

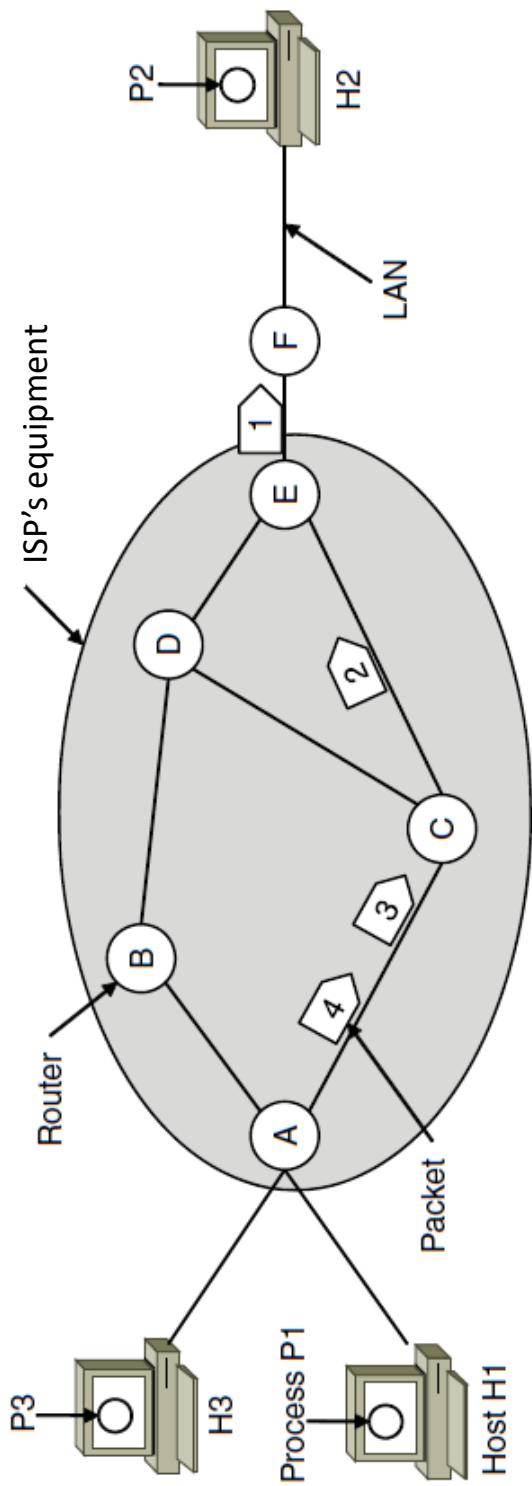
Network Layer: Forwarding

Routing Data models

- Virtual circuits
 - Connection oriented
 - Reservation-based
- Packet-switched
 - Store and Forward
 - Routers receive complete packet and forward it
 - Statistical multiplexing to share bandwidth over time

Connection-Oriented – Virtual Circuits

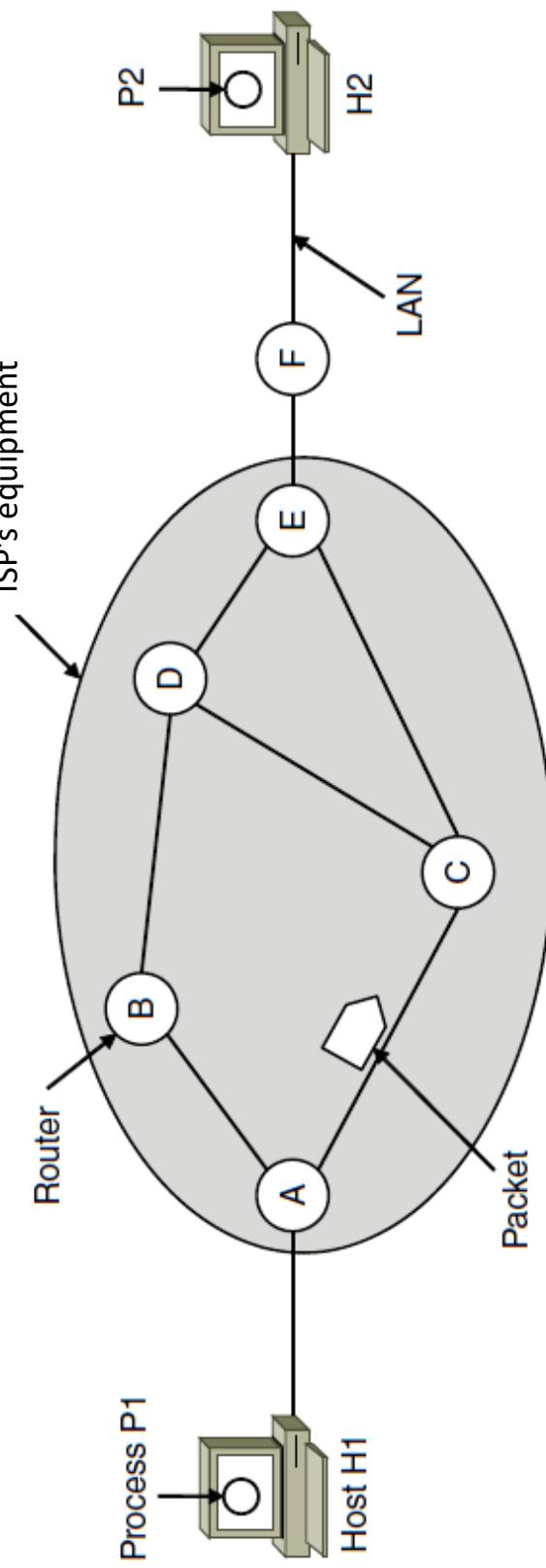
- Packet is forwarded along the circuit using tag
 - Virtual circuit (VC) is set up ahead of time



