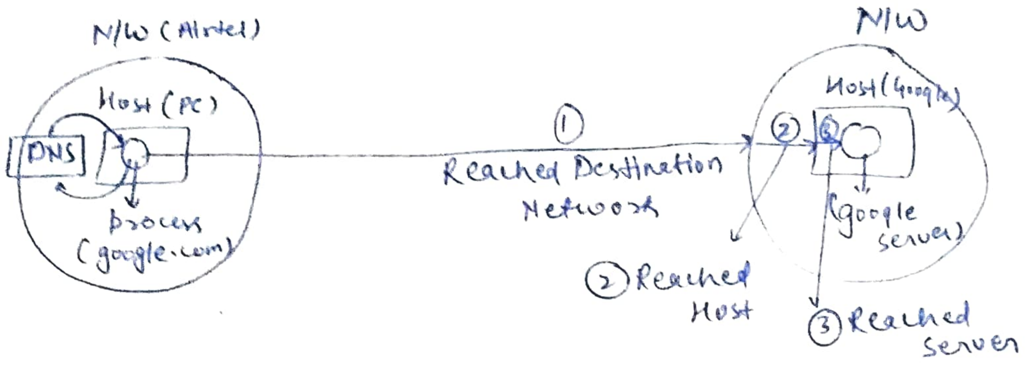
IP Address Subnetting & Supernetting (Day 1)

Introduction to Computer Network and IP Address



www. google. com   Domain name

⇓

① IP Address
- Network Id (NI)
- Host IP (HI)

IP Address

NI	HI

⇒ To reach process/server we need port no. for web services (Http) port no. used is 80 (fixed). ②

⇒ ISP (Internet Service Provides provides 'Domain Name server' that holds the IP Address for various domain Host (PC) request for IP address of a particular domain name to DNS.

We want to reach the server (destination) directly but it will go through DNS first to get IP address called 'DNS overheads' ③

Unary number system

1 — 0
2 — 0 0
3 — 0 0 0
| |

Input Symbols

U - 0
B - 0, 1
T - 0, 1, 2
O - 0, 1, 2, — 7

→ If base is n then, range of input symbols 0 → (n-1).

Conventions in binary number System

$2^1 - 2$, $2^2 - 4$, $2^{10} \rightarrow 1024 (K)$ $M - 2^{20}$, $G \rightarrow 2^{30}$, $T \rightarrow 2^{40}$

Binary number possible with different no of bits.

1 bit
0
1

2 bits	
0 0	→ 0
0 1	→ 1
1 0	→ 2
1 1	→ 3

3 bits
0 0 0
0 0 1
0 1 0
0 1 1
1 0 0
1 0 1
1 1 0
1 1 1

→ Using a single bit we can divide the number into parts (2^1)

→ Using two bit in four parts (2^2)

→ Using 3 bit in 8 parts (2^3)

0 1 . . . (n-1) n bits (2^n numbers possible)

K	(n-k)

If complete space of n bit devide into k part then each part will get $\frac{2^n}{2^k} = 2^{n-k}$ part

