|  |  |
| --- | --- |
|  | CS 542 - Assignment 1 |
|  |  |
|  | Sukanta Sharma (A20472623), Vidya Sudarshan (A20472468), Vidhi Kakini (A20473969)  CS 542 – Computer Networks – I | Spring 2021 | Illinois Institute of Technology  4/1/21 |

1. What is the range of addresses that can assign to users in the 2021 block of class C? (3 points)

Ans:

Class C addresses start with to with the first 3 bytes as Net Id and the last byte as Host Id. As the block number starts with 0, so the 2021st block will be to be added to the first block of class C.

## 2021st Block:

To find the first address of the 2021st block, we need to add to the Net Id of the first address of the class C in base-256 number system.

**Converting**  **to base-256:**

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 2020 | 7 | 228 |
| 256 | 228 | 0 | 7 |

Therefore, 🡪

To get the range of the addresses in the 2021st block class C, we must find the first and the last address of the given block.

## First Address:

To find the first address of the 2021st block, we need to add with the Net Id .

| **+/-** | **Byte4** | **Byte3** | **Byte2** |
| --- | --- | --- | --- |
|  | 192 | 0 | 0 |
| + |  | 7 | 228 |
| **Result** | **192** | **7** | **228** |

With Net ID followed by zeros (0 bits), we can find the first address in the 2021st block as .

## Last Address:

As this is a class C address and the number of Host Id bits is 8, so each block will have addresses. To find the last address of the 2021st block, we need to add to the first address of the block.

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 192 | 7 | 228 | 0 |
| + |  |  |  | 255 |
| **Result** | **192** | **7** | **228** | **255** |

So, the last address in the 2021st block as .

The range of addresses that can assign to users in the 2021st block of class C is .

1. Convert the number C0514019 in the hexadecimal base to the dotted-decimal notation. What is the class of this address? (consider classful addressing). (5 points)

Ans:

* Hexadecimal is a base-16 numerical system. It uses 16 distinct symbols to represent the value from 0 to 9, and to represent the value from 10 – 15. Here we will be considering per 2 digits of the hexadecimal to be equivalent to 1 byte in dotted-decimal notation and convert it to base-256 by each byte.

| **Hexadecimal** | **Conversion** | **Base-256 System** |
| --- | --- | --- |
|  |  |  |
|  | 5 |  |
|  | 4 |  |
|  | 1 |  |

The equivalent number of in dotted-decimal notation is **.**

1. Define the 1202 block of class B? (Give first and last address in the block) (3 points)

Ans:

Class B addresses start with to with the first 2 bytes as Net Id and the last 2 bytes as Host Id. As the block number starts with 0, so the 1202nd block will be to be added to the first block of class B.

## 1202nd Block:

To find the first address of the 1202nd block, we need to add to the Net Id of the first address of the class B in base-256 number system.

**Converting**  **to base-256:**

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 2020 | 7 | 228 |
| 256 | 228 | 0 | 7 |

Therefore, 🡪

To get the range of the addresses in the 1202nd block class B, we must find the first and the last address of the given block.

## First Address:

To find the first address of the 1202nd block, we need to add with the Net Id .

| **+/-** | **Byte4** | **Byte3** |
| --- | --- | --- |
|  | 128 | 0 |
| + | 4 | 177 |
| **Result** | **132** | **177** |

With Net ID followed by zeros (0 bits), we can find the first address in the 1202nd block as .

## Last Address:

As this is a class B address and the number of Host Id bits is 16, so each block will have addresses. To find the last address of the 1202nd block, we need to add to the first address of the block (i.e., ).

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 132 | 177 | 0 | 0 |
| + |  |  | 255 | 255 |
| **Result** | **132** | **177** | **255** | **255** |

So, the last address in the 1202nd block as .

The range of addresses that can assign to users in the 1202nd block of class B is .

1. Convert the decimal number 5141.01568603515625 to the base 256 number system. (5 points)

Ans:

To convert to base-256 number system, we need to convert the integer part and the fraction part separately to base-256 and then we can combine them to obtain the result.

