Note: Check the upcoming emails and announcements for any updates related to Midterm II.

1) **Subnetting (30 pts)** An organization is granted the block 16.0.0.0/8. The administrator wants to create 500 fixed-length subnets. Assume the subnets are numbered from 1 to 500. (16,351,232 in base 256 is 0.249.128.0).
   - **a)** Find the subnet mask.
   - **b)** Find the number of addresses in each subnet.
   - **c)** Find the 1st and last addresses in subnet 1.
   - **d)** Find the 1st and last addresses in subnet 500.

2) **Addressing (20 pts)** Find the range of addresses in the following blocks.
   - **a)** 123. 56.77.32/29
   - **b)** 200.17.21.128/27
   - **c)** 17.34.16.0/23
   - **d)** 180.34.64.64/30

3) **Routing (15 pts)** Find the topology of the network if router R1 has the following routing table.

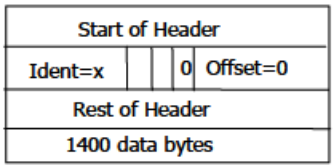
Mask	Network Address	Next Hop Address	Interface
/27	202.14.17.224	-	m1
/18	145.23.192.0	-	m0
Default	Default	130.56.12.4	m2

4) **TCP Flow (10 pts)** A window holds bytes 2001 to 5000. The next byte to be sent is 3001. Draw a figure to show the situation of the sliding window after the following two events:
   - **a)** An ACK segment with the acknowledgement number 2500 and window size advertisement 4000 is received.
   - **b)** A segment carrying 1000 bytes is sent.

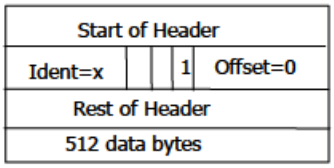
5) **TCP Connection (10 pts)** TCP opens a connection using an initial sequence number (ISN) of 14534. The other party opens the connection with ISN of 21732. Show the three TCP segments during the connection establishment.

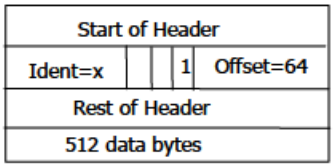
6) **Fragmentation (20 pts)** Suppose the fragments of the figure b) all pass through another router onto a link with an MTU of 380 bytes, not counting the link header. Show the fragments produced. If the packet were originally fragmented for this MTU, how many fragments would be produced?

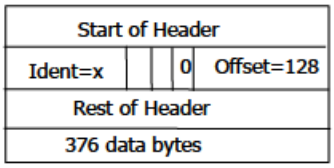
(a)



(b)



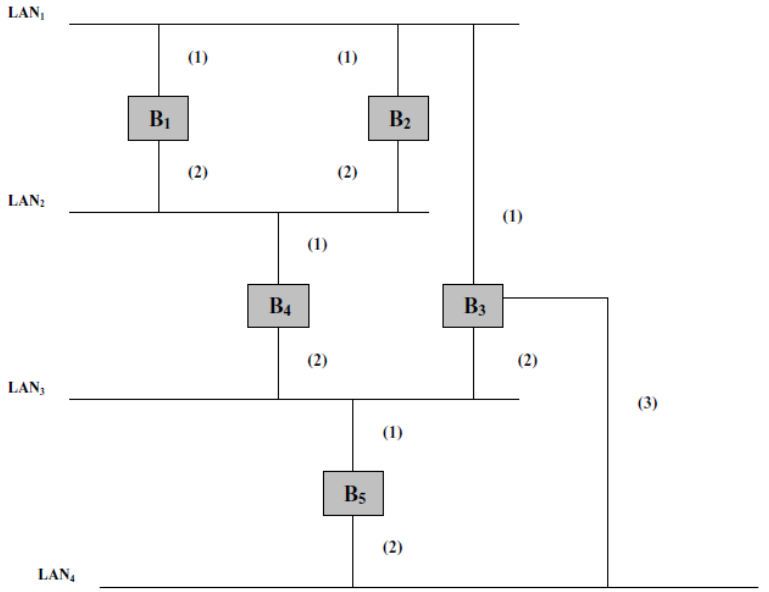




Header fields used in IP fragmentation: (a) unfragmented packet; (b) fragmented packets

7) **Bridge SPT (10 pts)** Construct a Spanning-tree topology computed by the spanning tree algorithm for the interconnected LAN shown below. Assume B1 is the Root Bridge. Go through the process in detail .Note that the ports for each bridge are numbered as shown in the Figure. You may assume equal and unit cost for ports of all bridges. Use the symbol "R" to indicate a "Root Port" and the Symbol "D" to indicate a "Designated Port".

