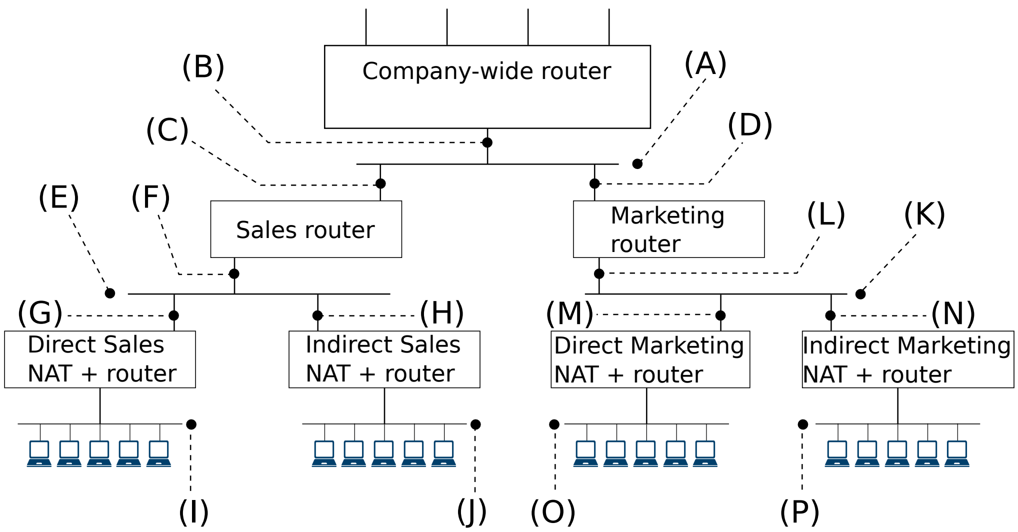
ECE 358, S'16 — Assignment 4

Total # Points = 42, Due: Fri, June 24, 11:59:59pm

Instructions Your submission must be typeset and in pdf.

1. You are a network admin for Acme, Inc. You have been provided the prefix $1.2.3.0/28$ to provide IP connectivity for Sales + Marketing, which together comprise 4 different sub-departments: $\{direct, indirect\} \times \{sales, marketing\}$.



(a) (5 points) Provide the information (A), ..., (P).

(A) Sales + Marketing subnet prefix	*(B) Company-wide router IP address*
(C) Sales router IP address	*(D) Marketing router IP address*
(E) Sales subnet prefix	*(F) Sales router IP address*
(G) Direct sales NAT + router IP address	*(H) Indirect sales NAT + router IP address*
(I) Direct sales subnet prefix	*(J) Indirect sales subnet prefix*
(K) Marketing subnet prefix	*(L) Marketing router IP address*
(M) Direct marketing NAT + router IP address	*(N) Indirect marketing NAT + router IP address*
(O) Direct marketing subnet prefix	*(P) Indirect marketing subnet prefix*

(b) (4 points) What are the routing tables at (i) the Sales router, and, (ii) the Marketing router?

Clarification: Assume longest prefix match is in effect. You need to provide 3 entries per row. (i) A prefix that corresponds to a destination, (ii) the next hop, which is either an IP address or the mnemonic "myself," and, (iii) the outgoing interface. For (iii), you can use the labels from the picture. That is, the Sales router has two interfaces: (C) and (F). The Marketing router has two interfaces: (D) and (L).

2. (5 points) Assume that every IP packet has a 20-byte header. An IP packet, whose 'Identification' field has the value *abcd* in hex, with 1800 bytes of payload (IP data), is sent by a host A bound for a destination B with the 'Do Not Fragment' bit clear. (I.e., the packet may be fragmented.) The packet first traverses a hop (a subnet) which supports a maximum IP packet size (including both IP payload and header) of at most 1000 bytes only. Thus, the packet is fragmented into two, f_1, f_2, where f_1 has fragment offset 0.