## Integer Part 🡪 :

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 5141 | 20 | 21 |
| 256 | 20 | 0 | 20 |

Therefore, 🡪

## Fraction Part 🡪 :

| **Multiplicand** | **Multiplier** | **Result** | **Integer Part** |
| --- | --- | --- | --- |
| 0.015686035 | 256 | 4.015625 | 4 |
| 0.015625 | 256 | 4 | 4 |

Therefore, 🡪 *[“,” is used as decimal point notation and “.” as separator of base-256 digits]*

Now, concatenating both the result we can write, 🡪 *[“,” is used as decimal point notation and “.” as separator of base-256 digits]*

1. What is the value of ? Give results in 256 base system. (Given numbers are in 256 base system) (4 points)

Ans:

## Conversion of to base-256 number system:

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 768 | 3 | 0 |
| 256 | 3 | 0 | 3 |

Therefore, is equivalent to

1. An organization is granted the block . The administrator wants to create 16 subnets.
2. Find the subnet mask (1 point).

Ans:

The block given to us is . The administrator wants to create 16 subnets. So, the number of extra bits that need to be added to the default mask is .

Subnet mask will be, *[in slash notation]* or *[in dotted-decimal notation].*

1. Find the number of addresses in each subnet (1 point)

Ans:

Here the number of bits of prefix *(same as the mask)*

The number of bits of suffix

The number address in each subnet is given by,

Therefore, the number of addresses in each subnet is  **addresses per subnet.**

1. Find the subnet address and the direct broadcast address for the first subnet. (2 points)

Ans:

## Subnet Address:

The subnet address is the first address of the given subnet. The first address of the first subnet is nothing but the first address of the given network, that is and the mask for this subnet is . So, subnet address of the first block is **.**

## Direct Broadcast Address:

The direct broadcast address is the last address of the given subnet. There are addresses in each subnet. So, to find the last address of the given subnet we need to add .

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 142 | 200 | 208 | 0 |
| + |  |  |  | 127 |
| **Result** | **142** | **200** | **208** | **127** |

Therefore, the direct broadcast address is **.**

1. Find the 4th and 99th addresses in the last subnet. (4 points)

Ans:

## 4th address:

There are address in each subnet. So, the 4th address of the last subnet (i.e., 16th subnet) is given by,

address

address

address

So, to get the 4th address of 16th subnet we need to add to the first address of the network in base-256 number system.

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 1923 | 7 | 131 |
| 256 | 3 | 0 | 7 |

Therefore, 🡪

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 142 | 200 | 208 | 0 |
| + |  |  | 7 | 131 |
| **Result** | **142** | **200** | **215** | **131** |

So, the 4th address of the last subnet is

## 99th address:

There are address in each subnet. So, the 99th address of the last subnet (i.e., 16th subnet) is given by,

address

address

address

So, to get the 9th address of 16th subnet we need to add to the first address of the network in base-256 number system.

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 1923 | 7 | 226 |
| 256 | 7 | 0 | 226 |

Therefore, 🡪

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 142 | 200 | 208 | 0 |
| + |  |  | 7 | 226 |
| **Result** | **142** | **200** | **215** | **226** |

So, the 4th address of the last subnet is

1. Give the mask in the dotted-decimal notation:
2. For a block of Class-A which results in 128 subnets (1 point)

Ans:

For class A, the default mask is . To have 128 subnets, it requires extra one’s bit. So, the mask, for a block of class A which results in subnets, is *[in slash notation]* or *[in dotted-decimal notation].*

1. Which combines 128 blocks of Class C into a supernet (1 point)

Ans:

For class C, the default mask is . To combine 128 blocks into a supernet, it requires less one’s bit. So, the mask, which combines blocks of class C into a supernet, is *[in slash notation]* or *[in dotted-decimal notation].*

1. Convert an IP address 254.128.64.32 to the binary notation (2 points)

Ans:

To convert the IP address to the binary notation, we need to convert each byte into binary. Then we can concatenate the binary numbers together to get the binary notation of the given IP address.

## Decimal to Binary Conversion:

| **#Byte** | **Value (in Decimal)** | **Value (in Binary)** |
| --- | --- | --- |
| 1 | 32 | 00100000 |
| 2 | 64 | 01000000 |
| 3 | 128 | 10000000 |
| 4 | 254 | 11111110 |

The equivalent IP address of in binary notation is given as,

**11111110 10000000 01000000 00100000.**

1. The 14th address of a block assigned to a specific organization is . The organization needs 120 addresses to give to its 120 users. Find the mask and define this block of addresses. Is there any wastage of the IP addresses? If yes, how many? (Note: The number of router interfaces is 2) (4 points)

Ans:

## Mask:

Given IP address belongs to class A, which has the default mask as . It is given that, there are 2 router interfaces. So, the number of subnets is 2 and the number of extra bits to create the subnet is . Therefore, the mask for the block is *[in slash notation]* or *[in dotted-decimal notation]*.

