CS144
An Introduction to Computer Networks

Packet Switching

How a packet switch works (1)

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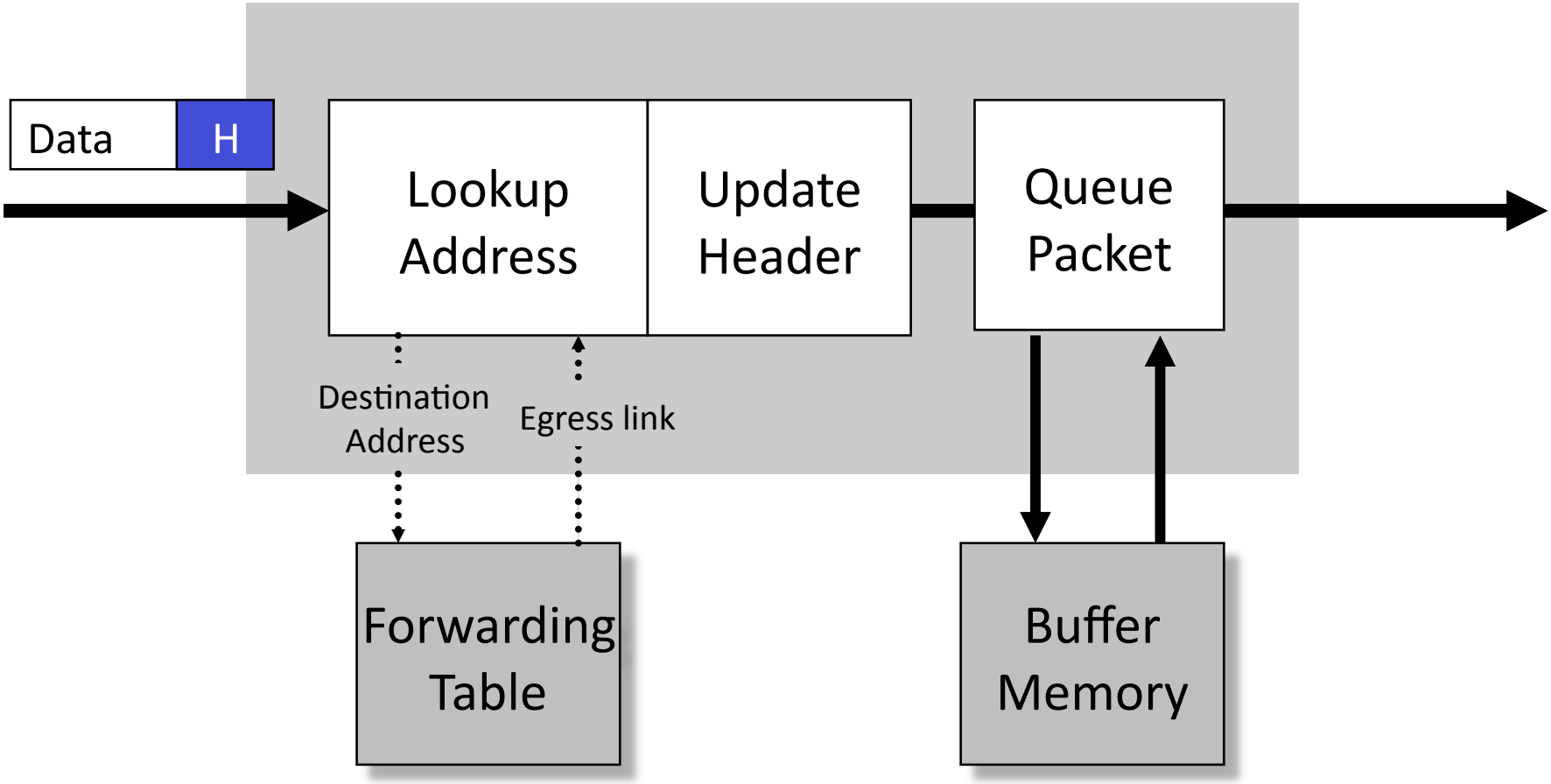
Outline

