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Computer Network Assignment

1. What is the address space in each of the following systems?

(a) A system with 8-bit address

An address space is the total number of addresses used by the protocol. If a protocol uses N bits to define an address, the address space is 2^N.

For a system with 8-bit addresses, N = 8 bits.

Therefore, the address space of the system $= 2^8 = 256$

(b) A system with 16-bit addresses

For a system with 16-bit addresses, N = 16 bits

Therefore, the address space of the system :-

$$2^{16} = 65,536$$

(c) A system with 64-bit addresses

For a system with 64-bit addresses, N = 64 bits

Therefore, the address space of the system :-

$$2^{64} = 1.844674407 \times 10^{19}$$
$$= 18,446,744,073,709,551,61$$

2. An address space has a total of 1024 addresses. How many bits are needed to represent an address?

We need $\log_2(n)$ bits to ~~ad~~ represent an address
n bytes

Here, $N = 1024$

So, $\log_2(1024) = 10$

Only 10 bits are needed to represent an address.

3. An address space uses three symbols: 0, 1, and 2 to represent addresses. If each address is made of 10 symbols, how many addresses are available in this system?

As it is given that address space uses the three symbols 0, 1, and 2 to represent addresses.
If each address is made of 10 symbols,

So the number of addresses are available in this system are :-

$$3^{10} = 59,049$$

4. Change the following IP addresses from dotted-decimal notation to binary notation:

(a) 114.34.2.8

In order to change the given IP address from dotted-decimal notation to binary notation, we need to replace each decimal number with its binary equivalent

114 . 34 . 2 . 8

01110010 00100010 00000010 00001000

Binary notation of 114.34.2.8 is :-

01110010 . 00100010 . 00000010 . 00001000

(b) 129.14.6.8

129 . 14 . 6 . 8

10000001 00001110 00000110 00001000

Binary notation of 129.14.6.8 is :-

10000001 . 00001110 . 00000110 . 00001000

(c) 208 · 34 · 54 · 12

208 · 34 · 54 · 12

11010000   00100010   00110110   00001100

Binary notation of 208 · 34 · 54 · 12 is :-

11010000   00100010   00110110   0001100

(d) 238 · 34 · 2 · 1

238 · 34 · 2 · 1

11101110   00100010   00000010   00000001

Binary notation of 238 · 34 · 2 · 1 is :-

11101110   00100010   00000010   00000001

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5. Change the following IP addresses from dotted-decimal notation to hexadecimal notation

(a) 114.34.2.8

In order to change the given IP addresses from dotted-decimal notation to hexadecimal notation, we need to replace each decimal number with its hexadecimal equivalent

$$\begin{array}{cccc} 114 \,. & 34 \,. & 2 \,. & 8 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 72 & 22 & 02 & 08 \end{array}$$

Hexadecimal notation of 114.34.2.8 is :- 72 22 02 08

(b) 129.14.6.8

$$\begin{array}{cccc} 129 \,. & 14 \,. & 6 \,. & 8 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 81 & E & 06 & 08 \end{array}$$

Hexadecimal notation of 129.14.6.8 is :-

81 E 06 08

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(c) 208 . 34 . 54 . 12

$$\begin{array}{cccc} 208 \cdot & 34 \cdot & 54 \cdot & 12 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ D0 & 22 & 36 & C \end{array}$$

Hexadecimal notation of 208 . 34 . 54 . 12 is:-

D0 22 36 C

(d) 238 . 34 . 2 . 1

$$\begin{array}{cccc} 238 \cdot & 34 \cdot & 2 \cdot & 1 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ EE & 22 & 02 & 01 \end{array}$$

Hexadecimal notation of 238 . 34 . 2 . 1 is:-

EE 22 02 01

6. Change the following IP address from hexadecimal notation to binary notation :-

(a) 0x1347FEAB

0x 1 3 4 7 F E A B

0001 0011 0100 0111 1111 1110 1010 1011

~~Binary~~ In order to change the given IP addresses from hexadecimal notation to binary notation, we need to replace each hexadecimal number with ists binary equivalent.