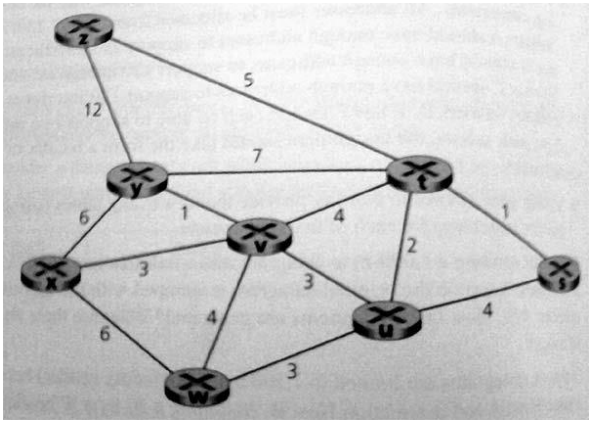
(The numbers in parenthesis next to ports are port numbers, not costs.)



8) **Subnetting (20 pts)** Consider a subnet with prefix 101.101.101.64/26. Give an example of one IP address(of form xxx.xxx.xxx.xxx) that can be assigned to this network. Suppose an ISP owns the block of addresses of the form 101.101.128/17. Suppose it wants to create four subnets from this

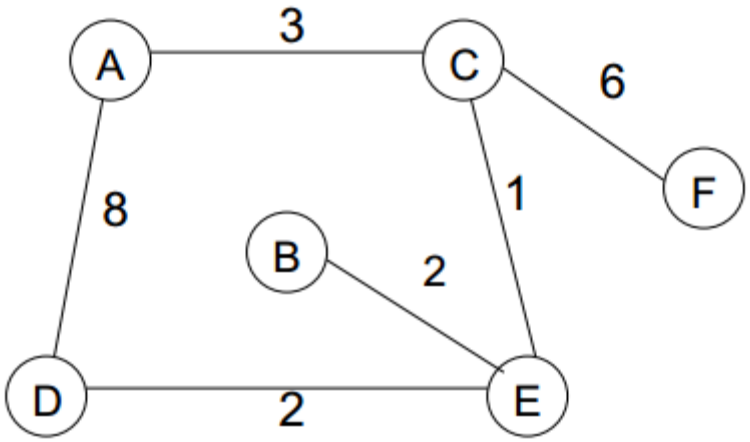
block, with each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets?

9) Dijkstra's Shortest Path (15 pts) Consider the following network.with the indicated link costs, use Dijkstra's shortest path algorithm to compute the shortest path from x to all network nodes.



10) IEEE802.5 (20 pts) An IEEE 802.5 token ring has five stations and a total wire length of 230 m. Assume each stations introduces one bit delay. How many bits of delay must the monitor insert into the ring such that the transmission delay of the token and ring latency match? Do this for both 4 and 16 Mbps. use a propagation rate of 2.3 x 10^8 m/s.

11) Distance Vector (10 pts) For the network below, give global distance-vector tables when:
a) Each node knows only the distances to its immediate neighbors.
b) Each node has reported the information it had in the preceding step to its immediate neighbors.
c) Step (b) happens a second time



12) Link State (10 pts) For the network in the previous problem, show how the link-state algorithm builds the routing table for node-D.

13) Addressing (10 pts) Consider a datagram network using 8-bit host addresses. Suppose a router uses longest prefix matching and has the following forwarding table:

Prefix match	Interface
1	0
11	1
111	2
otherwise	3

For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range.

14) Subnetting (20 pts) Consider a router that interconnects three subnets: Subnet1, Subnet2, and Subnet3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet1 is required to support up to 60 interfaces, Subnet 2- 90 interfaces and Subnet 3 – 12 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints.

15) .

CSMA/CD not in Midterm II, so ignore this problem

Recall that with the CSMA/CD protocol, the adapter waits $K \cdot 512$ bit times after a collision, where K is drawn randomly. For $K = 100$, how long does the adapter wait until returning to Step 2 for a 10 Mbps broadcast channel? For a 100 Mbps broadcast channel?

16)

CSMA/CD not in Midterm II, so ignore this problem

Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation delay between the two nodes is 325 bit times. Suppose CSMA/CD and Ethernet packets are used for this broadcast channel. Suppose node A begins transmitting a frame and, before it finishes, node B begins transmitting a frame. Can A finish transmitting before it detects that B has transmitted? Why or why not? If the answer is yes, then A incorrectly believes that its frame was successfully transmitted without a collision. *Hint*: Suppose at time $t = 0$ bits, A begins transmitting a frame. In the worst case, A transmits a minimum-sized frame of $512 + 64$ bit times. So A would finish transmitting the frame at $t = 512 + 64$ bit times. Thus, the answer is no, if B's signal reaches A before bit time $t = 512 + 64$ bits. In the worst case, when does B's signal reach A?

