Chapter 4 – Knowledge checks

THE NETWORK LAYER

- **Where is the network layer implemented?**
  - The network layer is implemented in hosts at the **networks edge.**
  - The network layer is implemented in routers in the **networks core**.

- **Which of the following travel actions below correspond to forwarding?**
  - A car takes the 3rd exit from a roundabout.
  - A car waits at a light and then turns left at the intersection
  - A car stops at an intersection to “gas-up” and take a “bathroom break”

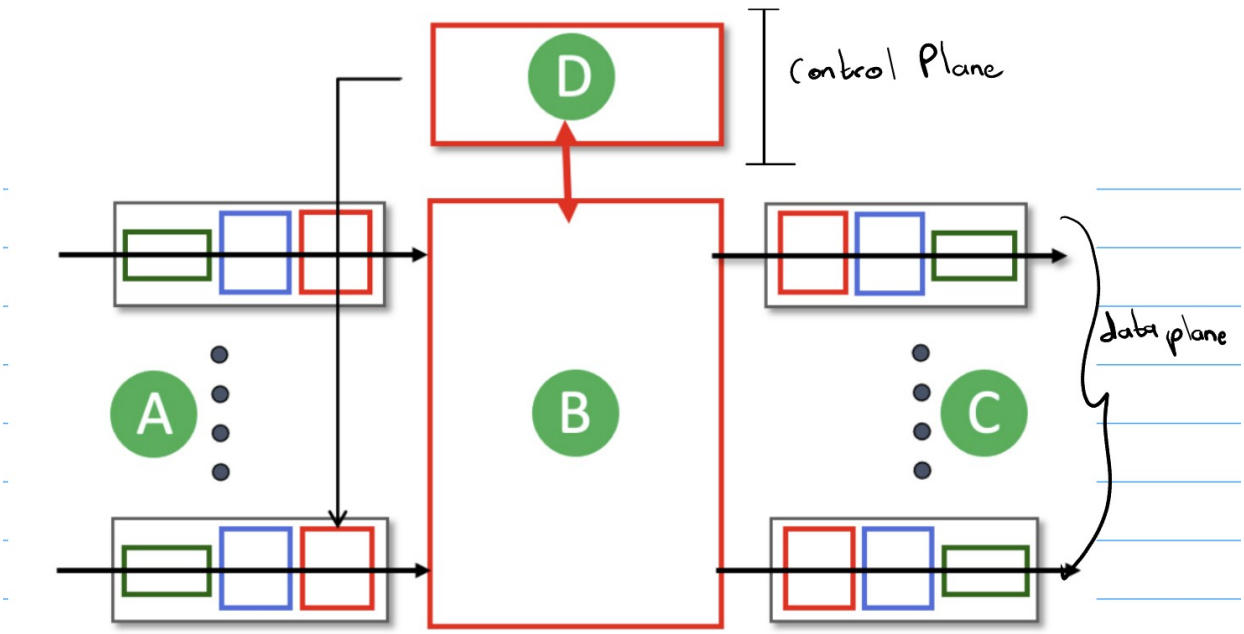
- **Actions that are primarily in the in the network-layer plane?**
  - Looking up address bits in an arriving data-gram header in the forwarding table.
  - Dropping a data-gram due to a congested (full) output buffer.
  - Moving an arriving data-gram from a router’s input port to the output port.

- **Which of the following actions occur in a per-router control-plane approach?**
  - A router exchanges messages with another router, indicating the cost for it (the sending router) to reach a destination host.
  - Routers send information about their incoming and outgoing links to other routers in the networks.

- **Which of the following quality-of-service guarantees are part of the Internet’s best-effort service model?**
  - None of the other services listed here are part of the best-effort service model. Evidently, best-effort service really means no guarantees at all!

WHATS INSIDE A ROUTER

-



A = input ports, operating primarily in the data plane.
B = the switching fabric, operating primarily in the data plane.
C = output ports, operating primarily in the data plane.

D = the routing processor, operating primarily in the control plane.