Binary notation of 0x1347FEAB is :-

00010011 01000111 11111110 10101011

(b) 0xAB234102

$0x_{16}$ A B 2 3 4 1 0 2

1010 1011 0010 0011 0100 0001 0000 0010

Binary notation of 0xAB234102 is :-

10101011 00100011 01000001 00000010

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(c) 0x0123A2BE

0x 0 1 2 3 A 2 B E

16 0000 0001 0010 0011 1010 0010 1011 1110

Binary notation of 0x0123A2BE is :-

00000001 00100011 10100010 10111110

(d) 0x00001111

0x 0 0 0 0 1 1 1 1

16 0000 0000 0000 0000 0001 0001 0001 0001

Binary notation of 0x00001111 is :-

00000000 00000000 00010001 00010001

7. How many hexadecimal digits are needed to define the netid in each of the following classes?

(a) Class A

In Class-A, 1 byte defines the netid

We already know that,

1 byte = 8 bits

and we also know that,

4 bits needed to define a hexadecimal digit

So,

(8 bits) / (4 bits per hexadecimal digits) =

2 hexadecimal digits.

2 Hexadecimal digits are needed to define the netid in the Class A.

(b) Class B

In Class B, 2 bytes define the netid

We already know that,

1 byte = 8 bits

$\Rightarrow$ 2 bytes = 16 bits

and we also know that, 4 bits needed to define a hexadecimal digit

So,

(16 bits) / (4 bits per hexadecimal digit) = 4 hexadecimal digits.

4 Hexadecimal digits are needed to define the netid in the class B

(c) Class C

In Class - C, 3 bytes define the netid

We already know that,

1 byte = 8 bits
3 bytes = 24 bits

and we also know that, 4 bits needed to define a hexadecimal digit

So,

(24 bits) / (4 bits per hexadecimal digit)

= 6 hexadecimal digit

6 Hexadecimal digit are needed to define the netid in the class - C.

8. Change the following IP addresses from binary notation to dotted - decimal notation.

(a) 01111111 11110000 01100111 01111101

In order to change the given IP address from binary notation to dotted - decimal notation, we need to replace each binary number with its decimal number equivalent and add dots for separation.

01111111	11110000	01100111	01111101
↓	↓	↓	↓
127	240	103	125

Dotted - decimal notation of 01111111 11110000 01100111 01111101 is:-

127 · 240 · 103 · 125

(b) 10101111 11000000 11111000 00011101

10101111	11000000	11111000	00011101
↓	↓	↓	↓
175	192	248	29

Dotted - decimal notation of 10101111 11000000 11111000 00011101 is:-

175 · 192 · 248 · 29

(c) 11011111 10110000 00011111 01011101

11011111	10110000	00011111	01011101
↓	↓	↓	↓
223	176	31	93

Dotted-decimal notation of 11011111 10110000 00011111 01011101 is:-

223 . 176 . 31 . 93

(d) 11101111 11110111 11000111 00011101

11101111	11110111	11000111	00011101
↓	↓	↓	↓
239	247	199	29

Dotted-decimal notation of 11101111 11110111 11000111 00011101 is:-

239 . 247 . 199 . 29

9. Find the class of the following IP addresses :-

(a) 208.34.54.12

The first byte is 208 (between 192 and 223);

The class is C.

(b) 238.34.2.1

The first ~~type~~ byte is 238 (between 224 and 239);

The class is D.

(c) 242.34.2.8

The first byte is 242 (between 240 and 255);

The class is E.

(d) 129.14.6.8

The first byte is 129 (between 128 and 191);

The class is B

10. Find the class of the following IP addresses

(a) 11110111 11110011 10000111 11011101

The first 4 bits are 1s. This is a class E address.

(b) 10101111 11000000 11110000 00011101

The first bit is 1; the second bit is 0; This is a class B address.

(c) 11011111 10110000 00011111 01011101

The first 2 bits are 1; the third bit is 0:

This is class C address.

(d) 11101111 11110111 11000111 00011101

The first 3 bits are 1; the fourth bit is 0.

This is class D address.

