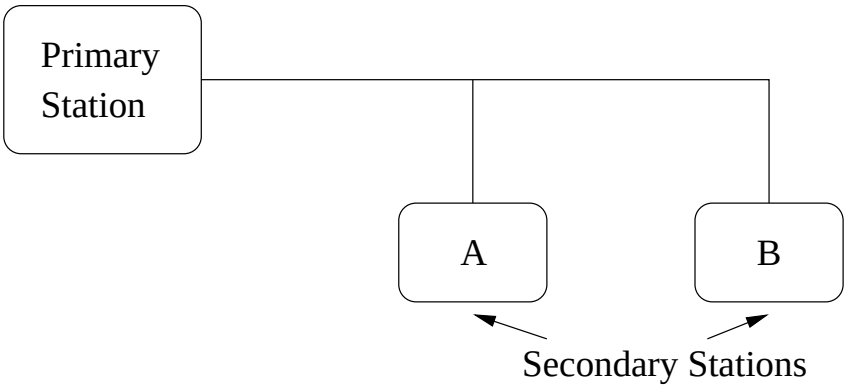
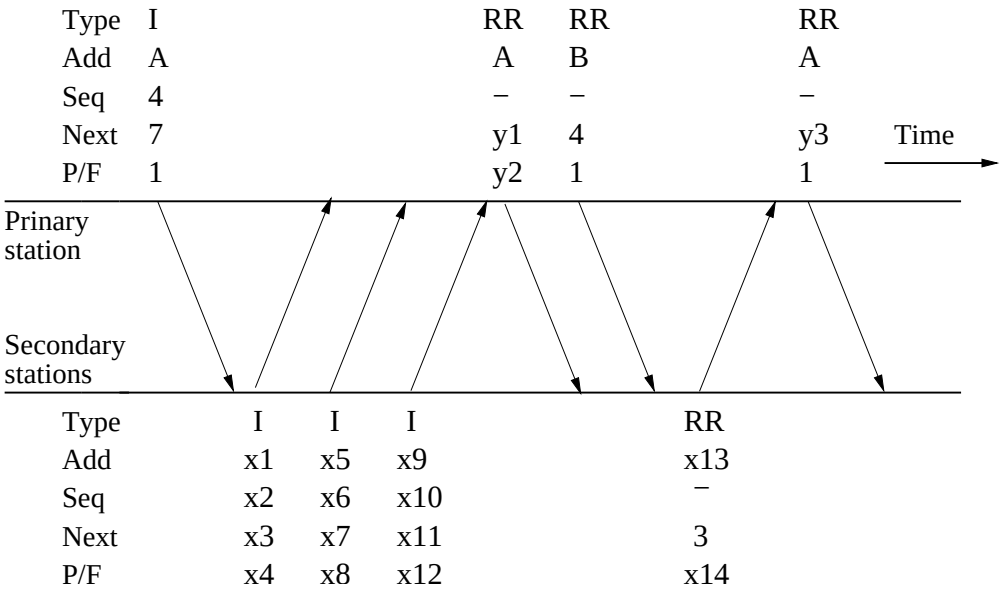
1. **(10 points)** Consider the following multidrop data-link configuration:

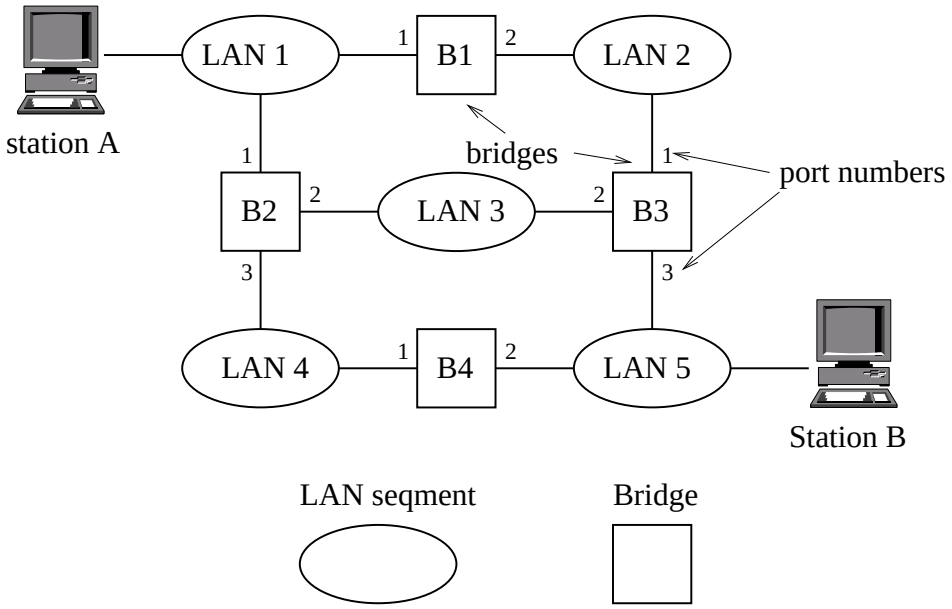


The time diagram below illustrates the data exchange between the primary station and the secondary stations using HDLC normal response mode.