- **Where in a router is the destination IP address looked up in a forwarding table to determine the appropriate output port to which the datagram should be directed?**
  - At the input port where a packet arrives

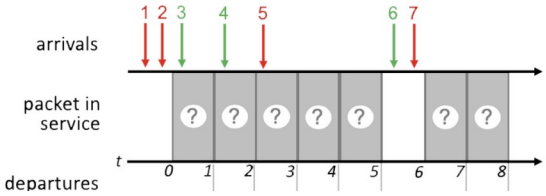
- **Where in a router does "match plus action" happen to determine the appropriate output port to which the arriving datagram should be directed?**
  - At the input port where a packet arrives

- **Suppose a datagram is switched through the switching fabric and arrives to its appropriate output to find that there are no free buffers. In this case:**
  - The packet will either be dropped or another packet will be removed (lost) from the buffer to make room for this packet, depending on policy, but the packet will definitely not be sent back to the input port.

- **What is meant by Head of the Line (HOL) blocking?**
  - A queued data-gram **waiting** (**NB not receiving, it is waiting for service**) for service at the front of the queue prevents other data-grams in queue from moving forward in the queue.

- Consider the pattern of red and green packet arrivals to a router's output port queue, shown below. Suppose each packet takes one time slot to be transmitted, and can only begin transmission at the beginning of a time slot after its arrival. Indicate the sequence of departing packet numbers (at t = 1, 2, 3, 4, 5, 7, 8) under FCFS scheduling. Give your answer as 7 ordered digits (each corresponding to the packet number of a departing packet), with a single space between each digit, and no spaces before the first or after the last digit, e.g., in a form like 7 6 5 4 3 2 1).

  [Note: You can find more examples of problems similar to this here.]



FCFS(first come first serve) – 1 2 3 4 5 6 7

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  Give your answer as 7 ordered digits (each corresponding to the packet number of a departing packet), with a single space between each digit, and no spaces before the first or after the last digit, e.g., in a form like 7 6 5 4 3 2 1).

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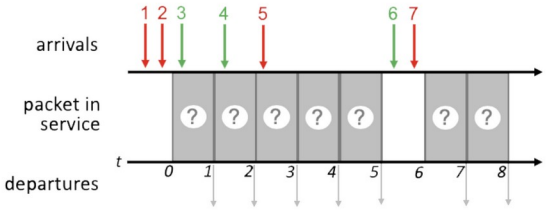

PRIORITY SCHEDULING (red higher priority) – 1 2 3 5 4 7 6

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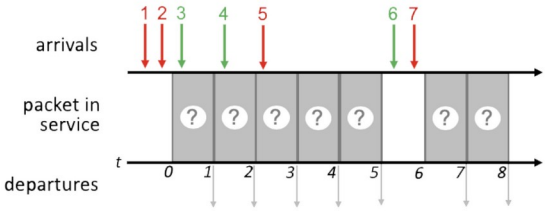

ROUND ROBIN (RED STARTS) - 1 3 2 5 4 6 7

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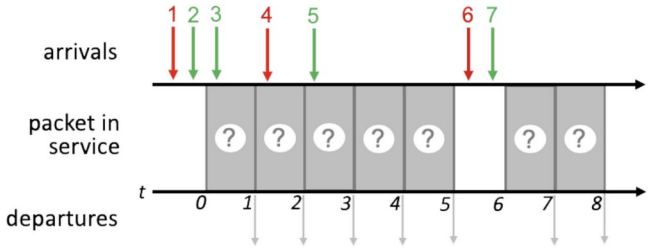

FCFS – 1 2 3 4 5 6 7

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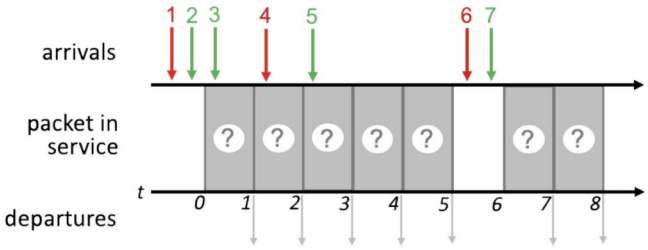