17) Addressing and Subnetting (100 pts) Answer the following subnet masking questions:

a) What is the last valid host on the subnetwork 172.20.144.0 255.255.240.0?
b) How many subnets and hosts per subnet can you get from 172.27.0.0 with mask 255.255.255.192 which is originally from a class B network
c) How many subnets and hosts per subnet can you get from 172.17.0.0/20, which is originally a class B network?
d) What is the last valid host on the subnetwork 172.26.52.128 255.255.255.128?
e) What is the broadcast address of the network 192.168.189.128/26?
f) How many subnets and hosts per subnet can you get from 172.20.0.0 with mask 255.255.254.0, which is originally from a class B network?
g) Which subnet does host 172.26.156.200/23 belong to?
h) Which subnet does host 172.16.113.150 with mask 255.255.254.0 belong to?
i) What is the broadcast address of the network 172.24.4.0 255.255.254.0?

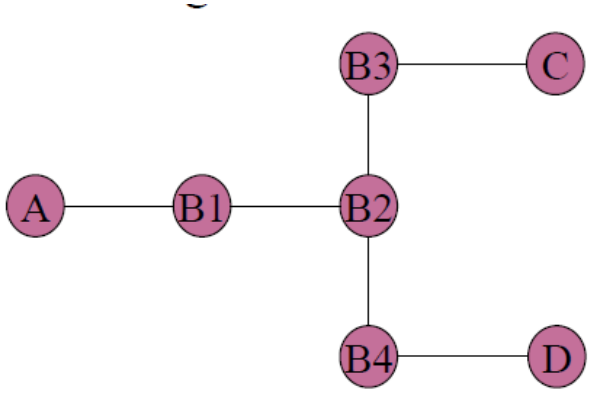
j) How many subnets and hosts per subnet can you get from 10.0.0.0/20 which is originally from a class A network?
k) What is the first valid host on the subnetwork that the node 172.22.114.124/23 belongs to?
l) Which subnet does host 192.168.113.50/26 belong to?
m) What is the first valid host on the subnetwork that the node 172.29.215.27/26 belongs to?
n) What is the broadcast address of the network 172.25.42.224/27?
o) What valid host range is the IP address 172.25.175.249 255.255.254.0 a part of?
p) How many subnets and hosts per subnet can you get from the class B network 172.23.0.0 255.255.252.0?
q) How many subnets and hosts per subnet can you get from the class B network 10.0.0.0/20?
r) How many subnets and hosts per subnet can you get from 172.17.0.0 with mask 255.255.255.0, which is originally from a class B network
s) How many subnets and hosts per subnet can you get from 192.168.32.0/28 which is originally from a class C network?
t) Which subnet does host 10.200.80.52/20 belong to?
u) What valid host range is the IP address 172.27.121.243 and mask 255.255.254.0 a part of?
v) What is the broadcast address of the network 172.20.11.224/27?
w) Which subnet does host 172.30.88.109/23 belong to?
x) Which subnet does host 192.168.27.129/29 belong to?
y) What is the broadcast address of the network 172.23.104.0 with mask 255.255.254.0?

18) Subnetting (30 pts) An ISP is granted a bock of addresses represented by 170.128.128.0/12. The ISP wants to distribute these blocks to customers as follows:
i. The first group has 200 customers; each needs 256 addresses.
ii. The second group has 112 customers; each needs 128 addresses.
iii. The third group has 100 customers; each needs 64 addresses.

a) Design the subblocks and give the slash notation for each subblock.
b) Find out how many addresses are still available after these allocations.

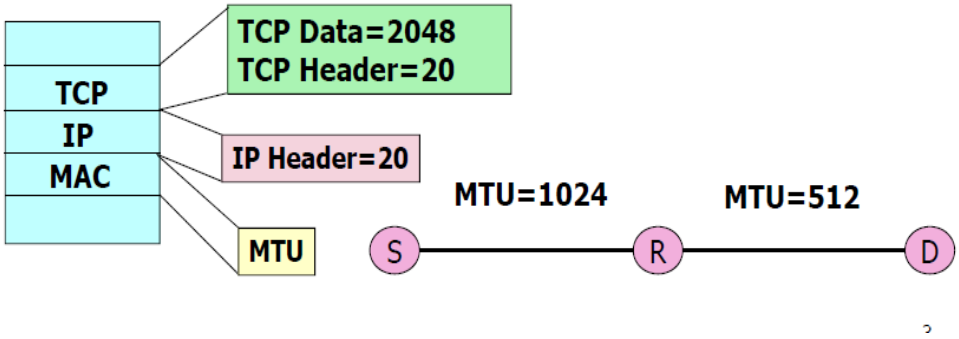
19) Subnetting (20 pts) Divide 183.120.0.0/19 network into 32 subnets. Specify the network address, the direct broadcast address and the range of host IP addresses for subnets 0, 15, and 31.

