18.7.2 Questions

Q18-1. Why does the network-layer protocol need to provide packetizing service to the transport layer? Why can't the transport layer send out the segments without encapsulating them in datagrams?
A : Packetizing adds source and destination address to the header, which is essential because it determines where the packet will go. Without this the final destination of the packet will be unknown.

Q18-2. Why is routing the responsibility of the network layer? In other words, why can't the routing be done at the transport layer or the data-link layer?
A : Communication at the transport layer is one single logical path between source port and destination port, and the communication at the data-link layer is between two nodes, so there is no need for routing.

Q18-3. Distinguish between the process of routing a packet from the source to the destination and the process of forwarding a packet at each router.
A : Routing means making a single path between different possible paths, the number of nodes included in routing can be many. Forwarding a packet means to send the packet to the one next node according to the routing table.

Q18-4. What is the piece of information in a packet upon which the forwarding decision is made in each of the following approaches to switching?
a. datagram approach : destination address
b. virtual-circuit approach : Flow label

Q18-5. If a label in a connection-oriented service is 8 bits, how many virtual circuits can be established at the same time?
A : 16

Q18-6. List the three phases in the virtual-circuit approach to switching.
A : Setup, Data-transfer, Teardown

Q18-7. Do we have any of the following services at the network layer of TCP/IP? If not, why?
a. flow control : No, the upper layer has the flow control and more of these at network layer will make the entire process inefficient
b. error control : No, the packet may be fragmented at this phase so it will be inefficient
c. congestion control : Yes

Q18-8. List four types of delays in a packet-switched network.
A : Transmission, Propagation, Processing, Queuing

Q18-9. In Figure 18.10, assume that the link between R1 and R2 is upgraded to 170 kbps and the link between the source host and R1 is now downgraded to 140 kbps. What is the throughput between the source and destination after these changes? Which link is the bottleneck now?
A : 140, Link 1

Q18-10. In classless addressing, we know the first and the last address in the block. Can we find the prefix length? If the answer is yes, show the process.
A : By knowing the first and the last address, we can figure out how long the suffix(0 at first, 1 at last) is. So we just have to subtract suffix length from the total length

Q18-11. In classless addressing, we know the first address and the number of addresses in the block. Can we find the prefix length? If the answer is yes, show the process.
A : Yes, the number of addresses in the block is 2^(32-prefix length), so we can get the prefix length

Q18-12. In classless addressing, can two different blocks have the same prefix length? Explain.
A : Yes it they can. Length of the prefix could be same, but if the value of the prefix is different, they are different blocks because the range does not overlap.

18.7.3 Problems

P18-1. What is the size of the address space in each of the following systems?
a. A system in which each address is only 16 bits. : 2^16
b. A system in which each address is made of six hexadecimal digits. : 2^24
c. A system in which each address is made of four octal digits. : 2^12

P18-2. Rewrite the following IP addresses using binary notation:
a. 110.11.5.88 : 01101110 00001011 00000101 01011000
b. 12.74.16.18 : 00001100 01001010 00010000 00010010
c. 201.24.44.32 : 11001001 00011000 00101100 00100000

P18-3. Rewrite the following IP addresses using dotted-decimal notation:
a. 01011110 10110000 01110101 00010101 : 190.176.117.88
b. 10001001 10001110 11010000 00110001 : 137.142.208.49
c. 01010111 10000100 00110111 00001111 : 87.132.55.15

P18-4. Find the class of the following classful IP addresses:
a. 130.34.54.12 : B
b. 200.34.2.1 : C
c. 245.34.2.8 : E

P18-5. Find the class of the following classful IP addresses:
a. 01110111 11110011 10000111 11011101 : A
b. 11101111 11000000 11110000 00011101 : D
c. 11011111 10110000 00011111 01011101 : C

P18-6. In classless addressing, show the whole address space as a single block using the CIDR notation.
A : 0.0.0.0/0

P18-7. In classless addressing, what is the size of the block (N) if the value of the prefix length (n) is one of the following?
a. n = 0 : 2^32
b. n = 14 : 2^18
c. n = 32 : 1

P18-8. In classless addressing, what is the value of the prefix length (n) if the size of the block (N) is one of the following?
a. N = 1 : 32
b. N = 1024 : 22
c. N = 232 : 24

P18-9. Change each of the following prefix lengths to a mask in dotted-decimal notation:
a. n = 0 : 0.0.0.0
b. n = 14 : 255.252.0.0
c. n = 30 : 255.255.255.252

P18-10. Change each of the following masks to a prefix length:
a. 255.224.0.0 : 11
b. 255.240.0.0 : 12
c. 255.255.255.128 : 25

P18-11. Which of the following cannot be a mask in CIDR?
a. 255.225.0.0
b. 255.192.0.0
c. 255.255.255.6

P18-12. Each of the following addresses belongs to a block. Find the first and the last address in each block.
a. 14.12.72.8/24 : 14.12.72.0 ~ 14.12.72.255
b. 200.107.16.17/18 : 200.107.0.0 ~ 200.107.63.255
c. 70.110.19.17/16 : 70.110.0.0 ~ 70.110.255.255

P18-13. Show the n leftmost bits of the following network-addresses/masks that can be used in a forwarding table.
a. 170.40.11.0/24 : 10101010 00101000 00001011
b. 110.40.240.0/22 : 01101110 00101000 111100
c. 70.14.0.0./18 : 01000110 00001110 00

P18-14. Explain how DHCP can be used when the size of the block assigned to an organization is less than the number of hosts in the organization.
A : DHCP dynamically provides the connection to the host on demand, so multiple hosts will be connected and disconnected via request and release

P18-15. Compare NAT and DHCP. Both can solve the problem of a shortage of addresses in an organization, but by using different strategies.
A : NAT maps the global address into the virtual address, covering the shortage of addresses by making it look like it has more addresses. DHCP dynamically connects/disconnects the hosts on demand.