PRIORITY SCHEDULING - 1 2 4 3 5 6 7

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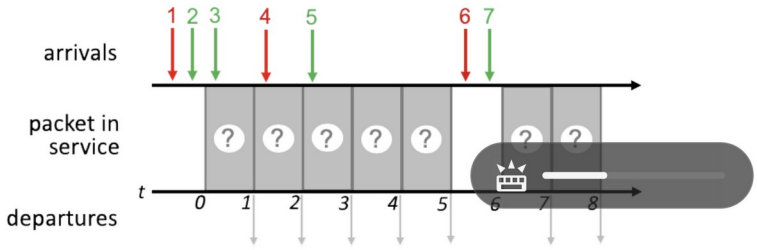


ROUND ROBIN - 1 2 4 3 5 6 7

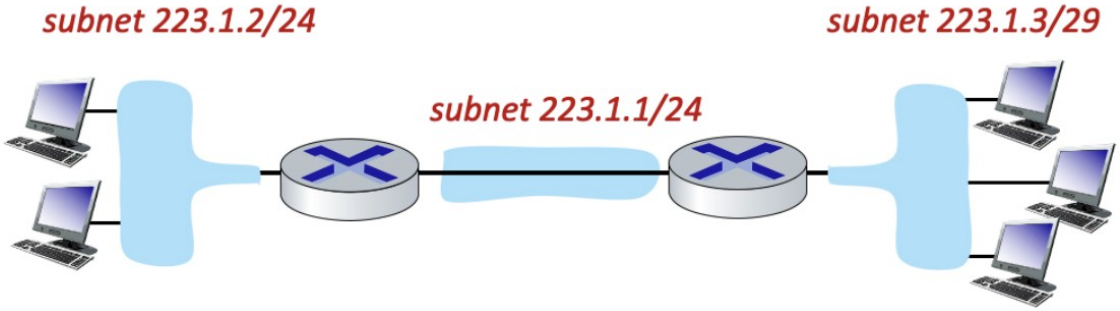
WHAT IS THE INTERNET PROTOCOL

- **What are the principal components of the IPv4 protocol (check all that apply)?**
  - IPv4 data-gram format
  - IPv4 addressing conventions
  - Packet handling conventions at routers (e.g. segmentation/reassembly)

- **Which of the following statements is true regarding an IP address?**
  - If a host has more than one interface, then it has more than one IP address at which it can be reached.
  - An IP address is associated with an interface
  - If a router has more than one interface, then it has more than one IP address at which it can be reached.

- **What is meant by IP subnet?**
  - A set of device interfaces that can physically reach each other without passing through an intervening router.
  - A set of devices that have a common set of leading high order bits in their IP address.

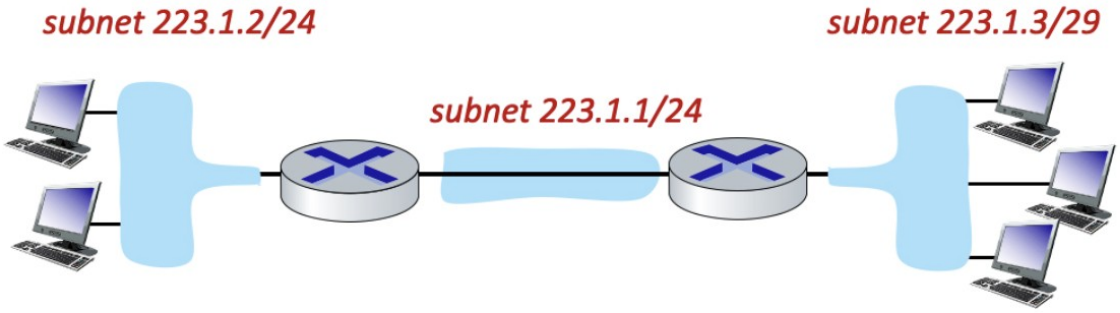
- Consider the three subnets in the diagram below.



What is the maximum # of interfaces in the 223.1.2/24 network?

