1): We made a distinction between the forwarding function and the routing function performed in the network layer. What are the key differences between routing and forwarding?

The key differences between forwarding and routing is that forwarding moves packets from router's input to appropriate router output, whereas routing determines the route taken by packets from source to destination. Typically, routing is done continuously before any forwarding to establish the routing tables before the packets are forwarded.

2): What is a private network address? Should a datagram with a private network address ever be present in the larger public Internet?

Within a private network there may be several computers. The computers in the network may share data easily, however, if a computer wants to access the Internet, they must have a unique IP address. The network may provide the computer with it’s own network address allowing the computer access to the Internet. That means only one public address is needed for hundreds or even thousands of users.

3): Consider a datagram network using 32-bit host addresses. Suppose a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as follows:

|  |  |
| --- | --- |
| Destination Address Range | Link Interface |
| 11100000 00000000 00000000 00000000  Through  11100000 00111111 11111111 11111111 | 0 |
| 11100000 01000000 00000000 00000000  Through  11100000 01000000 11111111 11111111 | 1 |
| 11100000 01000010 00000000 00000000  Through  11100001 01111111 11111111 11111111 | 2 |
| Otherwise | 3 |

a. Complete the following forwarding table according to the above setting, assuming longest prefix matching is used to decide where to forward a packet to the correct link interface. Note that the column of network prefix should be presented in decimal form of a.b.c.d/x. You need to decide how many entries that this table requires. Forwarding Table:

|  |  |
| --- | --- |
| Network Prefix (Decimal) | Output Link Interface |
| 11100000 00 | 0 |
| 11100000 01000000 | 1 |
| 1110000 | 2 |
| 11100001 1 | 3 |
| otherwise | 3 |

b. Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses:

11001000 10010001 01010001 01010101 – maps to link 3 (otherwise)

11100001 01000000 11000011 00111100 – maps to link 2 (1110000)

11100001 10000000 00010001 01110111 – maps to link 3 (1110001 1)

4): 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 128.16.0.0/12. Also suppose that Subnet 1 is required to support up to 300 interfaces, Subnet 2 is to support up to 120 interfaces, and Subnet 3 is to support up to 400 interfaces. Provide three network prefixes (of the form a.b.c.d/x) for the three subnets that satisfy these constraints.

Subnet1 requires 300 interfaces + 2 \* ( network + broadcast ) = 512 (2^9)

Subnet2 requires 120 interfaces + 2 \* ( network + broadcast ) = 128 (2^7)

Subnet3 requires 400 interfaces + 2 \* ( network + broadcast ) = 512 (2^9)

One solution:

Subnet2: 128.16.0.0/25: 128.16.0.0 -> 128.16.0.127

Subnet1: 128.16.0.128/23: 128.16.0.128 -> 128.16.2.127

Subnet3: 128.16.2.128/23: 128.16.2.128 -> 128.16.4.127

5): Consider a subnet with prefix 223.168.48.0/23. Suppose an ISP wants to create two subnets (Subnet 1 and Subnet 2) from the block of addresses defined by 223.168.48.0/23, with each block having the same number of IP addresses. Consider Subnet 1 takes addresses in the lower range, while Subnet 2 takes addresses in the upper range. What are the network prefixes (of the form a.b.c.d/x) for the two subnets?

Subnet1: 223.168.48.0/23: 223.168.48.0 -> 223.168.49.255

Subnet2: 223.168.50.0/23: 223.168.50.0 -> 223.168.51.255

6): IPv6 uses 16-byte addresses. If a block of 1 million addresses is allocated every picoseconds, how long will the addresses last? Compare that with the age of our universe (≈ 10^10 years)

In IPv6 there are 2^128 possible addresses. At a rate of (10^6 addresses allocated / (10^-12) seconds)

(2^128 addresses) / (10^18) = 340282366920938463463 s => 10790283070806 years

This is about 1079 times longer than the entire known existence of our universe.