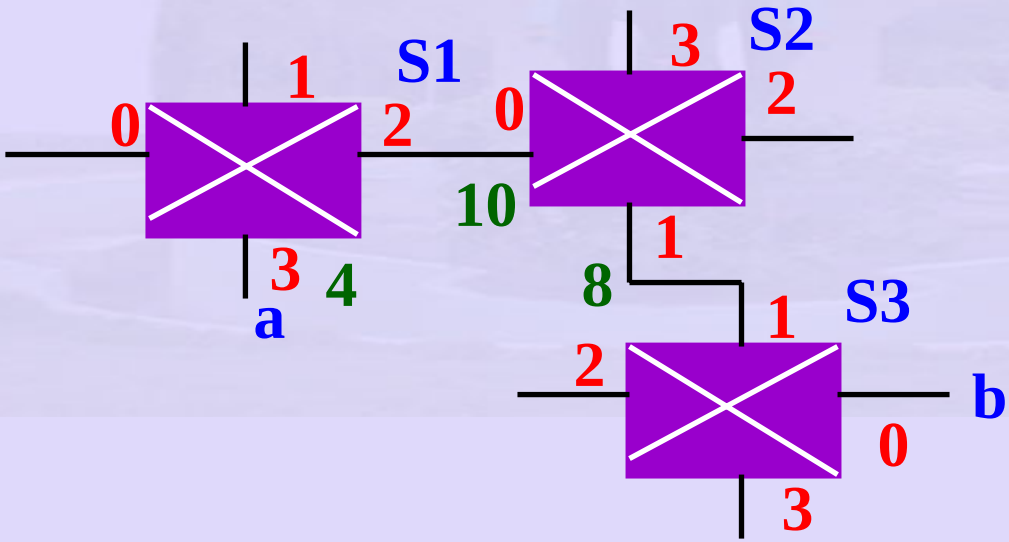
Source Routing



Entire route from source to destination in packet header

Virtual Circuit Switching

- host a wants to communicate with b



VC Tables

- An incoming interface
- An incoming virtual circuit identifier (VCI) for incoming packet
- An outgoing interface
- An outgoing virtual circuit identifier (VCI) for outgoing packet
- New Connection
  - Assign VCI not in table
  - Incoming VCI and outgoing VCI not globally unique

Setting up VCs

- Dynamic setting up of VC
  - Setup message all the way from a to b and back
    - Choose unused VCI 4 a to S1
    - Choose VCI 10 from S1 to S2
    - Choose VCI 6 from S2 to S3
    - Choose VCI 4 from S3 to b
    - When connection not required – tear down connection, free VCI, switches updated
- Other VCs
  - Permanent – set by network administration
  - Temporary – setup for duration of connection

VC Tables

- VC Tables setup before data transmission

VC Table S1:

In IF	In VCI	Out IF	Out VCI
3	4	2	10

VC Table S2:

In IF	In VCI	Out IF	Out VCI
0	10	1	8

VC Table S3:

In IF	In VCI	Out IF	Out VCI
1	8	0	5

VC Switching Issues

- Delays due to circuit setup
- Connection request full destination address
- Switch or link failure
  - New one has to be established again
- Route known before data being sent
- Requires flow control

VC Switching Advantages

- QoS guarantees
- Switches set aside resources
- Generally queues do not build up
  - Since traffic is delay sensitive
- Examples: X.25, Frame Relay (VPN), ATM