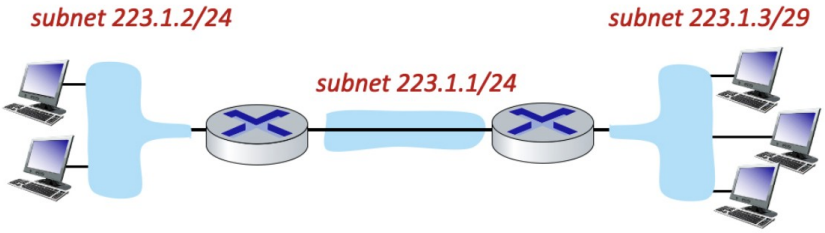
The notation "223.1.2/24" represents an IP address with a network prefix length of 24 bits. This means that the first 24 bits of the IP address are dedicated to the network, and the remaining 8 bits are available for addressing individual devices within that network. In a network with a 24-bit prefix length, there are **2^(32-24) = 2^8 = 256** possible addresses.

- Consider the three subnets in the diagram below.



What is the maximum # of interfaces in the 223.1.3/29 network?

32-29=3 → 2^3 = 8

- 

Which of the following addresses can *not* be used by an interface in the 223.1.3/29 network? Check all that apply.

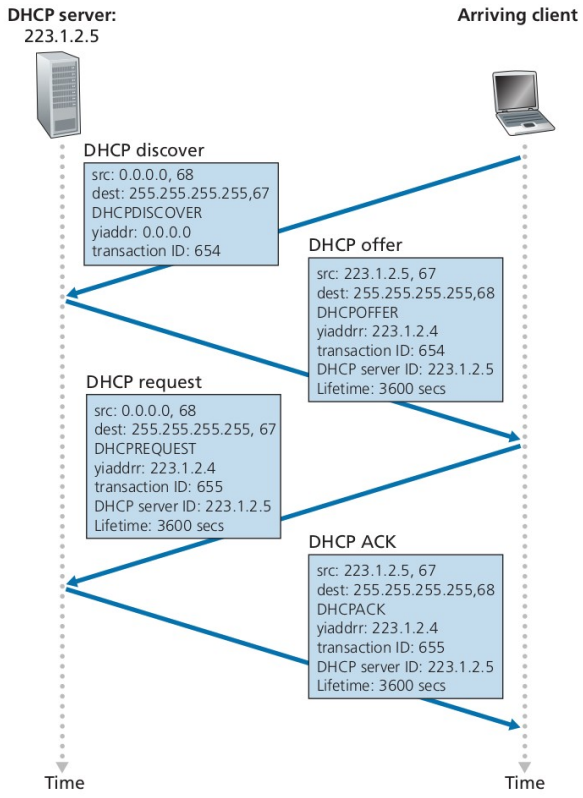
- [ ] 223.1.3.2
- [ ] 223.1.3.6
- [x] 223.1.3.28
- [x] 223.1.2.6
- [x] 223.1.3.16

That's Correct!

Explanation → 32-29 = 3 leaving us with 3 bits for host addresses hence we accept the range of 223.1.3.1 to 223.1.3.6 but 2^3 is 8 but in a subnet with 3 bits for host addresses we subtract 2 for the network address and broadcast address.

- **What is meant by saying that DHCP is a "plug and play" protocol?**
  - No manual configuration is needed for the host to join the network

- **Which of the following statements about a DHCP request message are true (check all that are true).**



  - e 4.24 ♦ DHCP client-server interaction
  - The transaction ID in a DCHP request message will be used to associate this message with future DHCP messages sent from, or to, this client.
  - A DHCP request message **may** contain the IP address that the client will use.
  - A DHCP request message is sent broadcast, using the 255.255.255.255 IP address

- **Which of the following fields occur ONLY in the IPv6 datagram header (i.e., appear in the IPv6 header but not in the IPv4 header)?**
  - 128-bit source and destination IP addresses
  - The flow label field

- **What is the purpose of the Dynamic Host Configuration Protocol?**
  - To obtain an IP address for a host attaching to an IP network.

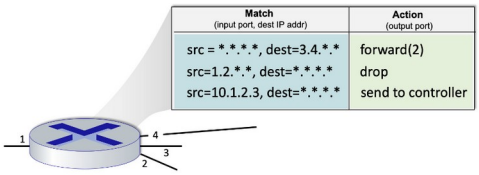
GENERALIZED FORWARDING

- **Destination-based forwarding, which we studied in section 4.2, is a specific instance of match+action and generalized forwarding. Select the phrase below which best completes the following sentence: "In destination-based forwarding, ..."**
  - ... after **matching** on the **destination IP** address in the datagram header, the action taken is to **forward** the **datagram** to the **output port** associated with that **destination IP address**.