Store-and-Forward Packet Switching

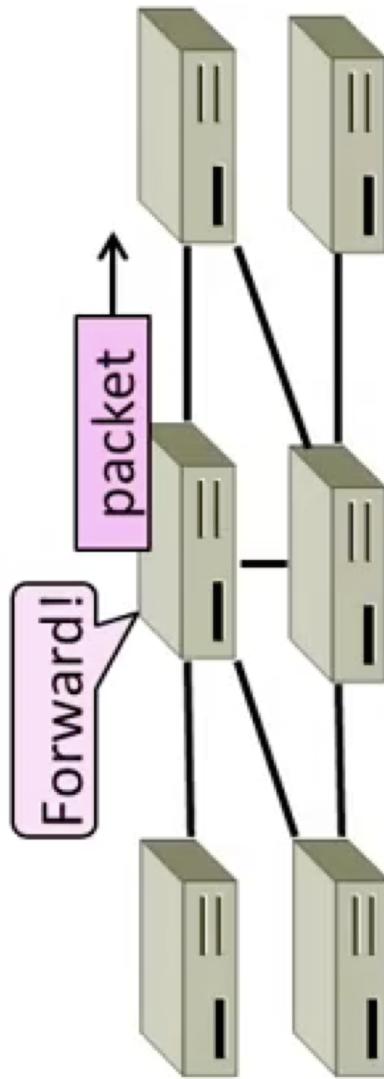
Best effort, packet has no history or state

This is used in the Internet today



First: Forwarding/Switching

- Process of sending a packet on its way.
- Lookup a routing table to forward packets.



Forwarding using a routing table

Routing Table in Router A	
Destination	Next Hop
A	-
B	B
C	C
D	B
E	C
F	B
G	B
H	B
K	B