Each frame carries an address field (Add) and an 8-bit control field. The control field contains a type field (Type), next field (Next), the P/F bit, and possibly the sequence field (Seq). The diagram shows the values in some of these fields. Determine all the other unknown values, from x1 to x14 and y1 to y3, in the diagram.

2. (a) **(10 points)**Consider the following Bridged LAN:



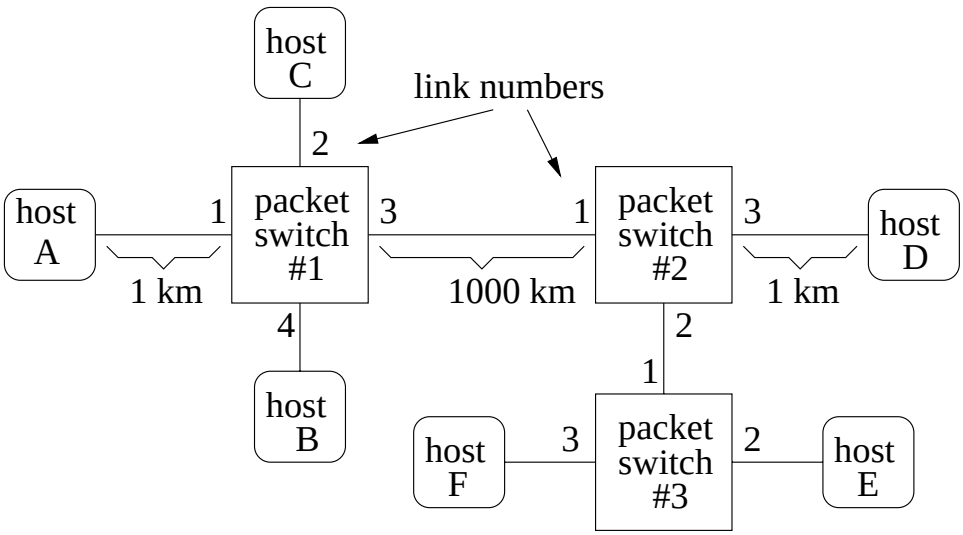
All the LAN segments are 100 Mbps Ethernet. Derive the spanning tree of the LAN under the following conditions:

BID of B1 < BID of B2 < BID of B3 < BID of B4,

where BID is the Bridge ID of a bridge. Indicate the status (Designated, root, or blocked) of each port. Explain your answer.

(b) **(10 points)** Based on the answer in part (a) and assuming that the bridge tables of all the bridges are initially empty, derive the bridge tables of all the bridges after station A sending one data packet to station B and subsequently receiving one data packet from station B.

3. Consider the following packet-switched network.



(a) **(8 points)** Determine the virtual circuit tables (routing tables) for all the switches after each of the following connections is established.

- Host A connects to host D.
- Host B connects to host E.
- Host C connects to host F.

Assume that the sequence of connections is cumulative, that is, the first connection is still up when the second connection is established, and so on. Also assume that the VC number assignment always picks the lowest unused VC number, starting at 0, on an outbound link.

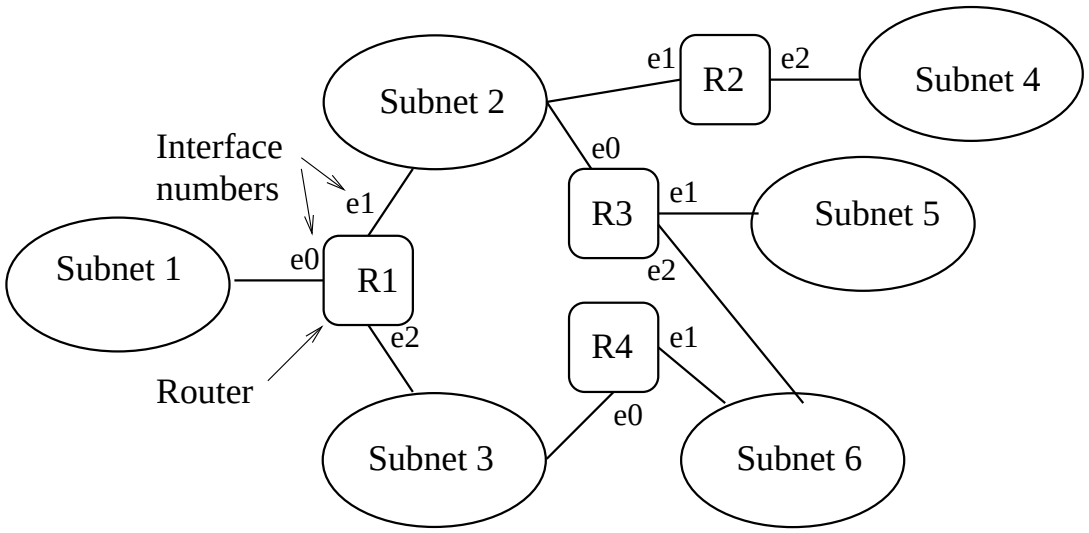
(b) **(7 points)** Calculate the total packet delay between host A and host D. The total packet delay is measured from the time the first bit of the packet is sent by the source (host A) to the time when the last bit of the packet is received by the destination (host D). The packet consists of 80-bit header and 1000-bit user data, the channel date rate is 1.5 Mbps, and the signal propagation speed is 2×10^5 km/sec. Assume the queuing and processing delays in each switch is negligible and thus can be ignored in the calculation.