## Block Definition:

To define the given block, we need to find the first and the last address of the block.

## First Address:

The 14th address of a block is . To find the first address of the block we need to subtract from the given address in base-256 number system.

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 120 | 65 | 89 | 141 |
| - |  |  |  | 13 |
| **Result** | **120** | **65** | **89** | **128** |

The first address of the block is .

## Last Address:

The mask for the block is , that means the number of prefix bits is and the number of suffix bits is . So, the total number of addresses in the block is . To find the last address we need to add to the first address of the block in base-256 number system. The conversion from decimal to base-256 number system is given as,

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 8388607 | 32767 | 255 |
| 256 | 32767 | 127 | 255 |
| 256 | 127 | 0 | 127 |

Therefore, 🡪 . Adding to the first address of the block is given by,

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 120 | 65 | 89 | 128 |
| + |  | 127 | 255 | 255 |
| **Result** | **120** | **193** | **89** | **127** |

Therefore, the last address of the block is **.**

The given block can be defined as a block with  **address** and the range from **to** **.**

## IP address wasted:

Total number of addresses in the given block is and the organization needs only address. So, the number of address wasted is **.**

1. A block of addresses granted to an ISP. These addresses are allocated between two groups of customers. The first group has 20 customers, each of which needs 64 addresses, the second group has 20 customers, each of which needs 128 addresses. Show the subblocks and range of addresses for the 10th customer of the first group and the 10th customer of the second group. How many addresses are still available after this allocation? (5 points)

Ans:

From the above information we can conclude that the address block need to be divided into first group with subnets with 64 addresses in each subnet and subnets with addresses in each subnet.

## First Group:

There are addresses in each subnet. So, the number of suffix bits is and the prefix bits is . Therefore, the mask for each of this block is *[in slash notation]*.

So, the first address of the 10th customer or the 10th subnet is given by,

address

address

address

So, to get the first address of 10th subnet we need to add to the first address of the block in base-256 number system.

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 576 | 2 | 64 |
| 256 | 2 | 0 | 2 |

Therefore, 🡪

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 120 | 200 | 240 | 0 |
| + |  |  | 2 | 64 |
| **Result** | **120** | **200** | **242** | **64** |

So, the first address of the 10th subnet is

Now, to get the last address of 10th subnet we need to add to the first address of the subnet in base-256 number system.

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 120 | 200 | 242 | 64 |
| + |  |  |  | 63 |
| **Result** | **120** | **200** | **242** | **127** |

Therefore, the last address of this subnet is

Therefore, the subblock for the 10th customer of the first group has  **address** and the range of the subblock is from  **to**

## Second Group:

There are addresses in each subnet. So, the number of suffix bits is and the prefix bits is . Therefore, the mask for each of this block is *[in slash notation]*.

So, the first address of the 10th customer of the second group is given by,

address

address

address

So, to get the first address of 10th customer we need to add to the first address of the block in base-256 number system.

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 2432 | 9 | 128 |
| 256 | 9 | 0 | 9 |

Therefore, 🡪

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 120 | 200 | 240 | 0 |
| + |  |  | 9 | 128 |
| **Result** | **120** | **200** | **249** | **128** |

So, the first address of the 10th customer in second group is

Now, to get the last address of 10th customer in second group we need to add to the first address of this subnet in base-256 number system.

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 120 | 200 | 249 | 128 |
| + |  |  |  | 127 |
| **Result** | **120** | **200** | **249** | **255** |

Therefore, the last address of this subnet is

Therefore, the subblock for the 10th customer of the second group has  **address** and the range of the subblock is from  **to**

## Available Address:

The ISP granted the IP address with mask . So, the number of suffix bits is .

There is total addresses for the granted block and the total number address used is given by,

addresses

addresses

Therefore, there  **addresses** are still available after this allocation.