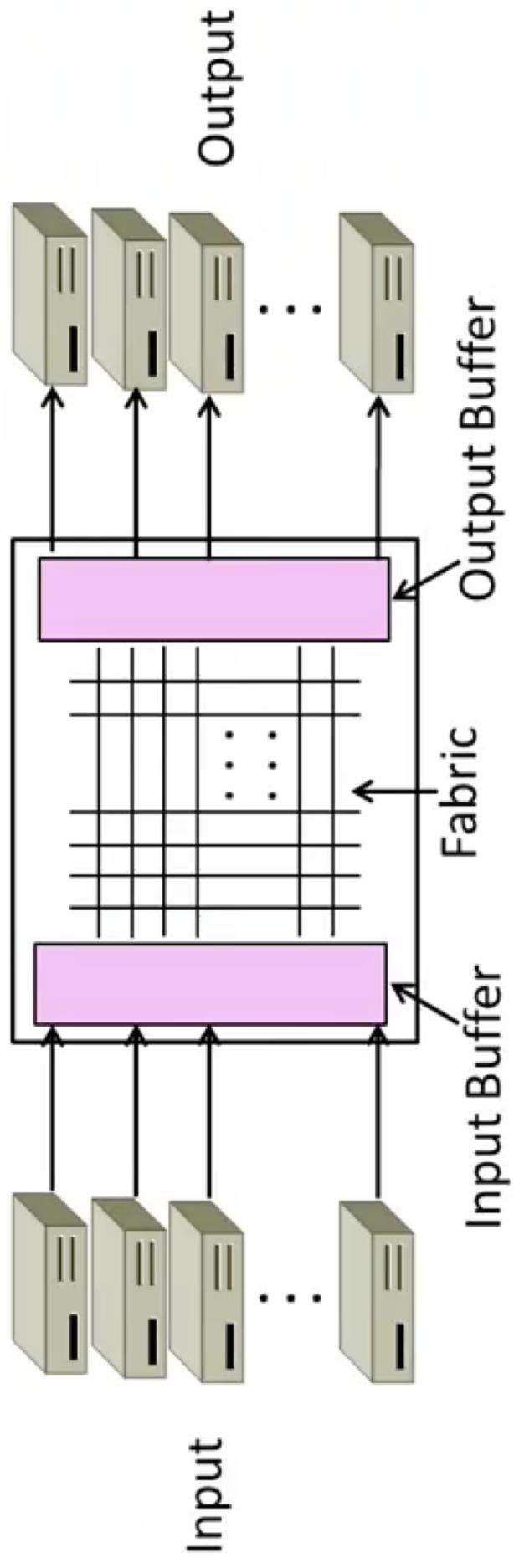
A, B, C etc are routers

In reality a routing table looks more like this.

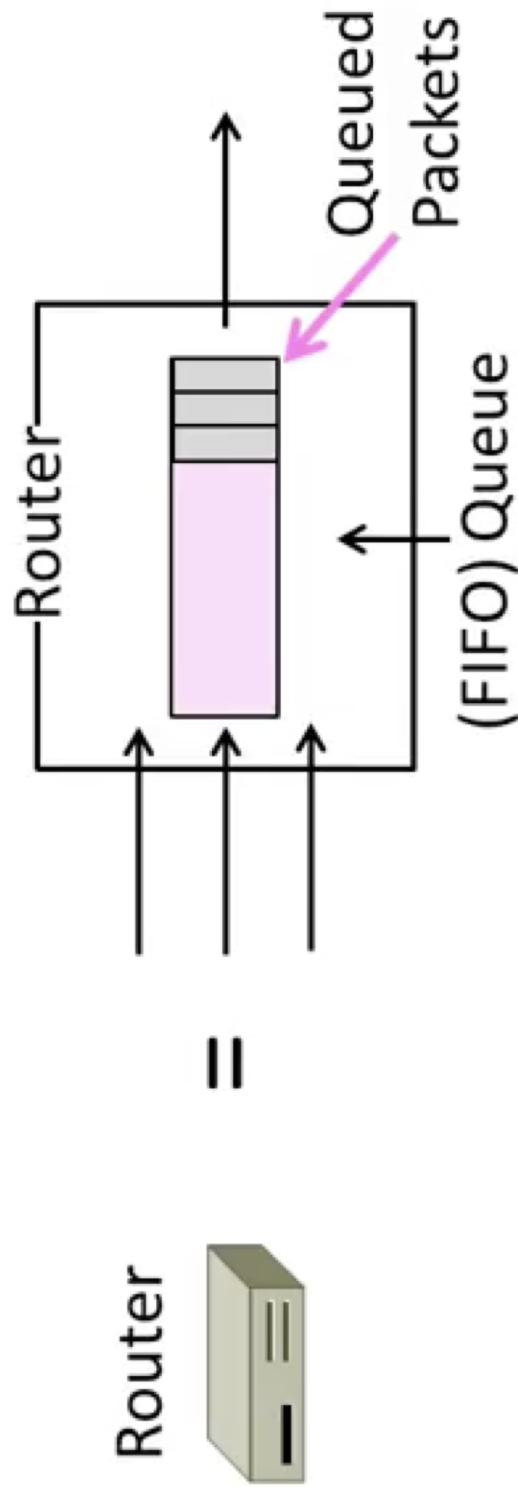
```
192.168.0.0/24 is variably subnetted, 6 subnets, 3 masks
C   192.168.0.0/25 is directly connected, GigabitEthernet2/0
C   192.168.0.236/30 is directly connected, GigabitEthernet1/0
C   192.168.0.224/30 is directly connected, FastEthernet0/0
S   192.168.0.192/27 is directly connected, GigabitEthernet1/0
S   192.168.0.160/27 is directly connected, FastEthernet0/0
S   192.168.0.128/27 is directly connected, FastEthernet0/0
R1#
```

Forwarding fabric: Several input and output ports

- Each port is a different network address.