n bits → IP Address

k → NID

(n-k) → HID

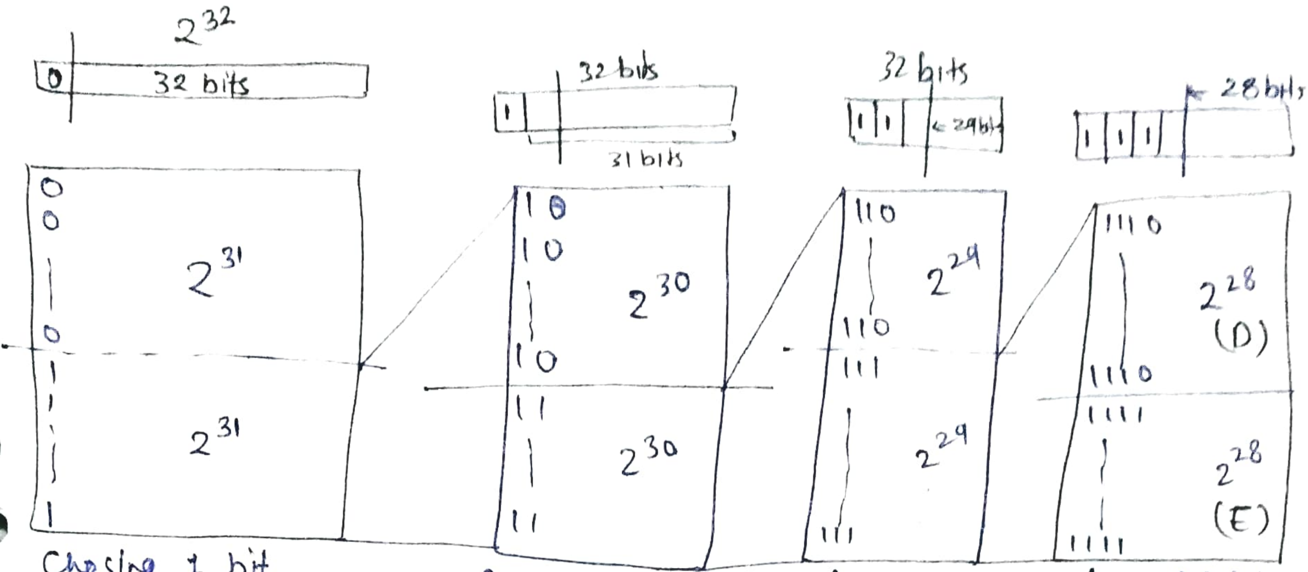
In Computer Networks n = 32 bits conserved. for IP Address we can devides 32 in multiple of 8 for division in NID and HID.

Initially 1980 →

8	24
↓ 256 (Networks)	↓ for 15 Million (Host)

] That was practically not possible in today's era

→ So we move on classful clasification of networks.



Chosing 1 bit devide all address in 2 parts. (Class A)	from remaining 31 bits we again choose 1 bit (Class B)	from 30 bits we again chose 1 bit (Class C)	from 29 bits we again choose 1 bits (Class D) and E
Total no of IP address present (TN) = 2^{31} →	$T(N) = 2^{30}$	$TN = 2^{29}$	$TN = 2^{28}$

(5)

Representation of IP Address

① Octet Represention or Dotted Decimal

8	8	8	8

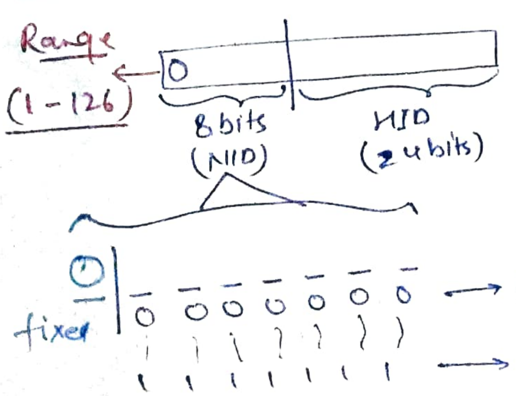
→ 4 octets

Prefix code

(6)
- 0 → for class A
- 1 0 → B
- 1 1 0 → C
- 1 1 1 0 → D
- 1 1 1 1 → E

No two classes have same prefix code.

Class A → Number of IP's possible → 2^{31}



(7) No. of network = 2^7 (128) because 1 bit is fixed.

(8) For each network no. of (HID / IP) present = 2^{24} (16 M) IP / N/w

(0 - 127) 128 but 0 and 127 doesn't use so 126 possible practically.

Class A networks used by large organizations like NASA and Pentagon.

Class B :- No. of IP Address → 2^{30}

10	
16 bits (NID)	16 bits (HID)

Range (128 – 191) → (for first octet)

(0 – 255) for second octet

Networks $= 2^{14} \cong 16K$

2^{16} IP / N/w (No. of HID) → ~~No of~~ Host $(2^{16} - 2)$

10 _ _ _ _ _ _

1 0 0 0 0 0 0 0 — 128

1 0 1 1 1 1 1 1 — 191

64 bits due to first 8 bit but we can generate upto 16 K N/w due to present of extra 8 bit in NID

as $64 \times 2^8 \rightarrow 16k$ → we devide in two octet because this representation is frequently used.