1. Find first address, last address, and number of addresses in the block, if one of the addresses in a block is (3 points)

Ans:

## First Address:

To find the first address or network address we need to perform logical **AND** operation between the given IP address and the mask. As the mask is , so we can perform this **AND** operation with the left 4 bits of the third byte from the left. The third byte is given as or .

Now,

In the network address first 16 bits will be all ones which is , third byte is and the rest of the bits will be all zeros.

Therefore, the network address or the first address is **.**

## Last Address:

One of the addresses in a block is given as . So, the number of suffix bits is .There number of suffix bits is . So, the total number of address is . To find the last address we need to add to the first address of the block in base-256 number system.

| **Divisor** | **Dividend** | **Quotient** | **Remainder** |
| --- | --- | --- | --- |
| 256 | 4096 | 15 | 255 |
| 256 | 15 | 0 | 15 |

Therefore, 🡪

| **+/-** | **Byte4** | **Byte3** | **Byte2** | **Byte1** |
| --- | --- | --- | --- | --- |
|  | 140 | 240 | 80 | 0 |
| + |  |  | 15 | 255 |
| **Result** | **140** | **240** | **95** | **255** |

So, the last address of the block is

## Number of Addresses:

One of the addresses in a block is given as . So, the number of suffix bits is .There number of suffix bits is . So, the total number of addresses is **.**

1. Consider the following routing table (the next-hop address is omitted):

| **Mask** | **Network Address** | **Interface** |
| --- | --- | --- |
| /27 | 144.56.55.0 | M0 |
| /26 | 123.80.97.0 | M1 |
| /25 | 123.80.97.128 | M2 |
| /24 | 118.114.132.0 | M3 |
| Default | Default | M4 |

Give the interface number for a packet whose destination IP address is:

1. 144.56.55.31 (1 point)

Ans:

To find the network address of the given IP address, we need to apply the masks in descending order. If the resultant network address is found, then the corresponding interface is chosen and if the resultant network address can not be found in the routing table the default interface is chosen.

The masks are applied as given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Destination IP Address** | **Mask** | **IP Address in binary (only in last byte) [A]** | **Mask in binary (only in last byte) [B]** | **[A] AND [B]** | **Network Address** |
| 144.56.55.31 | /27 | 3110 🡪 000101112 | 111000002 | 00000000­2 🡪 010 | 144.56.55.0 |

As, the resultant network address for mask is found in the routing table, the interface number chosen is **M0**.

1. 144.56.56.31 (1 point)

Ans:

The masks are applied as given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Destination IP Address** | **Mask** | **IP Address in binary (only in last byte) [A]** | **Mask in binary (only in last byte) [B]** | **[A] AND [B]** | **Network Address** |
| 144.56.56.31 | /27 | 3110 🡪 000101112 | 111000002 | 00000000­2 🡪 010 | 144.56.56.0 |
| 144.56.56.31 | /26 | 3110 🡪 000101112 | 110000002 | 00000000­2 🡪 010 | 144.56.56.0 |
| 144.56.56.31 | /25 | 3110 🡪 000101112 | 100000002 | 00000000­2 🡪 010 | 144.56.56.0 |
| 144.56.56.31 | /24 | 3110 🡪 000101112 | 000000002 | 00000000­2 🡪 010 | 144.56.56.0 |

As, the resultant network address for all masks is found in the routing table and the interface number chosen is **M4**.

1. 123.80.97.60 (1 point)

Ans:

The masks are applied as given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Destination IP Address** | **Mask** | **IP Address in binary (only in last byte) [A]** | **Mask in binary (only in last byte) [B]** | **[A] AND [B]** | **Network Address** |
| 123.80.97.60 | /27 | 6010 🡪 001111002 | 111000002 | 00100000­2 🡪 3210 | 123.80.97.32 |
| 123.80.97.60 | /26 | 6010 🡪 001111002 | 110000002 | 00000000­2 🡪 010 | 123.80.97.0 |

As, the resultant network address for mask is found in the routing table and the interface number chosen is **M1**.