P18-16. Assume we have an internet with an 8-bit address space. The addresses are equally divided between four networks (N0 to N3). The internetwork communication is done through a router with four interfaces (m0 to m3). Show the internet outline and the forwarding table (with two columns: prefix in binary and the interface number) for the only router that connects the networks. Assign a network address to each network.

Prefix	Interface
00	m0
01	m1
10	m2
11	m3

P18-17. Assume we have an internet with a 12-bit address space. The addresses are equally divided between eight networks (N0 to N7). The internetwork communication is done through a router with eight interfaces (m0 to m7). Show the internet outline and the forwarding table (with two columns: prefix in binary and the interface number) for the only router that connects the networks. Assign a network address to each network.

Prefix	Interface
000	m0
001	m1
010	m2
011	m3
100	m4
101	m5
110	m6
111	m7

P18-18. Assume we have an internet with a 9-bit address space. The addresses are divided between three networks (N0 to N2), with 64, 192, and 256 addresses respectively. The internetwork communication is done through a router with three interfaces (m0 to m2). Show the internet outline and the forwarding table (with two columns: prefix in binary and the interface number) for the only router that connects the networks. Assign a network address to each network.

Prefix	Interface
111	m2
0	m0
1	m1

P18-19. Combine the following three blocks of addresses into a single block:
a. 16.27.24.0/26 b. 16.27.24.64/26 c. 16.27.24.128/25
A : 16.27.24.0/24

P18-20. A large organization with a large block address (12.44.184.0/21) is split into one medium-size company using the block address (12.44.184.0/22) and two small organizations. If the first small company uses the block (12.44.188.0/23), what is the remaining block that can be used by the second small company? Explain how the datagrams destined for the two small companies can be correctly routed to these companies if their address blocks still are part of the original company.
A : 12.44.184.0/23, the routing is done correctly, because the roting table's search method is longest prefix matching, which matches the address with mask in the order of the longer prefix

P18-21. An ISP is granted the block 16.12.64.0/20. The ISP needs to allocate addresses for 8 organizations, each with 256 addresses.
a. Find the number and range of addresses in the ISP block
2^12 addresses, range 16.12.64.0 ~ 16.12.79.255
b. Find the range of addresses for each organization and the range of unallocated addresses.
16.12.64.0 ~ 16.12.64.255
16.12.65.0 ~ 16.12.65.255
16.12.66.0 ~ 16.12.66.255
16.12.67.0 ~ 16.12.67.255
16.12.68.0 ~ 16.12.68.255
16.12.69.0 ~ 16.12.69.255
16.12.70.0 ~ 16.12.70.255
16.12.71.0 ~ 16.12.71.255

unallocated : 16.12.72.0 ~ 16.12.79.255

c. Show the outline of the address distribution and the forwarding table.

Prefix	Interface
16.12.64.0/24	m0
16.12.65.0/24	m1
16.12.66.0/24	m2
16.12.67.0/24	m3
16.12.68.0/24	m4
16.12.69.0/24	m5
16.12.70.0/24	m6
16.12.61.0/24	m7

P18-22. An ISP is granted the block 80.70.56.0/21. The ISP needs to allocate addresses for two organizations each with 500 addresses, two organizations each with 250 addresses, and three organizations each with 50 addresses.
a. Find the number and range of addresses in the ISP block.
2^11 addresses, range 80.70.56.0 ~ 80.70.63.255
b. Find the range of addresses for each organization and the range of unallocated addresses.
80.70.56.0 ~ 80.70.57.255
80.70.58.0 ~ 80.70.58.255
80.70.59.0 ~ 80.70.59.255
80.70.60.0 ~ 80.70.60.63
80.70.60.64 ~ 80.70.60.127

80.70.60.128 ~ 80.70.60.191
unallocated : 80.70.60.192 ~ 80.63.255

c. Show the outline of the address distribution and the forwarding table.

Prefix	Interface
80.70.56.0/23	m0
80.70.58.0/24	m1
80.70.59.0/24	m2
80.70.60.0/26	m3
80.70.60.64/26	m4
80.70.60.128/26	m5

P18-23. An organization is granted the block 130.56.0.0/16. The administrator wants to create 1024 subnets.
a. Find the number of addresses in each subnet : 2^6 addresses
b. Find the subnet prefix : 10000010 00111000(130.56)
c. Find the first and the last address in the first subnet : 130.56.0.63
d. Find the first and the last address in the last subnet : 130.56.255.255

P18-24. Can router R1 in Figure 18.35 receive a packet with destination address 140.24.7.194? What will happen to the packet if this occurs?
A : Yes, it will be forwarded via interface m3, the default router (R2)

P18-25. Assume router R2 in Figure 18.35 receives a packet with destination address 140.24.7.42. How is the packet routed to its final destination?
A : It will be first headed to R1, and then will be forwarded to Organization 1, which is interface m0 in R1