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11. Find the netid and the hostid of the following IP addresses :

(a) 114 . 34 . 2 . 8

Class is A → netid : 114 and hostid : 34 . 2 . 8

(b) 132 . 56 . 8 . 6

Class is B → netid : 132.56 and hostid : 8.6

(c) 208 . 34 . 54 . 12

Class is C → netid : 208.34.54 and hostid : 12

(d) 251 . 34 . 98 . 5

Class is E →
The address is not divided into netid and hostid.

12. Find the number of addresses in the range if the first address is 14.7.24.0 and the last address is 14.14.34.255.

We can subtract the first address from the last address in base 256.

Last Address	14 . 14 . 34 . 255
First Addresss	14 . 7 . 24 . 0
Result	00 . 07 . 10 . 255

The Result is 0.07.10.255 in this base.

To find the number of addresses in the range (in decimal), we convert this number to base 10 and add 1 to the result.

Number of Addresses $= (0 \times 256^3 + 7 \times 256^2 + 10 \times 256^1 + 255 \times 256^0) + 1$

Number of Addresses $= (0 + 458,752 + 2560 + 255) + 1$

Number of Addresses $= (461,567) + 1$

$\boxed{\text{Number of Addresses} = 461,568}$

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13. If the first address in a range is 122.12.7.0 and there are 2048 addresses in the range, what is the last address?

We first convert the number of addresses in the range (minus 1) to base 256.

$$2048 - 1 = (0.0.7.255)_{256}$$

The result is 0.0.7.255 in the base 256.

We then add it to the first address to get the last address. Addition is in base 256.

First Address :	122	12	7	0
Difference (base 256)	0	0	7	255
Last Address :	122	12	14	255

So, the last address is 122.12.14.255.

14. Find the result of each operation.

(a) NOT (22.14.70.34)

Original Number :	22	14	70	34
Complement :	233	241	185	221

(b) NOT (145.36.12.20)

Original Number :	145	36	12	20
Complement :	110	219	243	235

(c) NOT (200.7.2.0)

Original Number :	200	7	2	0
Complement :	55	128	253	255

(d) NOT (11.20.255.255)

Original Number :	11	20	255	255
Complement :	244	235	0	0

15. Find the result of each operation:

(a) (22 · 14 · 70 · 34) AND (255 · 255 · 0 · 0)

First Number	22	·	14	·	70	·	34
Second Number	255	·	255	·	0	·	0
$\boxed{\text{Result}}$	22	·	14	·	0	·	0

(b) (12 · 11 · 60 · 12) AND (255 · 0 · 0 · 0)

First Number	12	·	11	·	60	·	12
Second Number	255	·	0	·	0	·	0
Result	12	·	0	·	0	·	0

(c) (14 · 110 · 160 · 12) AND (255 · 200 · 140 · 0)

First Number	14	·	110	·	160	·	12
Second Number	255	·	220	·	140	·	0
Result	14	·	72	·	$\overset{128}{0}$	·	0

(d) (28 · 14 · 40 · 100) AND (255 · 128 · 100 · 0)

First Number	28	·	14	·	40	·	100
Second Number	255	·	128	·	100	·	0
Result	28	·	0	·	32	·	0

16. Find the result of each operation.

(a) (22 · 14 · 70 · 34) OR (255 · 255 · 0 · 0)

First Number	22	14	70	34
Second Number	255	255	0	0
Result	255	255	70	34

(b) (12 · 11 · 60 · 12) OR (255 · 0 · 0 · 0)

First Number	12	11	60	12
Second Number	255	0	0	0
Result	255	11	60	12

(c) (14 · 110 · 160 · 12) OR (255 · 200 · 140 · 0)

First Number	14	110	160	12
Second Number	255	200	140	0
Result	255	238	172	12

(d) (28 · 14 · 40 · 100) OR (255 · 128 · 100 · 0)

First Number	28	14	40	100
Second Number	255	128	100	0
Result	255	142	108	100

17. In a class A subnet, we know the IP address of one of the hosts and the subnet mask as given below:

IP Address : 25.34.12.56 Subnet Mask : 255.255.0.0

What is the first address (subnet address)? What is the last address?