2^{14} Networks

128.0 → first address

128.1

⋮

128.255

129.0

⋮

191.255 → last adress

→ Used in Banking sector, IRCTC

Class C : 2^{29} IP address Possible

24	8

110 ← 21 →

2^{21} → Network possible ≃ 2 M

2^8 → IP / N/w $(2^8 - 2$ host)

Range :- (192 – 223) first octet

$32 \times 2^8 \times 2^8$ Possible more

→ Used in Colleges and small industry.

Class D → wastage of use

Range → (224 – 239)

2^{28} → IP Address Possible

→ Generally used for Millitary application

Class E

Range → (240 – 255)

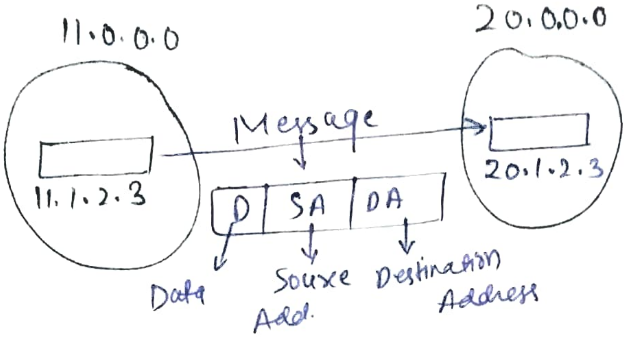
→ Reserved for future

→ 2^{28} IP Address possible.

Casting → Sending a packet from one host to another.

- → Unicast : between two host
- → Broadcast : between one to multiple host

Ex: Unicast



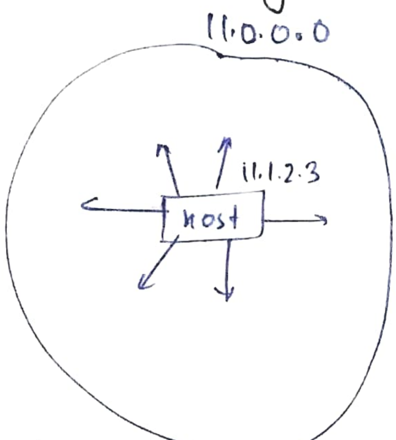
11 | 0.0.0
20 | 0.0.0

Always Reserved for Network IP Address

→ Represent No host means not alloted to host

Broadcasting
- → Limited
- → Directed

Limited Broadcasting:



Send message to various host in same network

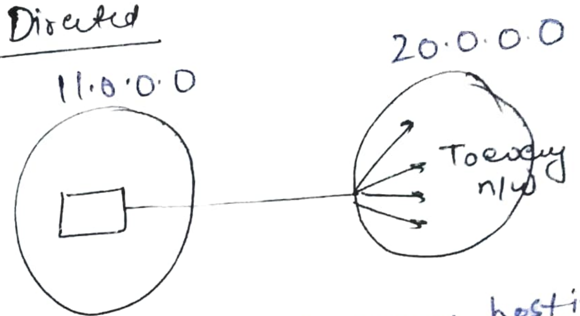
D	SA	255.255.255.255

At this address message will send to all N/W in same network

It is reserved and called as limited broadcast address

(255.255.255.255)

Directed



Send message to every host in different network

m	SA	20.255.255.255

Directed Broadcast Address

$[\text{NID}.\underbrace{(255.255.255)}_{\text{HID}}]$

Note: for n bit IP address we have $(2^{n-k} - 2)$ host

because

NID. 0.0.0 reserved for n/w ID and

NID. 255.255.255 resved for broadcasting.

IP	NID	DBA	LBA
1.2.3.4	1.0.0.0	1.255.255.255	255.255.255.255 } for Class A
10.15.20.60	10.0.0.0	10.255.255.255	255.255.255.255 } for Class A
130.1.2.3	130.1.0.0	130.1.255.255	" → Class B
150.0.150.150	150.0.0.0	150.0.255.255	" → Class B
200.1.10.100	200.1.10.0	200.1.10.255	" → Class C
250.0.1.2	X	X	X (Class E)
300.1.2.3	X	X	X (Not valid, valid upto 255 only)

→ Class E doesn't have any NID, DBA, LBA.
→ for class A reserved first octet for class B reserved 2 octet for C reserved C octet in NID and DBA.

