

## MCS-377 Intra-term Exam 2 Solutions

1. [ 10 Points ] Explain the following two distinctions:
  - (a) Forwarding versus routing
  - (b) Router versus link-layer switch

**Answer:**

Forwarding is the local action a packet switch takes with each packet: moving it from an input to the appropriate output. Routing, on the other hand, is the determination of a path through interconnected packet switches from source to destination. A router is a packet switch operating based on some network-layer header field that indicates the target network; an example would be an IP prefix. A link-layer switch, on the other hand, operates based on a link-layer header field, such as a destination MAC address.

2. [ 8 Points ] Translate between notations as indicated:
  - (a) Express the IP address 10100011 00010100 01100001 00001111 in dotted decimal.
  - (b) Express the IP address 194.79.127.10 in binary.
  - (c) Express the subnet mask 255.255.192.0 in the  $/x$  form (i.e., as a number of prefix bits).
  - (d) Express the subnet mask  $/20$  in dotted decimal form (producing a result akin to 255.255.192.0, but for a different number of prefix bits).

**Answer:**

163.20.97.15, 11000010 01001111 01111111 00001010,  $/18$ , 255.255.240.0

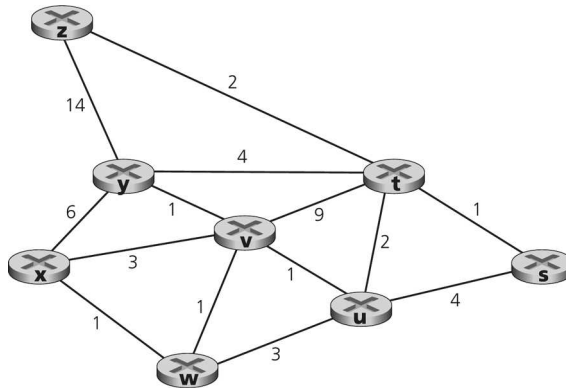
3. [ 8 Points ] An organization has been assigned the prefix 173.215.64.0/ $21$ . It wishes to subdivide this address range, establishing four subnets within the organization. Subnet A must be able to accommodate at least 1000 interfaces, subnet B at least 500, and subnets C and D at least 200 each. What would suitable prefixes, expressed in a.b.c.d/ $x$  form, be for the four subnets?

**Answer:**

The prefixes for A, B, C, and D need to be of sizes  $/22$ ,  $/23$ ,  $/24$ , and  $/24$  respectively. One possibility would be 173.215.68.0/ $22$ , 173.215.66.0/ $23$ , 173.215.65.0/ $24$ , and 173.215.64.0/ $24$ .

4. [ 14 Points ] The following network is the same one you used for problem 4.p21. Once again you are to use Dijkstra's shortest-path algorithm to compute the shortest path to all network nodes, showing your work in a table. However, this time, you are to compute the paths starting

from  $z$ . If you need to break any tie, pick the node that comes earlier in the alphabet.



| step | $N'$        | $D(s),$<br>$p(s)$ | $D(t),$<br>$p(t)$ | $D(u),$<br>$p(u)$ | $D(v),$<br>$p(v)$ | $D(w),$<br>$p(w)$ | $D(x),$<br>$p(x)$ | $D(y),$<br>$p(y)$ |
|------|-------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 0    | $z$         | $\infty$          | $2, z$            | $\infty$          | $\infty$          | $\infty$          | $\infty$          | $14, z$           |
| 1    | $zt$        | $3, t$            |                   | $4, t$            | $11, t$           | $\infty$          | $\infty$          | $6, t$            |
| 2    | $zts$       |                   |                   | $4, t$            | $11, t$           | $\infty$          | $\infty$          | $6, t$            |
| 3    | $ztsu$      |                   |                   |                   | $5, u$            | $7, u$            | $\infty$          | $6, t$            |
| 4    | $ztsuv$     |                   |                   |                   |                   | $6, v$            | $8, v$            | $6, t$            |
| 5    | $ztsuvw$    |                   |                   |                   |                   |                   | $7, w$            | $6, t$            |
| 6    | $ztsuvwxy$  |                   |                   |                   |                   |                   | $7, w$            |                   |
| 7    | $ztsuvwxyz$ |                   |                   |                   |                   |                   |                   |                   |

**Answer:**  
See above.

5. [ 10 Points ]

- (a) In distance vector routing, which of the following can result in a “count to infinity”: an increase of link cost, a decrease of link cost, removal of a link, addition of a link? (More than one may be correct; list as many as are correct.)
- (b) In distance vector routing, does poisoned reverse prevent all count-to-infinity problems, some count-to-infinity problems, or no count-to-infinity problems?
- (c) What field in the IPv4 header allows traceroute to probe a specific depth into a route?
- (d) What protocol allows traceroute to learn the final router reached by each of its probes?