Solution

The first address can be found by ANDing the mask with the IP address, ~~as sho~~

ANDing Operation

IP Address :	25	34	12	56
Mask :	255	255	0	0
First Address :	25	34	0	0

The last address can be found either adding the number of address in the subnet~~work~~ $2^{32-n} = 2^{24}$ or by ORing the complement of the mask with the IP address.

ORing Operation

IP Address :	25	34	12	56
Mask Complement :	0	0	255	255
Last Address :	25	34	255	255

So, The first address is 25.34.0.0 and the last address is 25.34.255.255.

18. In a class B subnet, we know the IP address of one of the hosts and the subnet mask as given below:

IP Address 131.134.112.66 Subnet Mask: 255.255.224.0

What is the first address (subnet address)? What is the last address?

Solution:-

The first address can be found by ANDing the mask with the IP address

ANDing Operation

IP Address :	131	134	112	66
Mask :	255	255	224	0
First Address :	131	134	96	0

The last address can be found either adding the number of address in the subnet $2^{32-n} = 2^{16}$ or by ORing the complement of the mask with the IP address.

ORing Operation

IP Address	131	134	112	66
Mask Complement	0	0	31	255
Last Address	131	134	127	255

So, The first address is 131.134.96.0 and the last address is 131.134.127.255.

19. In a class C subnet, we know the IP address of one of the hosts and the subnet mask as given below:

IP Address : 202.44.82.16   Subnet Mask : 255.255.255.192

What is the first Address (subnet address)? What is the last address?

The first address can be found by ANDing the mask with IP address :-

ANDing Operation

IP Address	:	202	.	44	.	82	.	16
Mask	:	255	.	255	.	255	.	192
First Address	:	202	.	44	.	82	.	0

The last address can be found either adding the number of address in the subnet $2^{32-n} = 2^{8} = 256$ or by ORing the complement of the mask with the IP address.

ORing Operation

IP Address	202	.	44	.	82	.	16
Mask Complement	0	.	0	.	0	.	63
last Address	202	.	44	.	82	.	63

So, The first address is 202.44.82.0
last Address is 202.44.82.63

20. Find the subnet mask in each case :

(a) 1024 subnets in class A

Here,

n_{sub} = is the length of each subnetid

n = is the length of netid

S = S is the number of subnets which must be a power of 2.

$n = 8$

$$n_{sub} = n + \log_2 S$$

$$n_1 = n_2 \ldots$$

$$n_{1024} = 8 + \log_2 (1024)$$

$$n_{sub} = 8 + 10$$

$$\boxed{n_{sub} = 18}$$

This means that the subnet mask has eighteen 1s and fourteen 0's.

So, The subnet mask is :-

11111111 11111111 11000000 00000000

= 255 . 255 . 192 . 0

(b) 256 subnets in class B

In class B $n = 16$,

$$n_{sub} = n + \log_2 S$$
$$n_1 + n_2 - n_{256} = 16 + \log_2(256)$$
$$n_1 + n_2 - n_{256} = 16 + 8$$
$$\boxed{n_1 + n_2 - n_{256} = 24}$$

This means that the subnet mask has 24 1's and 8 0's.

11111111	11111111	11111111	00000000
↓	↓	↓	↓
255 .	255 .	255 .	0

So, The subnet mask is :- 255.255.255.0

(c) 32 subnets in class C

In class C, $n = 24$

$$n_{sub} = n + \log_2 S$$
$$n_1 + n_2 - - n_{32} = 24 + \log_2(32)$$
$$n_1 + n_2 - - n_{32} = 24 + 5$$
$$\boxed{n_1 + n_2 - - n_{32} = 29}$$

This means that the subnet mask has 29 1's and 3 0's.

11111111	11111111	11111111	11111000
↓	↓	↓	~~248~~ ↓
255	255	255	288

So, The subnet mask is :- 255 . 255 . 255 . 248

(d) 4 subnets in class C

In class C, $n = 24$

$$n_{sub} = n + \log_2 S$$

$$n_1 = n_2 = n_3 = n_4 = 24 + \log_2(4)$$

$$n_1 = n_2 = n_3 = n_4 = 24 + 2$$

$$\boxed{n_1 = n_2 = n_3 = n_4 = 26}$$

This means that the subnet mask has 26 1's and 6 0's.