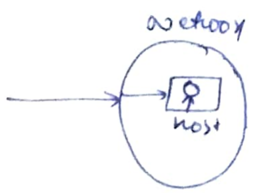
Subnets, Subnet Mask, Routing

→ Maintainance of large network is very difficult.
→ Security is tough.

Devide big network into small network of same size called subnetting.
In subnetting advantages are dominant over disadvantages

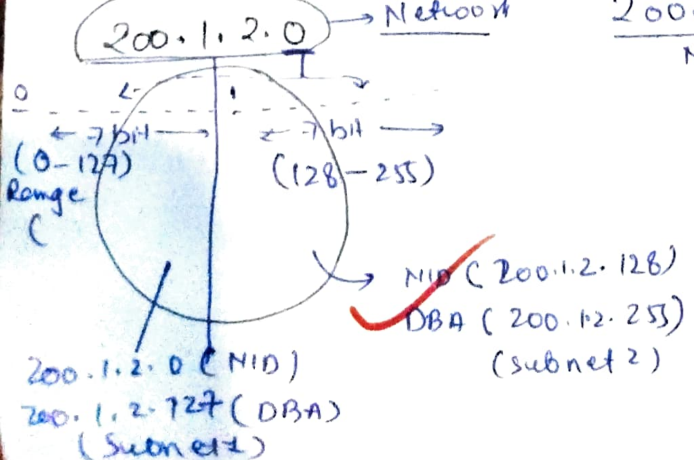
Disadvantage

Normaly (3 steps)



After subnetting (4 steps)

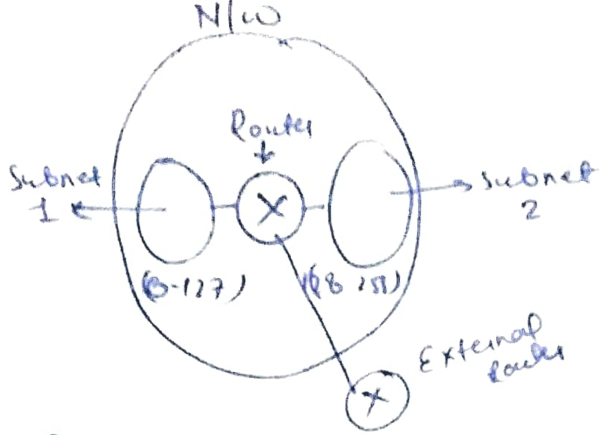
Network → Subnet → Host → Process



200.1.2.[ ] - - - - - - - HID
NID

↓ Use to define subnets | New Host ID (7 bits)

→ NID of subnet 1 and DBA of subnet 2 is also the NID and DBA of main Network. So to resolve conflict between subnet and network we do,



If you are outside the N/w 0 and 255 belongs to N/w (main) and inside 0 belongs to subnet 1 and 255 belongs to subnet 2