Then, the two fragments f_1, f_2 happen to take two different routes to the destination B. The fragment f_2

arrives without any further fragmentation. The fragment f_1, on the other hand, goes through another hop which supports a maximum IP packet size of 500 only.

Assume that all the fragments that correspond to this IP packet arrive at B. For each fragment that corresponds to this IP packet that arrives at B, identify, from its IP header: (i) the value of the 'Identification' field, (ii) the value of the 'More fragments' bit, (iii) the value of the 'Fragment offset' field, and, (iv) the value of the 'Total length' field.

You should order your list of fragments in increasing 'Fragment offset' value.

3. Each of the following questions is worth 2 points. Your justification for each should be brief, e.g., 1 terse sentence.

(a) It so happens that an IP packet sent by S to D, incurs no errors in transit. Is the value of the header checksum in the IP header of the packet that arrives at D the value that S put in the checksum field? Why or why not?

(b) Alice claims that if an odd number of bits in the IP header is flipped in transit, then a receiver is guaranteed to detect an error via the header checksum. Do you concur with her? Why or why not?

(c) It so happens that a UDP packet, which is encapsulated within an IP packet, sent by S to D, incurs no errors in transit. Is the value of the UDP checksum of the packet that arrives at D the value that S put in the UDP checksum field? Why or why not?

(d) In Slide 7 of Lecture 3-1, in the context of path MTU discovery using UDP, we assert that 'response received' implies 'that value of MTU is supported.'Is the converse necessarily true? Why or why not?

4. (5 points) In the proof of correctness of Dijkstra's algorithm (Page 14 of Lecture slides 4), show that $D(y) = \delta(y)$.

Clarification: what I mean is the following. In that slide, we have the following assertion, "Therefore, just before we choose w in the loop, $D(y) = \delta(y)$." That assertion is subject to proof. That's the proof you need to provide. That is, adopt all the premises that are relevant up to that point, and prove the assertion. The two important premises for this proof are: (i) at the point in time the slide considers, for every $a \in N'$, $D(a) = \delta(a)$ (because we are assuming that w is the first candidate for addition to N' for which that is not true). And, (ii) The path $u \rightsquigarrow y$ in the picture is a shortest path. (This is inferred in the sentence immediately prior, and is itself subject to proof. But you don't have to prove it; you just assume it.)

5. (5 points) Show that the Bellman-Ford equation on Page 17 of Lecture slides 4 is correct. That is, suppose:

- the graph under consideration is connected, undirected,
- $d_x(y)$ represents the smallest distance from x to y,
- $\mathit{neigh}(a)$ is the set of all vertices to whom a has an edge, and,
- $c(a, b)$ is the link-cost of edge $\langle a, b\rangle$. (See clarification below.)

Then, for all $y \neq x$: $\quad d_x(y) = \min_{v \in \mathit{neigh}(x)} \{c(x, v) + d_v(y)\}$

Clarification: We assume that $c(a, b) \geq 0$, for every a, b.

6. (5 points) Consider the Distance vector algorithm on Page 21 of Lecture slides 4 that is run on a weighted, connected, undirected graph G. From the start when a node has information about its own links only, assuming no link-costs change, in how many iterations do we converge to the minimum-cost routing table?

7. (5 points) Give an example of an undirected graph G and events as follows. Assume that poisoned reverse is in effect. (See Page 25 of Lecture Slides 4.) Initially, running a Distance-Vector routing protocol on G results in no routing loops. After we converge, events occur that cause the routing protocol to be run again among some nodes of G, and we end up, even temporarily, with a routing loop that comprises 4 nodes. (i.e., for some destination, A forwards to B, which forwards to C, which forwards to D, which in turn forwards to A.)

So the answer you provide should comprise: (i) the initial graph G, (ii) event(s) that cause the Distance vector routing protocol to run, and, (iii) the routing loop of size 4 with which we end up in G, with a brief justification as to why we end up with such a routing loop.