COMP 431 — INTERNET SERVICES & PROTOCOLS

Spring 2020

Homework 7, April 15

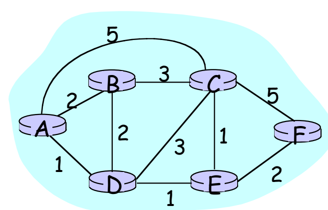
Due: 10:30 am, April 22

Note: Late solutions for this assignment ***cannot*** be accepted.

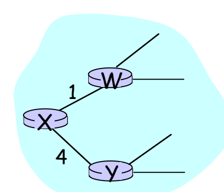
Note:

- Please typeset your answers and submit on Gradescope.
- Please include detailed steps and explanations.

1. Consider the network shown below. Enumerate all the paths from *A* to *F* that do not contain any loops. For each path you list, give the cost of the path.



2. Consider the network fragment shown below. Switch *X* has only two attached neighbors, *W* and *Y*. *W* has a minimum-cost path to destination *A* (not shown) of 5, and *Y* has a minimum-cost path to *A* of 6. The complete paths from *W* and *Y* to *A* (and between *W* and *Y*) are not shown. All link costs in the network have strictly positive integer values.

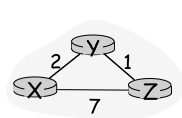


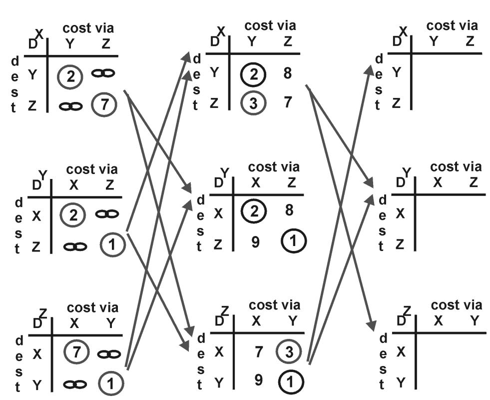
   a) Give *X*'s distance table (row) entries for destinations *W*, *Y*, and *A*.

   b) Give a link-cost change for either *c*(*X*,*W*) or *c*(*X*,*Y*) such that *X* will inform its neighbors of a new minimum-cost path to *A* as a result of executing the distance vector algorithm in the text.

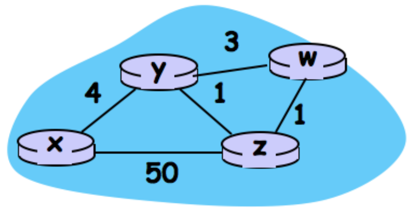
   c) Give a link-cost change for either *c*(*X*,*W*) or *c*(*X*,*Y*) such that *X* will *not* inform its neighbors of a new minimum-cost path to *A* as a result of executing the distance vector algorithm.

3. Compute the distance tables for *X*, *Y*, and *Z* shown in the rightmost column of the table below. After computation of the new distance tables, which nodes will send which updated values to which neighbors?





4. Suppose distance-vector routing is used with poisoned reverse in the following topology. Justify your answers below.



(a) When the distance vector routing has stabilized, router w, y, and z inform their distances to x to each other. What distance values do they tell each other?

(b) Now suppose that the link cost between x and y increases to 60. Will there be a count-to-infinity problem even if poisoned reverse is used? Why or why not? If there is a count-to-infinity problem, then how many iterations are needed for the distance-vector routing to reach a stable state again?

(c) How do you modify cost of the link between y and z, such that there is no count-to-infinity problem at all if the cost of the link between x and y increases from 4 to 60?

5. Consider a datagram network using 32-bit host addresses. Suppose a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as follows:

Destination Address Range	**Link Interface**
11111110 00000000 00000000 00000000 *through* 11111110 11111111 11111111 11111111	0
11111111 00000000 00000000 00000000 *through* 11111111 00000000 11111111 11111111	1
11111111 00000001 00000000 00000000 *through* 11111111 11111111 11111111 11111111	2
otherwise	3

a) Provide a forwarding table that has four entries, uses longest-prefix matching, and forwards packets to the correct link interfaces. Specify this table in both types of notation: binary string notation as well as the a.b.c.d/x notation.

b) Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses:

11111111 00000000 11000011 00111100

11111111 10000000 00010001 01110111

11110110 10010001 01010001 01010101

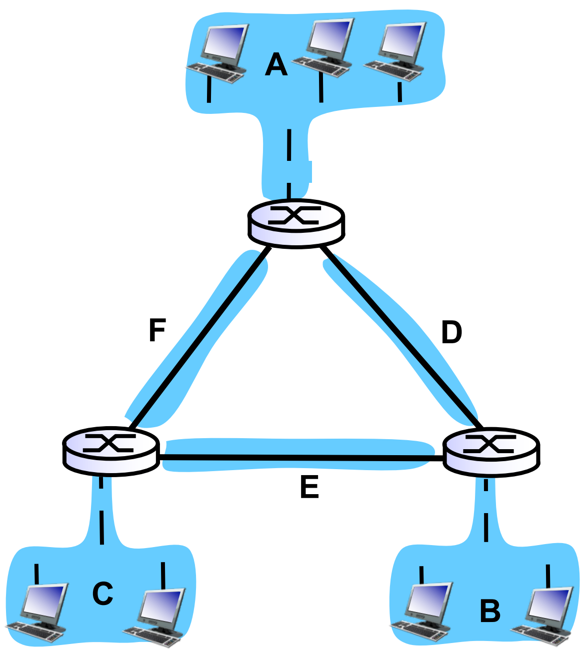
6. Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support up to 125 interfaces, and Subnets 2 and 3 are each required to support up to 60 interfaces. Provide three network addresses (of the form a.b.c.d/x) for these subnets that satisfy these constraints.