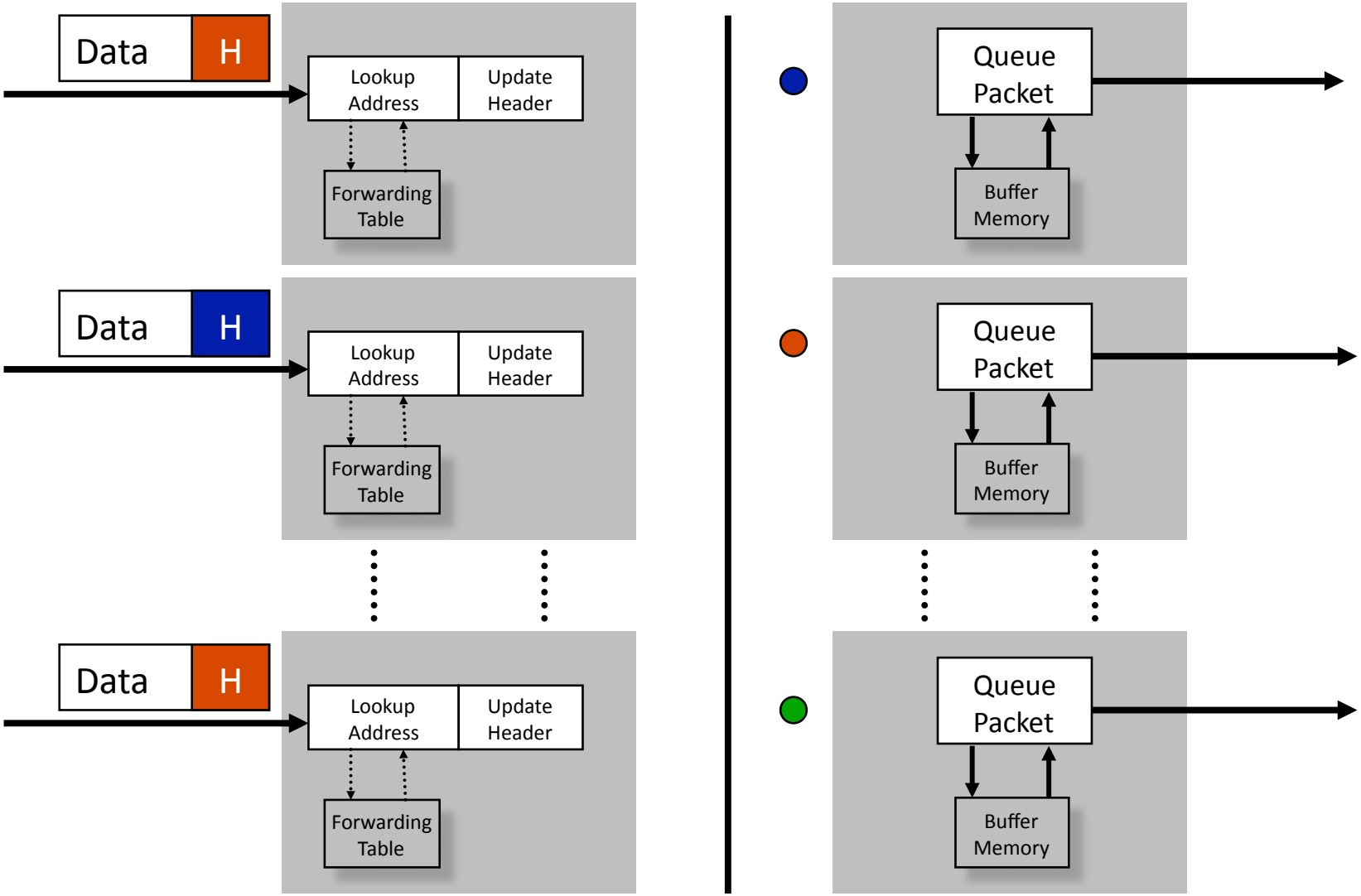
1. What does a packet switch look like?

2. What does a packet switch do?
   - Ethernet switch
   - Internet router
3. How address lookup works
   - Ethernet switch
   - Internet router

Generic Packet Switch



Generic Packet Switch



Ethernet Switch

1. Examine the header of each arriving frame.
2. If the Ethernet DA is in the forwarding table, forward the frame to the correct output port(s).
3. If the Ethernet DA is not in the table, broadcast the frame to all ports (except the one through which the frame arrived).
4. Entries in the table are learned by examining the Ethernet SA of arriving packets.