In class C total host possible = 256 − 2 = 254

After subnetting

Subnet 1 128 − 2 = 126

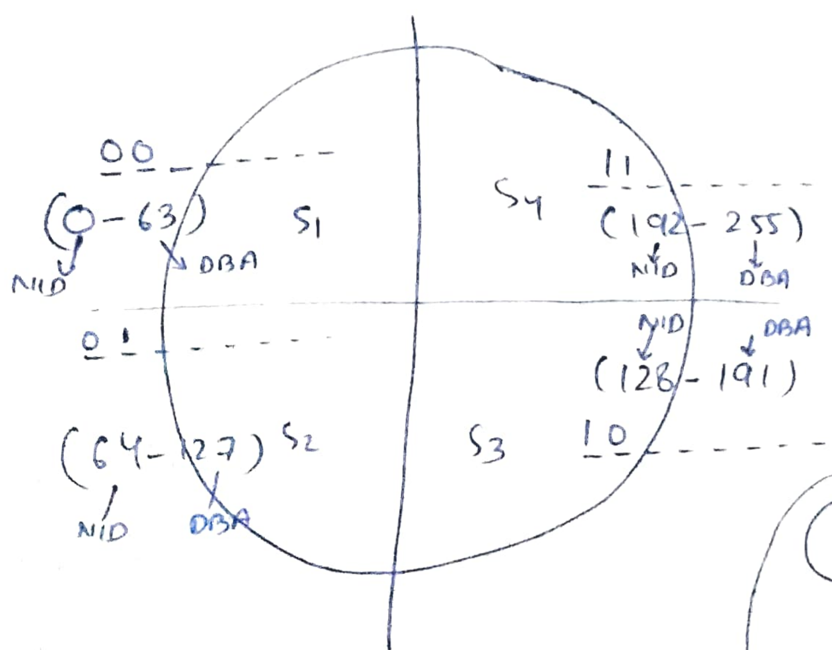
Subnet 2 128 − 2 = 126

Total 252 Hosts

You can do subnetting in the power of 2.

Ex. with 4 Subnets

200.1.2.0



200.1.2. _ _ - - - - - -

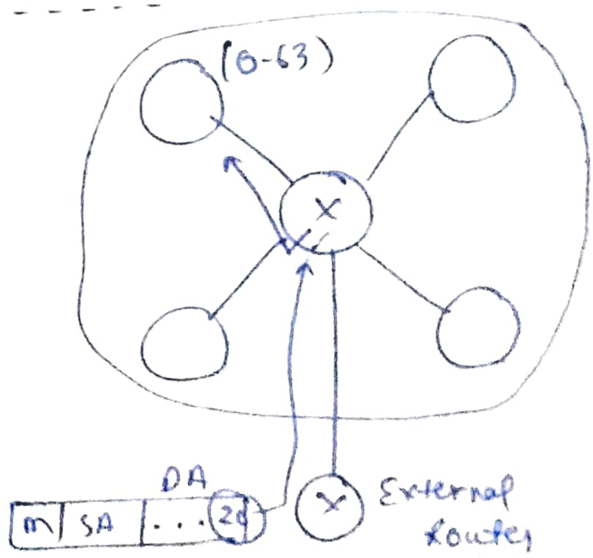
Reserved 2 bits

No. of Host = 254

After subnetting

256 − 8 = 248

Exter router sends data to internal router and it decide to which subnet message is to be send.



Subnet Mask : 32 bit

No. of 1's → NID & SID
No. of 0's → HID

Ex 200. 1.2.0] class C

NID: 200.1.2 (24 bits) | HID: 0

$\underline{11111111} . \underline{11111111} . \underline{11111111} . \underline{11000000}$] → subnet Mask

↳ 2 bits chosen for subnetting

255.255.255.192

(IP Address) (&) (SubnetMask) → Network Id of subnet

& ↓ Bitwise AND

Message

D	SA / 200.1.2.130

IP address

$$
\begin{array}{l}
11001000.00000001.00000010.10000010 \\
\&\ 11111111.11111111.11111111.11000000 \\
\hline
11001000.00000001.00000010.10000000 \\
\hline
200 \;.\; 1 \;.\; 2 \;.\; 128
\end{array}
$$

NID

(128-192)

•130 belong to n/w .128

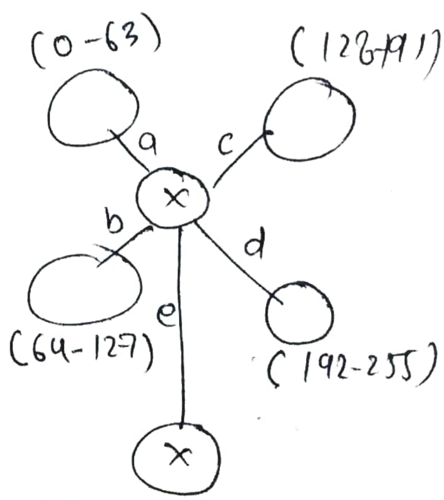
#

On bitwise AND any binary number with (n-bit) (2^n-1) is the same no.