11111111	11111111	11111111	11000000
↓	↓	↓	↓
255	255	255	192

So, The subnet mask is :- 255 . 255 . 255 . 192

21. In a block of addresses, we know the IP address of one host is 25.34.12.56/16. What is the first address (network address) and the last address (limited broadcast address) in this block?

- The network mask is 255.255.0.0.
- The number of address in the network is $2^{32-16} = 65,536$.

With the information given, the first address is found by ANDing the host address with the mask (/16).

Host Address	:	25	.	34	.	12	.	56
Network Mask	:	255	.	255	.	0	.	0
First Address (AND)	:	25	.	34	.	0	.	0

The last address can be found by ORing the host address with the mask complement 0.0.255.255.

Host Address	:	25	.	34	.	12	.	56
N.Mask Complement	:	0	.	0	.	255	.	255
Last Address (OR)	:	25	.	34	.	255	.	255

So,
The Network Address is :- 25.34.0.0 or
The Limited Broadcast Address is :- 25.34.255.255.

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22. In a block of address, we know the IP address of one host is 182.44.82.16/26. What is the first address (network address) and the last address (limited broadcast address) in this block?

- The network mask is 255.255.255.192.
- The number of address in the network is $2^{32-26} = 2^6 = 64$.

With the information given, the first address is found by ANDing the host address with the mask 255.255.255.192 (/26)

Host Address	:	182	.	44	.	82	.	16
Network Mask	:	255	.	255	.	255	.	192
First Address (AND)	:	182	.	44	.	82	.	0

The last address can be found by ORing the host address with the mask complement 0.0.0.63.

Host Address	:	182	.	44	.	82	.	16
N-Mask Complement	:	0	.	0	.	0	.	63
Last Address (OR)	:	182	.	44	.	82	.	63

So,

The First Address (Network Address) is :- 182.44.82.0

The Last Address (Limited Broadcast Address) is :- 182.44.82.63

23. In fixed length subnetting, find the number of 1s that must be added to the mask if the number of desired subnets is ________

(a) 2

$\log_2(2) = 1$ Number of 1's = 1 Number of created subnets = 2

(b) 62

$\log_2(62) = 5.95$ Number of 1's = 6 Number of created subnets = 64

(c) 122

$\log_2(122) = 6.93$ Number of 1's = 7 Number of created subnets = 128

(d) 250

$\log_2(250) = 7.96$

Number of 1's = 8

Number of created subnets = 256

24. An organization is granted the block 16.0.0.0/8. The administrator wants to create 500 fixed length subnets.

(a) Find the subnet mask

This Given address is from class-A, so $n = 8$, Given $S = 500$

$$n_{sub} = n + \log_2 S$$
$$n_{sub} = 8 + \log_2 (500)$$
$$n_{sub} = 8 + 8.96$$
$$n_{sub} = 16.96$$
$$\boxed{n_{sub} = 17 \text{ (Approx)}}$$

The subnet mask is /17

(b) Find the number of addresses in each subnet

The number of addresses in each subnet is

$2^{32-17} = 2^{15} = 32,768$ add in each subnet

(c) Find the first and the last address in the first subnet

First Subnet

The first address is the beginning address of the block.

$\boxed{\text{first address in subnet 1: } 16.0.0.0}$

To find the last address, we need to write 32,767 (one less than the number of address in each subnet) in base 256 (0.0.127.255) and add it to the first address (base 256)

First address in subnet 1:	16	0	0	0
Number of Address :	0	0	127	255
Last address in subnet 1:	16	0	127	255

(d) Find the first and the last address in the last subnet (subnet 500)

Last Subnet (subnet 500):

To find the first address in subnet 500, we need to add 16,351,232 (499 X 32,768) in base 256 (0.249.128.0) to the first address in subnet 1.

First Address in Subnet 1:	16	0	0	0
Number of Address :	0	249	128	0
First Address in Subnet (500):	16	249	128	0

Now we can calculate the last address in subnet 500 as we did for the first address.