Internet Router

1. If the Ethernet DA of the arriving frame belongs to the router, accept the frame. Else drop it.
2. Examine the IP version number and length of the datagram.
3. Decrement the TTL, update the IP header checksum.
4. Check to see if TTL == 0.
5. If the IP DA is in the forwarding table, forward to the correct egress port(s) for the next hop.
6. Find the Ethernet DA for the next hop router.
7. Create a new Ethernet frame and send it.

Basic Operations

1. Lookup Address: How is the address looked up in the forwarding table?
2. Switching: How is the packet sent to the correct output port?

Lookup Address: Ethernet

Ethernet addresses (in a switch)

Match	Action
Ethernet DA = 0xA8B72340E678	Forward to port 7
Ethernet DA = 0xB3D22571053B	Forward to port 3
…	…

Methods

- Store addresses in hash table (maybe 2-way hash)
- Look for exact match in hash table

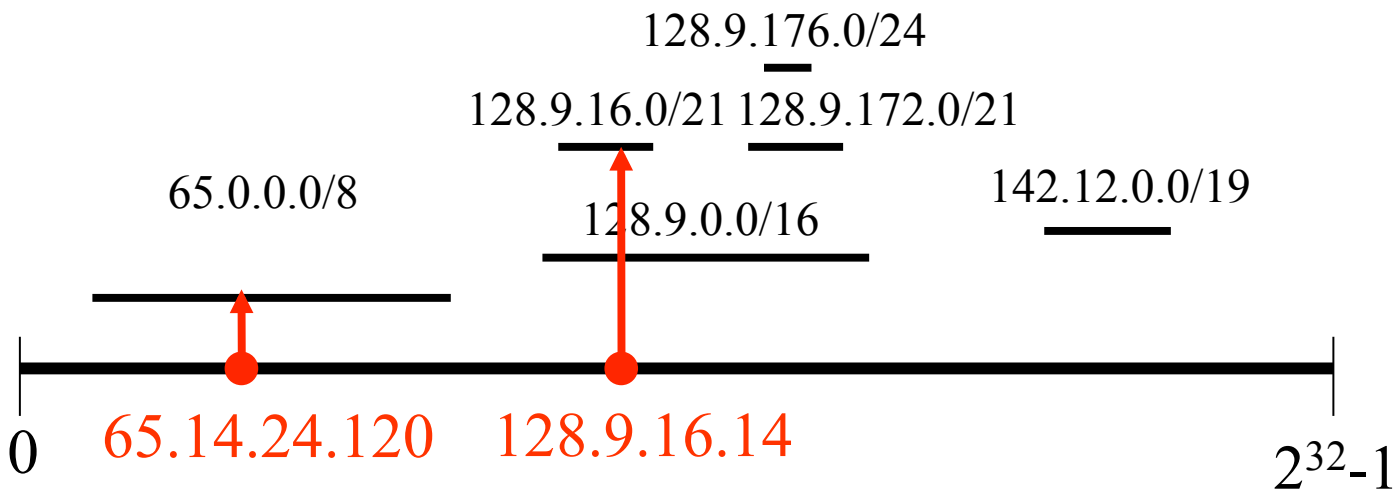
Lookup Address: IP

IP addresses (in a router)

Match	Action
IP DA = 127.43.57.99	Forward to 56.99.32.16
IP DA = 123.66.44.X	Forward to 22.45.21.126
IP DA = 76.9.X.X	Forward to 56.99.32.16
…	…