Routing table using subnet mask

NID	SM	Interface (Packet sent into)
200.1.2.0	255.255.255.192	a
200.1.2.64	"	b
200.1.2.128	"	c
200.1.2.192	"	d
0.0.0.0	0.0.0.0	Default Entry (e)

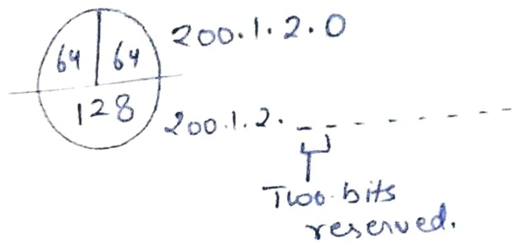
If address doesn't belong to network sent back to 'e'



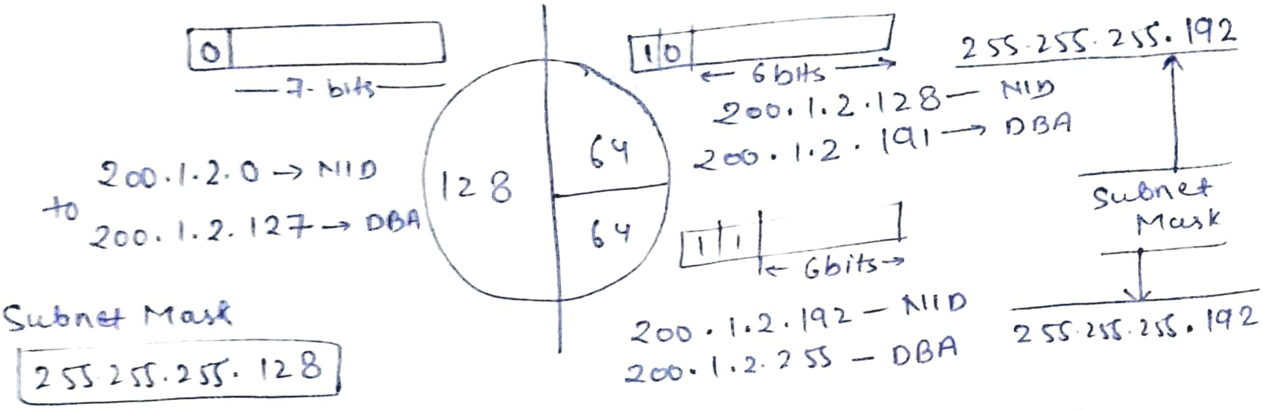
Imp → If a data pack matched with two NID's then sent it to NID with longest subnet mask (more no of 1's).

Variable length Subnet Masking (VLSM)

Subnets of unequal size



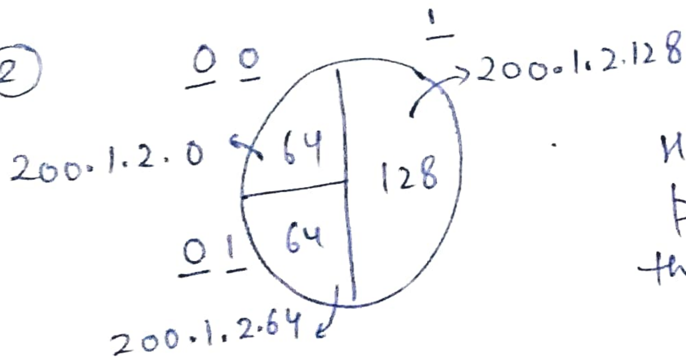
①



→ Network with same size get same subnet mask.

→ More the network size lesser the subnet mask (more 0's)

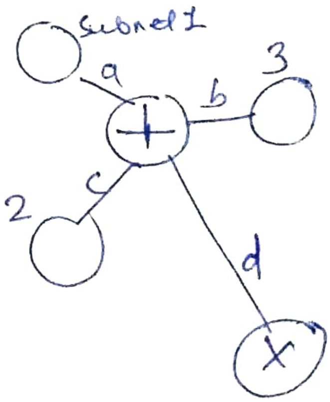
②



Here we divide in two part first then consider the second part.