First Address in Subnet 500:	16	249	128	0
Number of Addresses :	16	0	127	255
Last Address in Subnet 500:	16	249	255	255

25. An organization is granted the block 130.56.0.0/16. The administrator wants to create 1024 subnets.

(a) Find the subnet mask.

Given address is from class-B, so $n = 16$, Given $S = 1024$

$$n_{sub} = n + \log_2 S$$
$$n_{sub} = 16 + \log_2(1024)$$
$$n_{sub} = 16 + 10$$
$$\boxed{n_{sub} = 26}$$

The subnet mask is /26.

(b) Find the number of address in each subnet

The number of address in each subnet is :-

$2^{32-26} = 2^6 = 64$ address in each subnet

(c) Find the first and the last address in each subnet.

First Subnet

The first address is the beginning address of the block

First Address in Subnet 1: 130.56.0.0

To find the last address, we need to write 63 (one less then the number of address in each subnet) in base 256 (0.0.0.63) and add it to the first address (in base 256).

First Address in subnet 1:	130	56	0	0
Number of Address :	0	0	0	63
Last Address in subnet 1:	130	56	0	63

(d) Find the first and the last address in the last subnet. (subnet 1024)

Last Subnet (Subnet 1024):

To find the first address in subnet 1024, we need to add 65,472 (1023 x 64) in base 256 (0.0.255.192) to the first address in subnet 1.

First Address in Subnet 1 :	130	56	0	0
Number of Address :	0	0	255	192
First Address in subnet (1024):	130	56	255	192

Now we can calculate the last address in subnet 1024 as we did for the first address.

First Address in Subnet 1024 :	130	56	255	192
Number of Address :	0	0	0	63
Last Address in subnet 1024 :	130	56	255	255

26. An organization is granted the block 211.17.180.0/24. The administrator wants to create 32 subnets.

(a) Find the subnet mask.

Given address is from class-C, so $n = 24$, Given $S = 32$

$$n_{sub} = n + \log_2 S$$
$$n_{sub} = 24 + \log_2(32)$$
$$n_{sub} = 24 + 5$$
$$n_{sub} = 29$$

The subnet mask is /29.

(b) Find the number of address in each subnet.

The number of address in each subnet is :-

$$2^{32-29} = 2^3 = 8 \text{ address in each subnet}$$

(c) Find the first and the last address in the first subnet

First Subnet

The first address is the beginning address of the block.

First Address in Subnet 1 : 211 . 17 . 180 . 0

To find the last address, we need to write 7 (one less than the number of addresses in each subnet) in base 256 (0.0.0.7) and add it to the first address (in base 256)

First Address in Subnet 1 :	211	17	180	0
Number of Addresses :	0	0	0	7
Last Address in subnet 1 :	211	17	180	7

(d) Find the first and the last address in the last subnet (subnet 32)

Last Subnet (Subnet 32)

To find the first address in subnet 32, we need to add 248 (31x8) in base 256 (0.0.0.248) to the first address in subnet 1.

First Address in Subnet 1 :	211	17	180	0
Number of Addresses :	0	0	0	248
First Address in subnet (32) :	211	17	180	248

Now we can calculate the last address in subnet 32 as we did for the ~~to~~ first address.

First Address in Subnet (32) :	211	17	180	248
Number of Addresses :	0	0	0	7
Last Address in Subnet (32) :	211	17	180	255

27. Write the following mask in slash notation (/n):

(a) 255.255.255.0

We first change the mask to binary to find the number of 1's:

11111111 11111111 11111111 00000000 → /24

(b) 255.0.0.0

11111111 00000000 00000000 00000000 → /8

The slash notation of 255.0.0.0 is :- /8.

(c) 255.255.224.0

11111111 11111111 11100000 00000000 → /19

The slash notation of 255.255.224 is /19

(d) 255.255.240.0

11111111 11111111 11110000 00000000 → /20

The slash notation of 255.255.240.0 is /20

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28. Find the range of addresses in the following blocks :-

- We can find first address by setting the 32-n rightmost bit to 0.
- OR the last address by setting the 32-n bits to 1.