Lookup is a longest prefix match, not an exact match

Longest prefix match

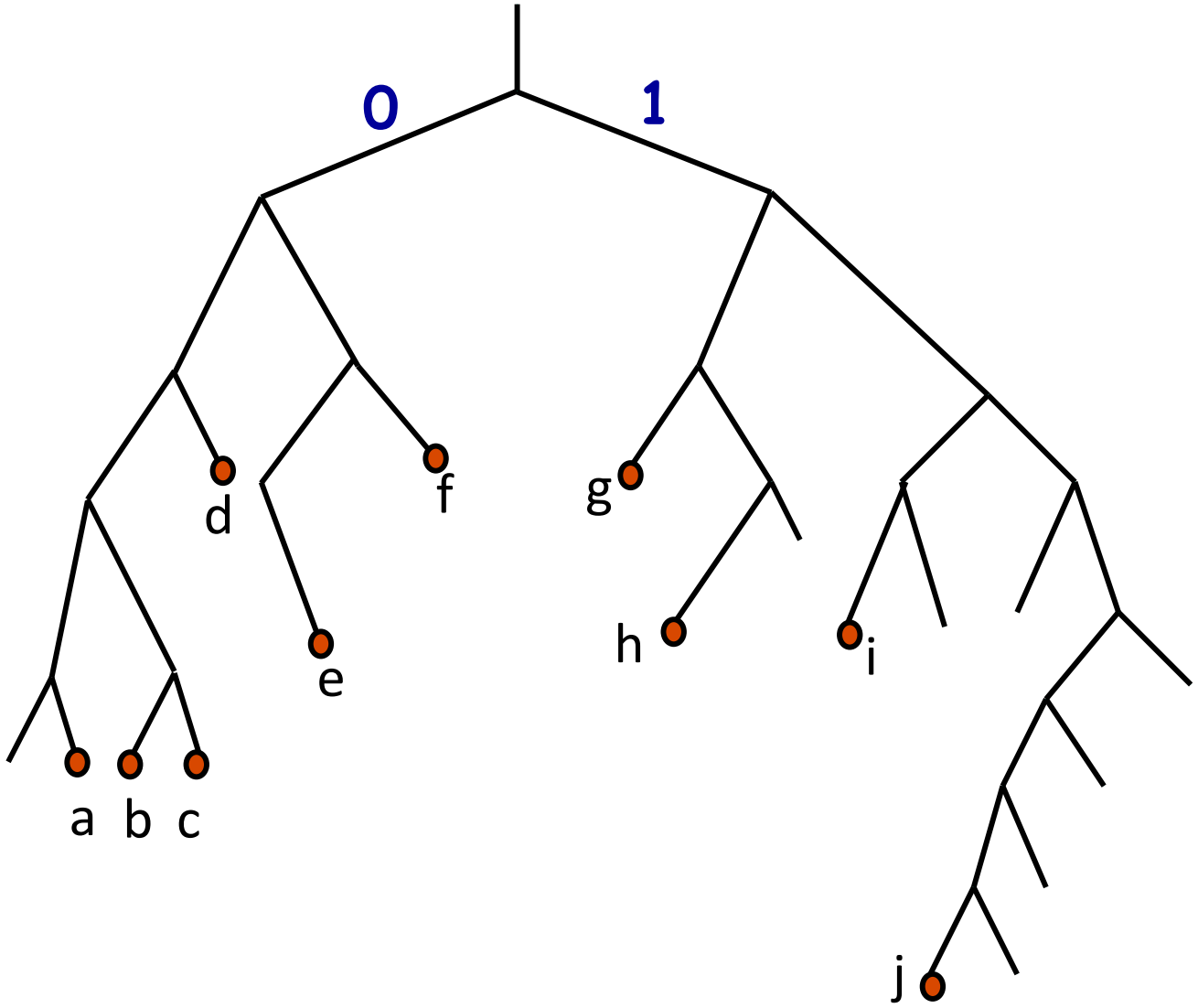


Routing lookup: Find the longest matching prefix (aka the most specific route) among all prefixes that match the destination address.

Longest prefix match lookup

Binary tries

Entry	Prefix
a	00001
b	00010
c	00011
d	001
e	0101
f	011
g	100
h	1010
i	1100
j	11110000

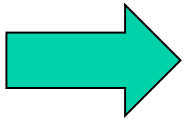


Longest prefix match lookup

Ternary Content Addressable Memory (TCAM)

Entry	Prefix
a	00001
b	00010
c	00011
d	001
e	0101
f	011
g	100
h	1010
i	1100
j	11110000

Binary value
+ Mask



Entry	Prefix
a	00001XXX 11111000
b	00010XXX 11111000
c	00011XXX 11111000
d	001XXXXX 11100000
e	0101XXXX 11110000
…	…
j	11110000 11111111

Routing lookup: Compare address against every masked entry at the same time.

Lookup Address: Generic

Generic or abstract lookups: <Match, Action>

Match	Action
IP DA = X	Forward to port 7
Eth DA = Y AND IP DA = Z	Drop packet

Generalization of lookups and forwarding action in switches, routers, firewalls, etc.

Summary

Packet switches perform two basic operations:

- Lookup addresses in a forwarding table
- Switching to the correct egress port

At a high level, Ethernet switches and Internet routers perform similar operations

Address lookup is very different in switches and routers.