Routing Table (for fig.1)

NID	Subnet Mask	Interface
200.1.2.0	255.255.255.128	a
200.1.2.128	255.255.255.192	b
200.1.2.192	255.255.255.192	c
0.0.0.0	0.0.0.0	d (Default)



Given a subnet mask

255.255.255.192

$\underbrace{11111111.11111111.11111111.11}_{26\text{-}1\text{'s}}\underbrace{000000}_{6\text{-}0\text{'s}}$

Depends on class — (NID) + SID   (HID)

2^6 IP address are present per subnet

Assume, ① class A : NID → 8
SID → 18

Possible No. of subnets → 2^{18}

② Class B: NID → 16
SID → 10

Possible No. of subnets → 2^{10}

③ Class C: NID → 24
SID → 2

No. of subnets → 2^2

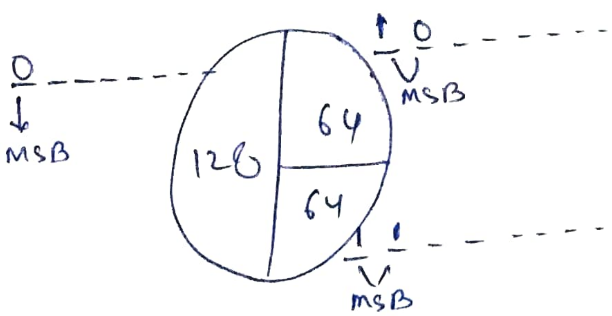
* With subnet mask we can only find no. of IP Adrees
* To find no. of subnets we need subnet mask and class both.

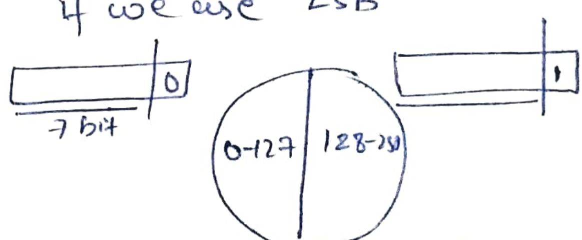
→ If SID have n-1's then no. of subnets = 2^n

→ Practically the subnet mask is always run of 1's then run of 0's.

→ But theoretically you may do it using least significant bit as

we generally use MSB but if we use LSB





then all even number falls on one side and odd on another

Todo

Q No. of subnets is 2^n or 2^n-2? Always

Ans → ~~2^n-2~~ always in power of 2.

bcoz 1st IP of 1st subnet → NID of full N/w

Last IP of last → DBA of full N/w.

Subnet Masking Question

Trust to help.

	Subnet Mask	No. of Host	No. of subnets Class (A)	class (B)	Class C
00000000 ↳ 0	255.255.0.0	$2^{24}-2$	1	X	X
10000000 ↳ 128	255.128.0.0	$2^{23}-2$	2^1	X	X
11000000 ↳ 192	255.192.0.0	$2^{22}-2$	2^2	X	X
11100000 ↳ 224	255.240.0.0	$2^{20}-2$	2^4	X	X
11110000 ↳ 240	255.255.0.0	$2^{16}-2$	2^8	1	X
11111000 ↳ 248	255.255.254.0	2^9-2	2^{15}	2^7	X
11111100 ↳ 252	255.255.255.0	2^8-2	2^{16}	2^8	1
11111110 ↳ 252	255.255.255.224	2^5-2	2^{19}	2^{11}	2^3
11111111 ↳ 255	255.255.255.240	2^4-2	2^{20}	2^{12}	2^4

255.0.0.0 → have only 1 subnet and also called default subnet mask of class A.

Minimum subnet mask for
- Class B : 255.255._._
- Class C : 255.255.255._

→ No of subnets class (A) = $2^8 \times$ Class (B) = 2^{16} class (C)
But if no. is less than 1 then (X) not possible.

→ Subnet mask use to identify (no. of host) and network ID part and class use to find no. of subnets. IP address with

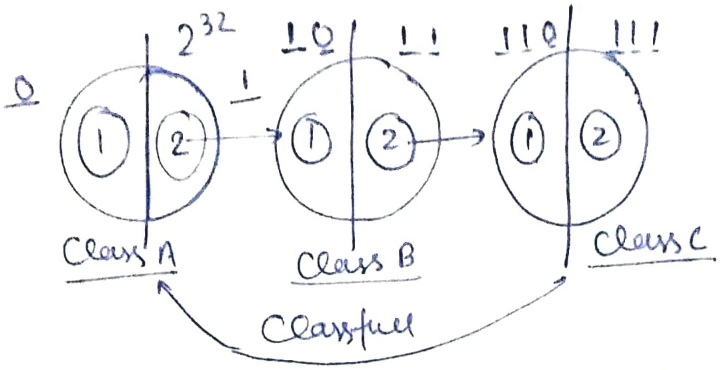
In exam they will give a subnet mask (for no. of host) and IP address (for class)