**Answer:**  
Count to infinity can arise from an increase in link cost or the removal of a link; poisoned reverse prevents some instances. Traceroute uses the TTL field to probe to a given depth, and then receives an ICMP message in response.

6. [ 10 Points ] A computer receives the eight data bits 10001011 followed by the three CRC bits 101; the generator is 1001. Does this indicate that one or more bits were corrupted in transmission? Show your work.

**Answer:**

```

      ----10011000
1001|10001011101
      1001
      ----
      0011
      0000
      ----
      0110
      0000
      ----
      1101
      1001
      ----
      1001
      1001
      ----
      0001
      0000
      ----
      0010
      0000
      ----
      0101
      0000
      ----
      101

```

Because the remainder is 101, rather than 0, there must have been an error in transmission.

7. [ 10 Points ] In the DHCP protocol,
- A client sends its discover message to the broadcast address, 255.255.255.255, so that any server on the network can respond. The server responds with an offer, which is also addressed to 255.255.255.255, even though it only needs to go to one client. Why?
  - Do servers send back acknowledgments in response to request messages, release messages, both, or neither? Why?

**Answer:**

Offers are broadcast because the client is not yet configured with an IP address. Servers acknowledge a request, so that the client knows it can use the address, but not a release, because the client has no reason to care that the release succeeded, and need not retry it if it failed, because the lease will eventually expire anyhow.

8. [ 10 Points ] Suppose the propagation delay between Ethernet hosts A and B is 225 bit times. Suppose that host A starts transmitting a frame at time 0, and host B starts transmitting a frame at time 10 bit times. The two will collide. Suppose each picks  $K = 0$ . What is the earliest time at which A will start retransmission? What is the earliest time at which B will start retransmission? Show your work.

**Answer:**

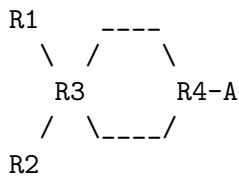
Assuming each host detects the collision upon receiving the other's first bit, A will do so at bit time 235 and B at bit time 225. Each starts its 48 bit time jam signal at that point, ending at bit times 283 and 273, respectively. These also take 225 bit times to propagate, meaning that A hears silence at 498 and B at 508. Each needs to wait for 96 bit times before retransmitting, so A can go again at bit time 594 and B at 604.

9. [ 10 Points ] An Ethernet frame arrives along one Ethernet cable at a box used to connect several different Ethernet cables. The box might be a hub or a switch, and the frame might have any destination MAC address. Under what circumstances of box type and destination address is the frame sent out on all of the other cables, rather than just one?

**Answer:**

If the box is a hub, it always sends the frame out on every cable. If the box is a switch, it sends the frame out on every cable if the destination address is a broadcast address or one that the switch has not recently seen as a source address.

10. [ 10 Points ] Consider the following network:



In this network, the routers R3 and R4 are connected by two different links. The routers R1 and R2 each only have one interface shown, which we can number as interface 0 in each case. The router R3 has four interfaces; number the northwest, northeast, southeast, and southwest interfaces 0, 1, 2, and 3 respectively. The router R4 has three interfaces. Number the northwest, east, and southwest interfaces 0, 1, and 2 respectively. Give MPLS forwarding tables for each of the four routers such that traffic from R1 to destination A will follow the northern link between R3 and R4, while traffic from R2 to A will follow the southern link.

**Answer:**

|     |          |           |      |               |
|-----|----------|-----------|------|---------------|
| R1: | in label | out label | dest | out interface |
|     |          | 1         | A    | 0             |
| R2: | in label | out label | dest | out interface |
|     |          | 2         | A    | 0             |
| R3: | in label | out label | dest | out interface |
|     | 1        | 0         | A    | 1             |
|     | 2        | 0         | A    | 2             |
| R4: | in label | out label | dest | out interface |
|     | 0        | -         | A    | 1             |