7. In the topology shown below, assign network addresses to each of the subnets A-F, such that:

- All addresses are allocated from 152.83.254/23
- Subnet A has enough addresses to support 250 interfaces
- Subnet B has enough addresses to support 120 interfaces
- Subnet C has enough addresses to support 120 interfaces
- Subnets D, E, anf F should each be able to support two interfaces.

(a) Specify your address assignment for each subnet in the form a.b.c.d/x or a.b.c.d/x – e.f.g.h/y.

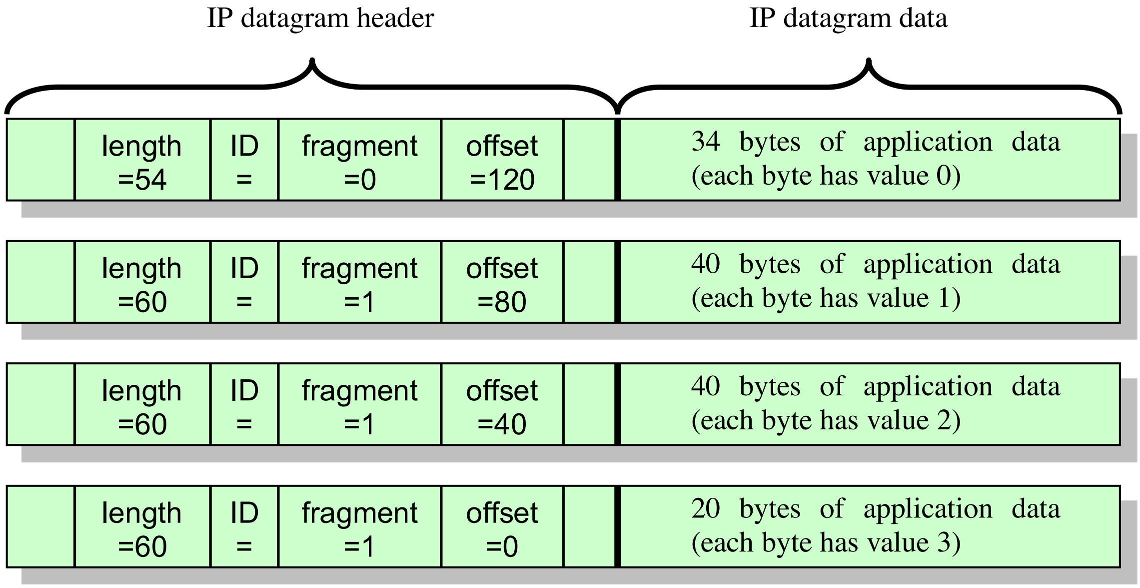
(b) Using your answer to part (a), provide the forwarding tables (using longest prefix matching) for each of the three routers.



8. Consider a link with an MTU of 700 bytes. Suppose you send a 2400-byte datagram on the link, stamped with the identification number 422. How many fragments are generated? What are the values in the various fields in the IP datagram(s) generated related to fragmentation?

9. BGP Suppose ASs X and Z are not directly connected but instead are connected by AS Y. Further suppose that X has a peering agreement with Y, and that Y has a peering agreement with Z. Finally, suppose that Z wants to transit all of Y's traffic, but does not want to transit X's traffic. Does BGP (alone) allow Z to implement this policy?

10. Shown below is the partial format sketch for 4 IP datagram fragments that have arrived at a host. Shown for each datagram are four fields from the IP datagram headers and the number and values of bytes of application-level data contained in each datagram. Assume all four IP datagrams have the same source and destination IP addresses, all have the same source and destination port addresses, and all indicate TCP as the transport protocol (the application is running on top of a TCP socket).



a) Sketch (using a similar format) the final IP datagram that will result from reassembling these datagrams. Be sure to indicate the **position and length of IP and TCP headers** and the **position, length, and values of all the application data bytes**. Assume that IP and TCP headers have no options fields present.

b) Suppose the IP datagram with fragment = 0 in the datagram header had been lost by the network but the remaining three with fragment = 1 had arrived safely. How would the datagram reassembly be handled in this case?

A Reminder on the Honor Code

Students are *encouraged* to work together on this homework assignment. *Acceptable collaboration* includes:

- Discussing the assigned problems to understand their meaning,
- Discussing possible approaches to assigned problems,

In *all* cases you must *explicitly* acknowledge *any and all substantive help received from other individuals* during the course of the preparation of your homework solution. That is, if you collaborate with other individuals then you *must* include an explicit acknowledgment in your homework solution of the persons from whom you received aid. You should include the acknowledgement with your Honor Code pledge. Acknowledging others, if done properly, will not adversely affect your grade.

Unacceptable collaboration on written homework includes:

- Copying (verbatim use) of physical papers or computer files,[1] and
- Submission of solutions that are jointly authored, or authored either wholly or in part by other individuals.

The general rule to be followed is that the strategy and approach of solutions may be developed jointly but *all* actual solutions (*i.e.*, the final solution) must be *constructed* and *written up* individually. Work done jointly should not be done in sufficient detail as to make it a final solution. For example, solutions may *sketched* out jointly, however each student must construct the final form of their solution individually and write-up their own solution. Should questions arise the course of working on a problem please feel free to immediately contact the instructor either by telephone, electronic mail, or by an office visit. In principle, if you work with others in good faith and are honest and generous with your attributions of credit you will have no problems.

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[1] This includes computer files that are copied and then edited and/or reformatted.