1. 123.80.97.200 (1 point)

Ans:

The masks are applied as given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Destination IP Address** | **Mask** | **IP Address in binary (only in last byte) [A]** | **Mask in binary (only in last byte) [B]** | **[A] AND [B]** | **Network Address** |
| 144.56.55.31 | /27 | 3110 🡪 000101112 | 111000002 | 00000000­2 🡪 010 | 144.56.55.0 |
| 144.56.55.31 | /26 | 3110 🡪 000101112 | 110000002 | 00000000­2 🡪 010 | 144.56.55.022 |
| 144.56.55.31 | /25 | 3110 🡪 000101112 | 100000002 | 00000000­2 🡪 010 | 144.56.55.022 |
| 144.56.55.31 | /24 | 3110 🡪 000101112 | 000000002 | 00000000­2 🡪 010 | 144.56.55.022 |

As, the resultant network address for mask is found in the routing table and the interface number chosen is **M0**.

1. 123.80.97.88 (1 point)

Ans:

The masks are applied as given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Destination IP Address** | **Mask** | **IP Address in binary (only in last byte) [A]** | **Mask in binary (only in last byte) [B]** | **[A] AND [B]** | **Network Address** |
| 144.56.55.31 | /27 | 3110 🡪 000101112 | 111000002 | 00000000­2 🡪 010 | 144.56.55.0 |
| 144.56.55.31 | /26 | 3110 🡪 000101112 | 110000002 | 00000000­2 🡪 010 | 144.56.55.022 |
| 144.56.55.31 | /25 | 3110 🡪 000101112 | 100000002 | 00000000­2 🡪 010 | 144.56.55.022 |
| 144.56.55.31 | /24 | 3110 🡪 000101112 | 000000002 | 00000000­2 🡪 010 | 144.56.55.022 |

As, the resultant network address for mask is found in the routing table and the interface number chosen is **M0**.

1. 118.114.133.1 (1 point)

Ans:

The masks are applied as given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Destination IP Address** | **Mask** | **IP Address in binary (only in last byte) [A]** | **Mask in binary (only in last byte) [B]** | **[A] AND [B]** | **Network Address** |
| 144.56.55.31 | /27 | 3110 🡪 000101112 | 111000002 | 00000000­2 🡪 010 | 144.56.55.0 |
| 144.56.55.31 | /26 | 3110 🡪 000101112 | 110000002 | 00000000­2 🡪 010 | 144.56.55.022 |
| 144.56.55.31 | /25 | 3110 🡪 000101112 | 100000002 | 00000000­2 🡪 010 | 144.56.55.022 |
| 144.56.55.31 | /24 | 3110 🡪 000101112 | 000000002 | 00000000­2 🡪 010 | 144.56.55.022 |

As, the resultant network address for mask is found in the routing table and the interface number chosen is **M0**.

1. The routing table of routers R1, R2, and R3 are given. Draw the possible network configuration with all 3 routers, not separate configurations corresponding to each routing table. Indicate the next-hop addresses in the figure. (10 points)

R1:

| **Mask** | **Network Address** | **Next-Hop Address** | **Interface Number** |
| --- | --- | --- | --- |
| /24 | 80.70.56.0 | 100.160.32.67 | M2 |
| /24 | 130.135.7.0 | 150.137.45.78 | M1 |
| /16 | 180.170.0.0 | ----------------- | M0 |
| /16 | 100.160.0.0 | ----------------- | M2 |
| /16 | 150.137.0.0 | ----------------- | M1 |
| Default | Default | 180.170.4.6 | M0 |

R2:

| **Mask** | **Network Address** | **Next-Hop Address** | **Interface Number** |
| --- | --- | --- | --- |
| /24 | 80.70.56.0 | ----------------- | M0 |
| /16 | 100.160.0.0 | ----------------- | M1 |
| Default | Default | 100.160.56.7 | M1 |

R3:

| **Mask** | **Network Address** | **Next-Hop Address** | **Interface Number** |
| --- | --- | --- | --- |
| /24 | 130.135.7.0 | ----------------- | M0 |
| /16 | 150.137.0.0 | ----------------- | M1 |
| Default | Default | 150.137.72.48 | M1 |

Ans:

Considering the above routing tables for R1, R2, and R3, the possible network configuration diagram with all 3 routers is shown as below:



Figure 1: Network Diagram

1. Consider the network configuration below. A packet arrived at the router R3 with the destination address 150.14.8.56. Show how it is forwarded. (Assume classless addressing and mask of each network is /24) Create a routing table for R1 and R3. (10 points)Ans: