Problem 1

Answer the following questions regrading IP.

(a) Suppose Host A receives an IP datagram. How does the network layer in Host A know it should pass the segment (that is, the payload of the datagram) to TCP rather than to UDP or to something else?

(b) Can a host have more than one IP address? Justify your answer briefly.

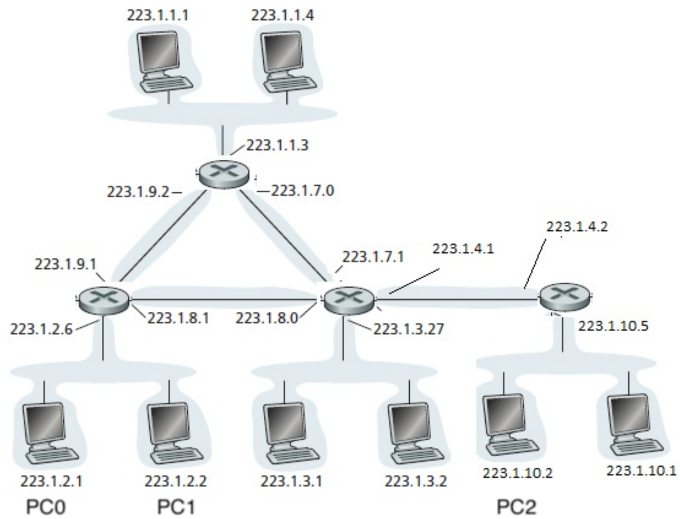
(c) How does Skype work between two hosts which are behind two different NAT boxes?

(d) Do you think NAT is still needed if IPv6 is globally deployed?

Write your solution to Problem 1 in this box

Problem 2

Consider the network shown below.



(a) How many subnets are in this network?

(b) What DHCP messages will be exchanged if PC0 moves to PC2's network?

(c) If PC0 does not use DHCP and keeps its original IP address configuration (i.e. does not request new IP address) when it moves to PC2's network, what issues might arise when it attempts to communicate? How can the use of DHCP alleviate these issues?

Write your solution to Problem 2 in this box

Problem 3

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 10.0.0/24. Also suppose that Subnet 1 is required to support at least 100 interfaces, Subnet 2 is to support at least 50 interfaces, and Subnet 3 is to support at least 25 interfaces. Provide three subnet addresses (of the form a.b.c.d/x) that satisfy the constraints. You may use th e following link to help verify your result: `http://jodies.de/ipcalc`.

Write your solution to Problem 3 in this box

Problem 4

Network Address Translation (NAT) is the translation of an IP address used within one network to a different IP address known within another network. A NAT capable router essentially translates private IP address within a network to public IP addresses that can be visited publicly. A simple NAT-capable router will have mappings between the private addresses within the network to the public address(es) that it uses. Suppose that the router has a single public address 131.179.176.1 which it uses for all communication with hosts that are not part of the private network. The private network used is subnet 10.0/16. The router multiplexes its public IP address(es) as needed and keeps track of the multiplexing in a NAT translation table.

Assume that the router multiplexes the public address using ports starting from 8000 and then increments the port number by one for each new entry, which essentially identifies a process of the communication. For example, if a host behind the router with address and port 10.0.0.5:5000 sends a message to an external server 8.8.8.8:53, then the entry in the NAT table would be filled in as below.

Table 1: NAT Translation Table

IP:port within private network	IP:port outside private network
10.0.0.5:5000	131.179.176.1:8000
...	...

The next time the router will use port 8001 to establish a new connection and so on.

(a) Draw the resulting NAT Translation Table at the end of the following message exchanges following the format of Table 1 (including the original entry):

(1) 10.0.0.6:5000 sends a message to 172.217.11.78:80

(2) 10.0.0.10:6000 sends a message to 204.79.197.200:80

(3) 10.0.1.101:6001 sends a message to 206.190.36.45:80

(4) 10.0.0.10:6000 sends a message to 204.79.197.200:80

(5) 10.0.1.101:6001 sends a message to 172.217.11.78:80

(6) 10.0.0.7:7000 sends a message to 63.245.215.20:80

(7) 204.79.197.200:80 sends a message to 131.179.176.1:8002

(8) 204.79.197.200:80 sends a message to 131.179.176.1:8003

(b) For simplicity, let's denote transport-layer messages in the format of MSG <Sender, Receiver>, where Sender and Receiver represent the IP-port pair of the message's sender and receiver respectively. For example, if a host in the private network with IP address and port 10.0.0.5:5000 sends a message to 132.239.8.45:80. Then from the router's point of view, we denote the message received at router and sent from the router as follows:

Message Received from Host: MSG <10.0.0.5:5000, 132.239.8.45:80>

Message Sent from Router: MSG <131.179.176.1:8000, 132.239.8.45:80>

Using the same format as above, list the messages received from the host at the router and the message sent from the router for the following messages:

(1) 10.0.0.6:5000 sends a message to 172.217.11.78:80

(2) 10.0.0.10:6000 sends a message to 204.79.197.200:80

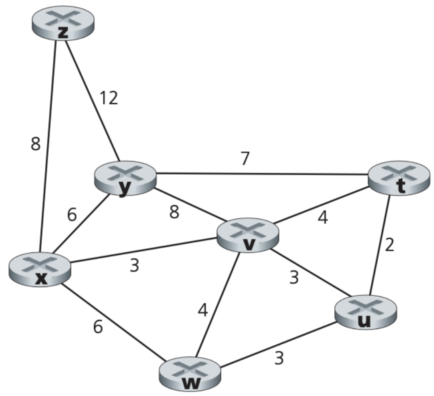
Assume the entries from your NAT Translation Table in (a) to do this.

Problem 4 continued on next page. . .

Write your solution to Problem 4 in this box

Problem 5

Consider the following network. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from node t to each of the other network nodes. Please show intermediate steps for full credit.



Write your solution to Problem 5 in this box

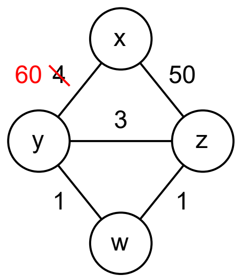
Problem 6

Consider the network shown below. The costs of all links are initially: c(x,y) = 4, c(x,z) = 50, c(y,w) = 1, c(z,w) = 1, c(y,z) = 3. Suppose the distance-vector algorithm introduced in the lecture is used.

(a) When the distance vector routing is 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. Can y, z, w settle their optimal distances to x within several (say, ≤ 5) iterations? Why or why not?

(c) Will the distance tables eventually reach a stabilized state? Why or why not?



Write your solution to Problem 6 in this box