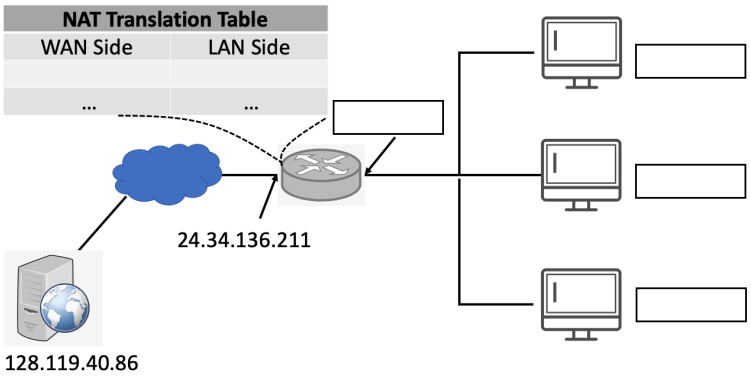
Assignment 4: IP and Network Routing

Please submit your answers in a single PDF file.

1. (2 points) IPv6 uses 128-bit 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).

2. (5 points) Consider the network setup in the following figure. Suppose that the ISP assigns the router the address 24.34.136.211 and that the network prefix of the home network is 192.168.1.0/24.



   a. Assign addresses to all 3 interfaces in the home network and the network interface of the router connected to the home network.
   b. Suppose each host has 2 ongoing TCP connections, all to port 80 at host 128.119.40.86. Provide the 6 corresponding entries in the NAT translation table.

NAT Translation Table	
WAN Side	LAN Side

3. (1 point) 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?

4. (4 points) 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 01110000 00000000 00000000 through 11100000 01111111 11111111 11111111	2
11100001 10110000 00000000 00000000 through 11100001 10111111 11111111 11111111	3
11100010 10000000 00000000 00000000 through 11100010 11111111 11111111 11111111	4

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 the 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

b. According to the above forwarding table, give the output link interface for each datagram with the following destination addresses:

   225.180.128.1, 224.135.1.2, 224.111.0.1

5. (3 points) 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 should use addresses in a large block defined by prefix 128.16.0.0/12. You need to further divide this large address block into three smaller **non-overlapping** address blocks for these three subnets. They need to further meet the following conditions:

   a. Subnet 1 is required to support at least 300 interfaces, and the last address for this subnet is 128.31.255.255.
   b. Subnet 2 is to support at least 120 interfaces, and the last address for this subnet is 128.16.1.127.
   c. Subnet 3 is to support at least 400 interfaces, and the last address for this subnet is 128.17.7.255.

   Provide three network prefixes (of the form a.b.c.d/x) for the three subnets that satisfy the above constraints and also minimize the numbers of addresses for these subnets.