Simplified router representation



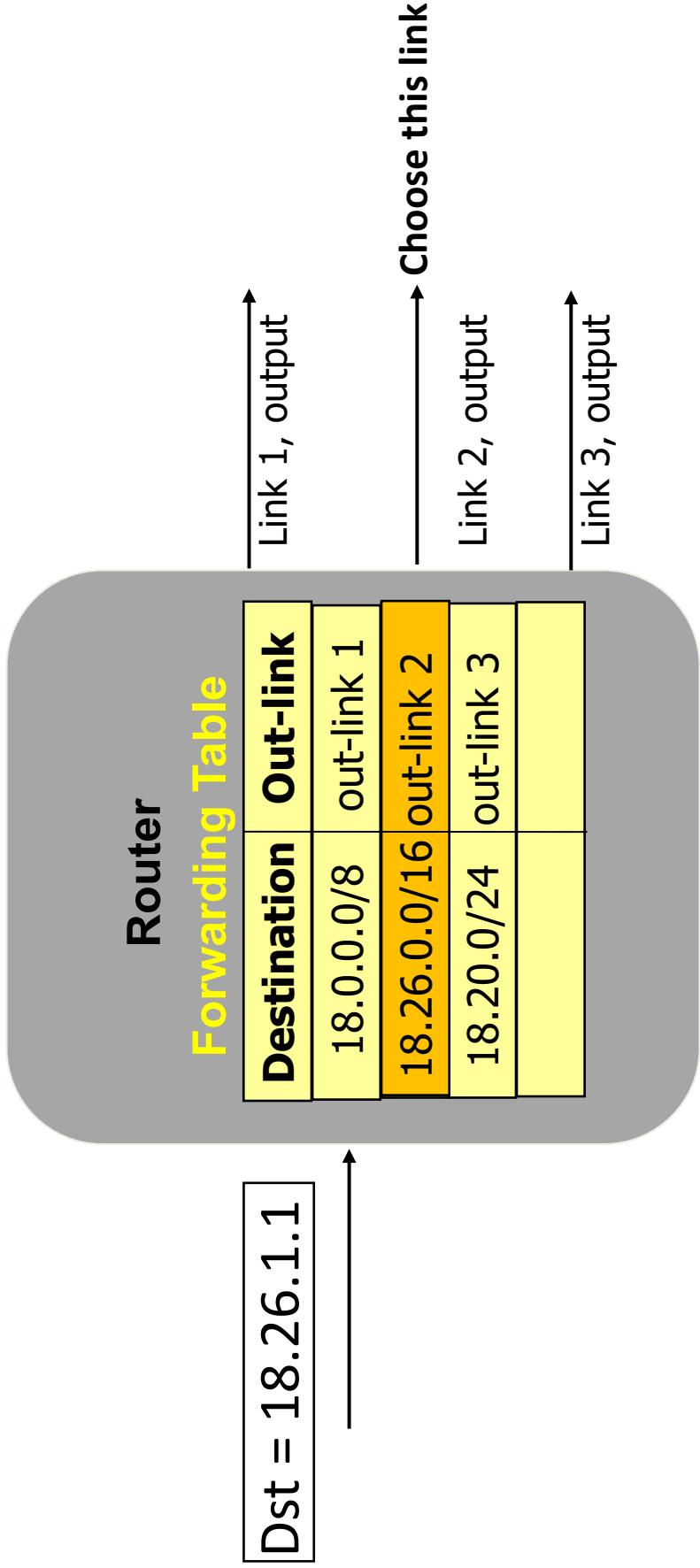
- Forwarding is done using a routing table.
- Forwarding is literally a “no brainer”
- Modern routers use special hardware (TCAM) for efficient forwarding

Forwarding process

- A frame enters the one of router's input interface
 - If packet is corrupted, throw it out
 - Router reads the destination IP
 - If packet is meant for the local router, then strip the network header and pass the packet to higher layer.
 - Otherwise, if packet destination is not on the local router, packet is routed. If the packet TTL, written in the header, is greater than 1, packet routing proceeds
 - If ok, router looks at his own routing table for **most specific prefix match** for destination IP.

Longest Prefix Match

A Router forwards a packet according to the entry in the **forwarding table** that has the longest matching prefix



TCAM with addressing

- Ternary Content Addressable memory
 - Can address “0”, “1”, and “X”
- Uses associative memory to return data.
 - Match for network address, add “X” (don’t care bits) for host address
- Heavily uses parallelization

TCAM in operation