- **Which of the following match+actions can be taken in the generalized OpenFlow 1.0 match+action paradigm that we studied in Section 4.4? Check all that apply.**
  - ... after matching on the port number in the segment's header, the action taken is to decide whether or not to drop that datagram containing that segment.
  - ... after matching on the destination IP address in the datagram header, the action taken is to decide whether or not to drop that datagram.
  - ... after matching on the port number in the segment's header, the action taken is to forward the datagram to the output port associated with that destination IP address.
  - ... after matching on the 48-bit link-layer destination MAC address, the action taken is to forward the datagram to the output port associated with that link-layer address.
  - ... after matching on the source and destination IP address in the datagram header, the action taken is to forward the datagram to the output port associated with that source and destination IP address pair.
  - ... after matching on the destination IP address in the datagram header, the action taken is to forward the datagram to the output port associated with that destination IP address.
  - ***IF HE TAKES THIS FROM THE SITE (GIVES US 7 OPTIONS) THE ANSWER IS ALL OF THEM EXCEPT THE ONE WHICH HAS MATCHING OF URL CONTAINED IN AN HTTP GET REQUEST***

- **Which of the following fields in the frame/datagram/segment/application-layer message can be matched in OpenFlow 1.0?**
  - IP type-of-service field
  - IP destination address
  - Source and/or destination port number
  - IP source address
  - Upper layer protocol field

- Consider the figure below that shows the generalized forwarding table in a router. Recall that a * represents a wildcard value. Now consider an arriving datagram with the IP source and destination address fields indicated below. For each source/destination IP address pair, indicate which rule is matched. Note: assume that a rule that is earlier in the table takes priority over a rule that is later in the table and that a datagram that matches none of the table entries is dropped.



QUESTION LIST:

Source: 1.2.56.32 Destination:128.116.40.186

D

Source: 65.92.15.27 Destination: 3.4.65.76

C

Source: 10.1.2.3 Destination: 7.8.9.2

B

Source: 10.1.34.56 Destination: 54.72.29.90

A

ANSWER LIST:

A. No match to any rule.

B. Rule 3, with action *send to controller*

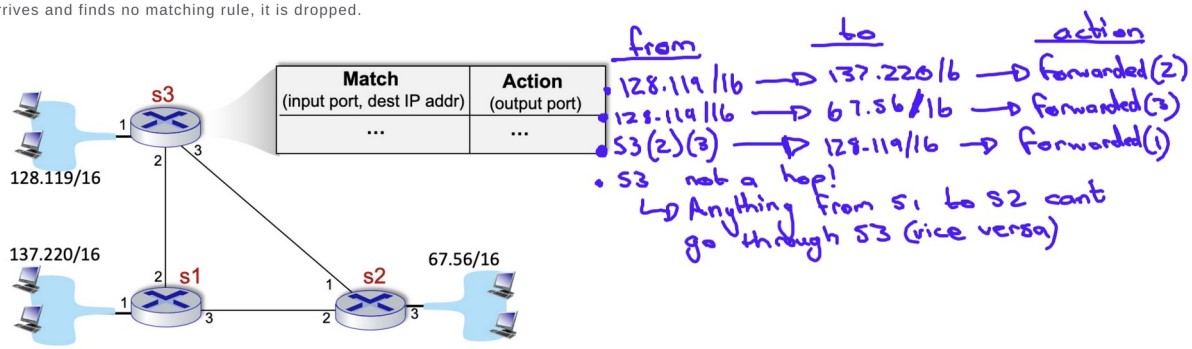
C. Rule 1, with action *forward(2)*

D. Rule 2, with action *drop*

- Consider the network below. We want to specify the match+action rules at s3 so that only the following network-wide behavior is allowed:

  1. traffic from 128.119/16 and destined to 137.220/16 is forwarded on the direct link from s3 to s1;
  2. traffic from 128.119/16 and destined to 67.56/16 is forwarded on the direct link from s3 to s2;
  3. incoming traffic via port 2 or 3, and destined to 128.119/16 is forwarded to 128.119/16 via local port 1.
  4. No other forwarding should be allowed. In particular s3 should not forward traffic arriving from 137.220/16 and destined for 67.56/16 and vice versa.

