1. (10%) Packet routing. A router has just received the following new IP addresses: 140.121.112.0/22, 140.121.116.0/22, 140.121.120.0/22, and 140.121.124.0/22. If all of them use the same outgoing line, can they be aggregated? (5%) If so, to what? If not, why not? (5%)

2. (10%) IP subnet partition. 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 140.121.199/24. Also suppose that Subnet 1 is required to support up to 24 interfaces, Subnet 2 is to support up to 48 interfaces, and Subnet 3 is to support up to 12 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints.

3. (10%) Error detection. Given a 10-bit data 1101011110 and the generator G (=1001), find the Cyclic Redundancy Code (CRC). (5%) How does the receiver determine if the received data is correct or not using CRC? (5%)

4. (10%) Wireless communication. Consider the delay of pure ALOHA versus slotted ALOHA at low load. Which one is less? (2%) Explain your answer. (8%)

5. (10%) Multiple access control. Six stations, A through F, communicate using the CSMA/CA mechanism. Is it possible for two transmissions to take place simultaneously? (2%) Explain your answer. (8%)

6. (20%) Packet transmission over IP subnets. Figure 1 shows an example of two IP subnets (111.111.111.0/24 and 222.222.222.0/24) connected via a router R. Besides the router R, two hosts (A and C) are with IP subnet 111.111.111.0/24, and another two hosts (B and D) are with IP subnet 222.222.222.0/ 24). Assume host B is a web server, with a domain name www.foo.com. And, assume initially all IP and MAC address table are empty for all the hosts except the router R. Also, all the hosts are well configured with corresponding netmask/gateway/dns.

(a). According to Figure 1 and the above setting, what is the netmask for host A? (2%)

(b). Assume host A sets both of its gateway and dns to the router R. what should be the IP address of the dns and the gateway according to Figure 1? (2%)

(c). Assume host A wants to access the web server (host B). Host A did not know the IP address of host B, but it's domain name. Through what

protocol, host A can get host B's IP? (2%)

(d). Continue from (c), what is the first packet sent by host A, and why? (2%)

(e). Now suppose host A gets the IP address of host B, then should host A need to know the mac address of host B? why or why not (2%)

(f). Suppose in the end host A has got everything needs to know to send a packet to host B. Consider the packet sent out from host A for host B, what are the four addresses, source IP/destination IP/source MAC/destination MAC, associated in the packet. (3%)

(g). Continue from above, definitely the packet should be forwarded by the router R. Consider the forwarding packet sent out from R for host B, what are the four addresses, source IP/destination IP/source MAC/destination MAC, associated in the forwarding packet. (3%)

(h). Now suppose initially host A is configured with a wrong subnet mask as 255.255.0.0. Should host A still can successfully access the web pages from host B? Why? (2%)

(i). Similar to (h), now suppose initially host A is configured with a wrong subnet mask as 255.255.255.255. Should host A still can successfully access the web pages from host B? Why? (2%)

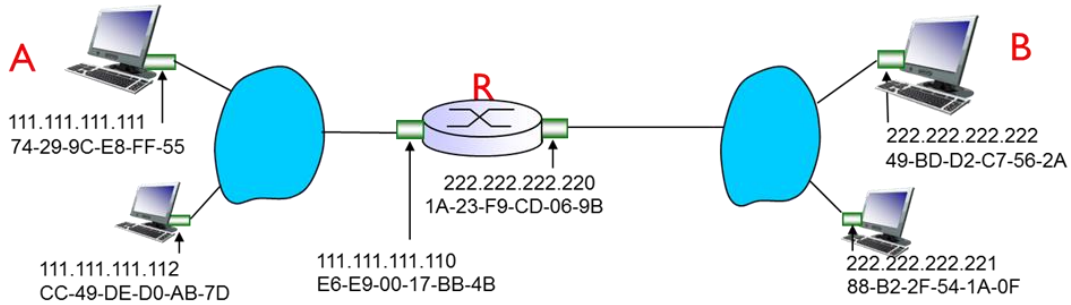


Figure 1. An example of network topology

7. (20%) IP Packet trace. Figure 2(b) shows IPv4 packet format. For IPv4, both ver and head length fields take 4 bits, and the flgs field takes 3 bits. An example of an IPv4 packet (encapsulated in an Ethernet frame) is shown in Figure 2(b), in which IP header consists of 20 bytes starting from 15-th byte (that is, the IP header byte stream is "45 00 00 2C E4 67 00 00 …8c 79 C5 C4".)

(a). What is minimal length of IPv4 packet header? (2%)

(b). What is maximal length of IPv4 packet header?
(note: the length field is in 4-byte words) (2%)

(c). Why we need a TTL (time to live) field in IPv4 header? (2%)

(d). Why we need a 16-bit identifier in IPv4 header? (2%)

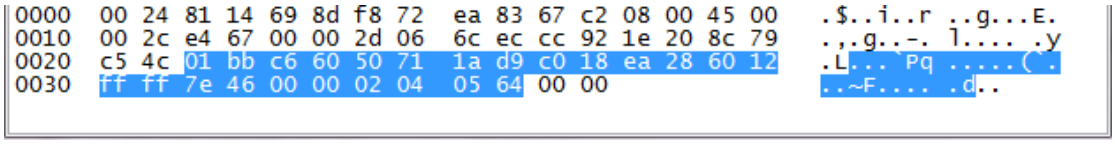
(e). Why we need fragment offset field in IPv4 header? (2%)

(f). In practice, fragmented packets are reassembly in end hosts, but not being done in the intermediate routers. Why? (2%)

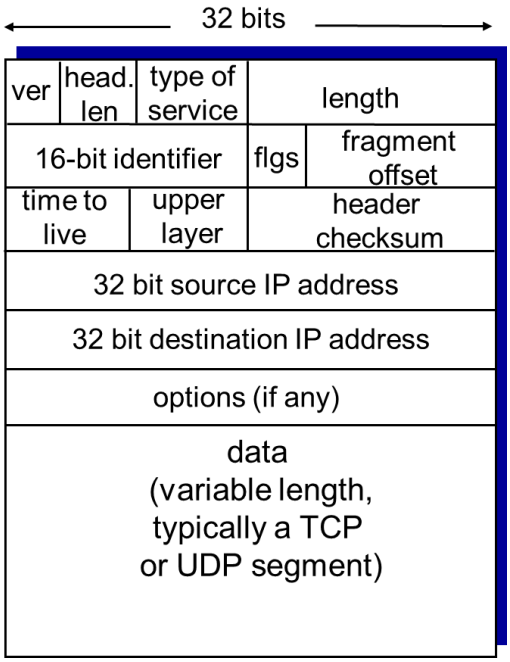
(g). According to Figure 2(a), what is the IP packet length (including header and data) of this packet? (2%)

(h). What is the header checksum value carried by the packet? (2%)

(i). Please verify if the IP checksum is correct or not for this packet (shown in Figure 2(a)). (4%)



(a)



(b)

Figure 2. (a) Example of an IPv4 packet encapsulated in an Ethernet frame. (b)IPv4 packet format.

8. (10%) TCP connection management.

(a). What is the TCP connection setup mechanism (that is, the three-way handshaking mechanism)? (5%)

(b). What is the TCP connection teardown (termination) mechanism? (5%)