20) Learning Bridges (10 pts) Consider the arrangement of the learning bridges shown in the following figure. Assuming all are initially empty , give the forwarding tables for each of the bridges B1 through B4 after the following transmissions



- A sends to C
- C sends to A
- D sends to C

21) Fragmentation (15 pts) Suppose that a TCP message that contains 2048 bytes of data and 20 bytes of TCP header is passed to IP for delivery across two networks of the Internet (i.e. from the source host to a router to the destination host). The first network has an MTU of 1024 bytes and the second network has an MTU of 512 bytes. Each network's MTU gives the total packet size that may be sent including the network header. Give the sizes of the fragments delivered to the network layer at the destination host, assuming all IP headers are 20 bytes.

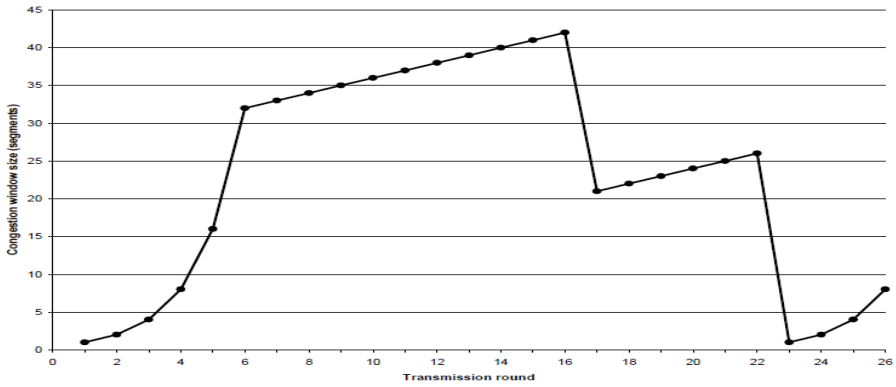


22) Forwarding (20 pts) Suppose a router has built up its routing table. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Assume the router does the longest prefix match. Describe what the router does with a packet addressed to each of the following destinations:

(a) 128.96.171.92
(b) 128.96.167.151
(c) 128.96.163.151
(d) 128.96.169.192
(e) 128.96.165.121

SubnetNumber	SubnetMask	NextHop
128.96.170.0	255.255.254.0	Interface 0
128.96.168.0	255.255. 254.0	Interface 1
128.96.166.0	255.255. 254.0	R2
128.96.164.0	255.255. 252.0	R3
(default)		R4

23) TCP Reno (30 pts) Consider the following plot of TCP window size as a function of time.



Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

- **a)** (4 pts) Explain why the horizontal axis did not start from 0.
- **b)** (1 pt) Identify the intervals of time when TCP is in slow start phase.
- **c)** (1 pt) Identify the intervals of time when TCP congestion avoidance is operating.
- **d)** (1 pt) After the 16th transmission round (RTT) is segment loss detected by a triple duplicate ACK or by a timeout?
- **e)** (1 pts) After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
- **f)** (1pt) What is the initial value of Threshold at the first transmission round?
- **g)** (1 pt) What is the value of Threshold at the 19th transmission round?
- **h)** (1 pt) What is the value of Threshold at the 25th transmission round?
- **i)** (2 pts) Assuming a packet loss is detected after the 27th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and the Threshold?
- **j)** (10 pts) Plot the cumulative number of segments as a function of RTT transmission round; up to the 26th round.
- **k)** (2 pts) During what transmission round is the 75th segment sent?
- **l)** (5 pts) Assuming the maximum segment size as 2KBytes plot the cumulative number of bytes as a function of RTT transmission round; up to the 26th round. Hint: Repeat part (j) however instead of segments show the number of bytes.

24) TCP Flow (15 pts) A window holds bytes 2001 to 10000. The next byte to be sent is 7001. Draw a figure to show the situation of the sliding window after the following 3 events:

i. An ACK segment with the acknowledgement number 2500 is received.

ii. A segment carrying 1000 bytes is sent.

iii. An ACK segment with the acknowledgement number 4501 and window size advertisement 4000 is received.