  From the list of match+action rules below, select the rules to include in s3's flow table to implement this forwarding behavior. Assume that if a packet arrives and finds no matching rule, it is dropped.

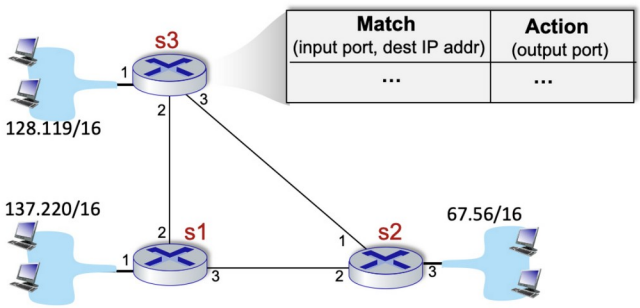


- [x] Input port: 3; Dest: 128.119/16 Action: forward(1)
- [x] Input port: 2; Dest: 128.119/16 Action: forward(1)
- [ ] Input port: 3; Dest: 137.220/16 Action: forward(2)
- [ ] Input port:1 ; Dest: 137.220/16 Action: forward(3)
- [ ] Input port: 2; Dest: 67.56/16 Action: forward(3)
- [ ] Input port: 1; Dest: 67.56/16 Action: forward(2)
- [x] Input port:1 ; Dest: 137.220/16 Action: forward(2)
- [x] Input port: 1; Dest: 67.56/16 Action: forward(3)

That's Correct!

- Consider the network below. We want to specify the match+action rules *at s3* so that s3 *acts only as a relay* for traffic between 137.220/16 and 67.56/16. In particular s3 should not accept/forward and traffic to/from 128.119/16.

  From the list of match+action rules below, select the rules to include in s3's flow table to implement this forwarding behavior. Assume that if a packet arrives and finds no matching rule, it is dropped.



ITS A RELAY!

- [ ] Input port: 1; Dest: 67.56/16 Action: forward(3)
- [ ] Input port:1 ; Dest: 137.220/16 Action: forward(2)
- [ ] Input port:1 ; Dest: 137.220/16 Action: forward(3)
- [ ] Input port: 2; Dest: 128.119/16 Action: forward(1)
- [x] Input port: 2; Dest: 67.56/16 Action: forward(3)
- [x] Input port: 3; Dest: 137.220/16 Action: forward(2)
- [ ] Input port: 3; Dest: 128.119/16 Action: forward(1)
- [ ] Input port: 1; Dest: 67.56/16 Action: forward(2)

- **What is meant by generalized forwarding (as opposed to destination-based forwarding) in a router or switch?**
  - Any of several actions (including drop (block), forward to a given interface, or duplicate-and-forward) can be made based on the contents of one or more packet header fields.

MIDDLE-BOXES AND SUMMARY

- **Which of the following network devices can be thought of as a "middle box"? Check all that apply.**
  - Network Address Translation Box
  - HTTP load balancer
  - HTTP cache

- **What protocol (or protocols) constitutes the "thin waist" of the Internet protocol stack? Check all that apply.**
  - IP

- **Which of the statements below are true statements regarding the "end-to-end principle"?**
  - The end-to-end argument advocates placing functionality at the network edge because some functionality cannot be completely and correctly implemented in the network, and so needs to be placed at the edge in any case, making in-network implementation redundant.
  - The end-to-end argument allows that some redundant functionality might be placed both in-network and at the network edge in order to enhance performance

- **What is meant when it is said that the Internet has an “hourglass” architecture? See the picture below if you are unfamiliar with an "hourglass" (ITS A NORMAL HOURGLASS).**
  - The Internet protocol stack has a “thin waist” in the middle, like an hourglass. The Internet Protocol (IP) is the only network-layer protocol in the middle layer of the stack. Every other layer has multiple protocols at that layer.

- **In the US, which of the following services has been regulated by the Federal Communications Commission (FCC) going back into the 20th century?**
  - Telecommunication Services