4. (a) **(5 points)** Consider an internet site that is granted a class C address 210.128.128.0 and needs to have 6 subnets. Table 1 shows the number of hosts in each subnets.

Subnet	1	2	3	4	5	6
number of hosts	60	40	28	28	25	25

Design an appropriate subnet address and subnet mask for each of the subnets.

(b) **(5 points)** Suppose the topology of the internet site above is as shown:



Each router in the site runs RIP to learn routes to all the subnets in the site. Derive the routing table of router R1 after the routing process reaches stability. An entry in the routing table consists of the destination address, the next hop IP address and the outgoing interface (The interface numbers are shown in the topology diagram). You can freely assign appropriate IP addresses to the routers in the site as long as they are consistent to the addressing scheme derived in part (a).

(c) **(10 points)** Suppose you are given four routers, two Ethernet switches and sufficient number of hubs (repeaters) to build the internet site described by the logical topology in part (b). The Ethernet switches have 12 ports and 20 ports, respectively. Each hub has 10 Ethernet ports for the connections to the hosts. It also has an uplink port that is used to connect to a Ethernet switch. Design and sketch a physical topology of the internet based on the network equipment given above. Your design (and the corresponding sketch) should satisfy the requirements shown in Table 1 at part (a). Consequently, sufficient Ethernet ports for host connections should be available to each subnet. Provide details on how you would configure the ports of the Ethernet switches.

5. **(15 points)** A given host, host A, attached to an Ethernet LAN has an IP address of 135.95.05.132 and network mask of 255.255.255.128. The routing tables of Host A and its default router R1 are given as follows:

Routing Table of host A

Network IP address	next hop	Network Interface
135.95.05.128/25	-	Ethernet 0
0.0.0.0/0	135.95.05.129	Ethernet 0

Routing Table of router R1

Network IP address	next hop	Network Interface
135.95.05.128/25	directly connected	Ethernet 0
135.95.05.64/26	directly connected	Ethernet 1
135.95.05.32/27	directly connected	Ethernet 2
135.95.05.0/27	135.95.05.130	Ethernet 0
150.10.10.0/24	135.95.05.33	Ethernet 2
150.10.10.128/25	135.95.05.65	Ethernet 1
150.10.10.192/26	135.95.05.130	Ethernet 0
0.0.0.0/0	135.95.05.33	Ethernet 2

Describe in detail the action to be taken by host A and router R1 when host A wants to forward datagrams with the following destination addresses:

- 135.95.05.166
- 150.10.10.180

Assume the ARP tables in host A and router R1 are both initially empty. Your description should include sketches of all the frames generated by host A and router R1. In the sketch of each frame, indicate the source and destination MAC (Ethernet) addresses and the type of the frame. In addition, if the payload of the frame is an IP datagram, specify the source and destination IP addresses of the datagram. Use MAC(R1) to represent all the MAC addresses of router R1. For any other IP address X, use MAC(X) to denote the corresponding MAC address.

6. (a) **(5 points)** A TCP connection is setup between program A and program B. The two programs are running in different hosts. If program A uses a **write** system call to send a 100-byte message to program B What is the maximum number of the corresponding **read** system calls that program B may invoke in order to collect the complete message? Explain your answer!

   (b) **(10 points)** Modify the File transfer application in project 2 of the COE768 course based on the following change:

   - The 'length' field is eliminated, instead, an end-of-file character (Oxff) is introduced to provide the file boundary. Specifically, once the client process receives the end-of-file character, it will assume that the file is completely received.

   You only need to show the portions of the client and server programs that associated with the actual file data transfer.

   (c) **(5 points)** Explain why the method described in part (b) only works for the transmission of ASCII (text) file.