(a) 123.56.77.32/29

First Address :- 123.56.77.32
Last Address :- 123.56.77.39

Therefore, the range of addresses is 123.56.77.32 to 123.56.77.39.

(b) 200.17.21.128/27

First Address :- 200.17.21.128
Last Address :- 200.17.21.159

Therefore, the range of addresses is 200.17.21.128 to 200.17.21.159

(c) 17.34.16.0/23

First Address :- 17.34.16.0
Last Address :- 17.34.17.255

(d) 180.34.64.64/30

First Address :- 180.34.64.64
Last Address :- 180.34.64.67

29. 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 and give an example.

If the first and the last addresses are known, the block is fully defined. We can first find the number of addresses in the block. We can then use the relation

$$\boxed{N = 2^{32-n} \longrightarrow n = 32 - \log_2 N}$$

to find the prefix length. ~~For~~

For example, if the first address is 17.24.12.64 and the last address is 17.24.12.127, then the number of address in the block is 64. We can find the prefix length as

$$n = 32 - \log_2 N$$
$$n = 32 - \log_2 64$$
$$n = 26$$

The block is then 17.24.12.64/26

30. In classless addressing, can two blocks have the same prefix length? Explain.

Many blocks can have the same prefix length. The prefix length only determines the number of addresses in the block, not the block itself. Two blocks can have the same prefix length but start in two different point in the address space. For example, the following two blocks

127.15.12.32/27	174.18.19.64/27

have the same prefix length, but they are definitely two different blocks. The length of the blocks are the same, but the blocks are different.

32. An ISP is granted a block of addresses starting with 150.80.0.0/16. The ISP wants to distribute these blocks to 2600 customers as follows:

(a) The first group has 200 medium-size businesses; each needs approximately 128 addresses.

Group 1

For this group, each customer needs 128 addresses. This means the suffix length is $\log_2 128 = 7$). The prefix length is then $32 - 7 = 25$. The range of addresses are given for the first, second, and the last customer. The range of the addresses for other customers can be easily found:

1st customer:	150.80.0.0/25	to	150.80.0.127/25
2nd customer:	150.80.0.128/25	to	150.80.0.255/25
.....	.....		....
200th customer:	150.80.99.128/25	to	150.80.99.255/25

Total addresses for group 1 = 200 X 128 = 25,600 addresses.

(b) The second group has 400 small businesses; each needs approximately 16 addresses.

Group 2

For this group, each customer needs 16 addresses. This means the suffix length is $\log_2 16 = 4$. The prefix length is then $32 - 4 = 28$. The addresses are:

1st customer	:	150.80.100.0/28	to	150.80.100.15/28
2nd customer	:	150.80.100.16/28	to	150.80.100.31/28
.....		....		......
400th customer	:	150.80.124.240/28	to	150.80.124.255/28

Total addresses for group 2 = 400 × 16 = 6400 addresses

(c) The third group has 2000 households; each needs 4 addresses. Design the subblocks and give the slash notation for each subblocks. Find out how many addresses are still available after these allocations.

Group 3

For this group, each customer needs 4 addresses. This means the suffix length is $\log_2 4 = 2$ The prefix length is then $32 - 2 = 30$. The addresses are :

1st customer	:	150.80.125.0/30	to	150.80.125.3/30
2nd customer	:	150.80.125.4/30	to	150.80.100.7/30
....				
64th customer	:	150.80.125.252/30	to	150.80.125.255/30
65th customer	:	150.80.126.0/30	to	150.80.126.3/30
....				
208th customer	:	150.80.156.252/30	to	150.80.156.255/30

Total addresses for group 3 = 2048 × 4 = 8192 addresses

Number of allocated addresses : 40,192
Number of available addresses : 25,344

32. An ISP has a block of 1024 addresses. It needs to divide the addresses to 1024 customers. Does it need subnetting? Explain your answer.

There are actually two choices. If the ISP wants to use subnetting (a router with 32 outputs ports) then the prefix length for each customer is $n_{sub} = 32$. However, there is no need for a router and subnetting. Each customer can be directly connected to the ISP server. In this case, the whole set of the customer can be taught of addresses in one single block with the prefix length n (the prefix length assigned to the ISP).