Ex Given
255.255.255.192 → subnet mask
200.1.2.3 → IP address

find size and no. of subnets

Sol^n: Class-C
No of host → 2^6-2
No. of subnet → 2^2

Classless Inter Domain Routing (CIDR)



Internet Assign Number Authority (IANA) have control over IP Addresses.

→ Class C is smallest network with 2^8 (256) IP Addresses In classful if we requiree 100 address then we will go for 256 (class C) means 156 IP address are wast or if we require 257 then we will go for class B means other (2^{16} - 257) are wasted so, we come with solution of classless as – CIDR. CIDR gives only those no. of IP address which are requireo

Disadvantage of CIDR: It is difficult to identify which part is HID or NID part. because there may not be equal distribution of parts.

So its representation is like,

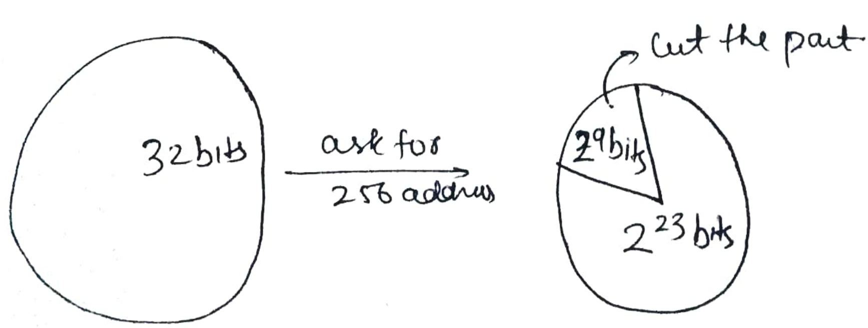
20.10.50.100/20 → It denotes that network ID part take 20 bits

↓ CIDR Representation.

Total bits → 32
NID → 20
HID → 12 → 2^{12} IP Addresses

we are currently using CIDR in practical fields.

How to form a CIDR blocks?



Rules for CIDR blocks -

① All IP address should be contiguous.

.10, .11, .12, ---- (✓)

not → .10, .22, .256 (X)

② Block size should always be power of 2. (2^n)

1011 / 2 → Remainder (1) → ~~Mos~~ Least Significant bit.
Quotient → 5 (101) 3 MSB

1011 / 2^2 → Remainder → 2 LSB (11 : 3)
Quotient → 2 MSB

1011 / 2^3 → Remainder → 3 LSB (011 : 3)
Quotient - 1 MSB

So, n-bits / 2^k

$\underbrace{\boxed{n-k}}_{\text{Quotient}}\underbrace{\boxed{k}}_{\text{Remainder}}$

32 / 2^5

$\underbrace{\leftarrow 27\ \text{bits} \rightarrow}_{\text{(NID)}}\underbrace{\leftarrow 5\ \text{bits}}_{\text{HID}}$

③ First IP Address in the block should be divisible (even) by size of block.

32 bit

Starting Address ← | NID | 000000 HID |

Devide even no. of 2, remainder is 0.

So, HID can be in range 00...0 to 11---1
No. of 0's and 1's depends on condition.

Ex 100.1.2.32
100.1.2.33
|
100.1.2.47

Given IP address forming a CIDR block or not.

→ It follows rule ①
→ 32-47 (16) = 2^4 (follows 2nd rule)
→ 100.1.2.32 is also divisible by 2 as 100.1.2. 00100000 divisible by 2.
so, ③ rule also follows.

So above block is CIDR Block.

2)

20.10.30.32
|
|
20.10.30.63] Block of IP address.

① follows rule 1
② 2^5 is size of block so follows 2nd rule.
③ It is also divisible by 2 evenly so 3rd rule follows.

→ Above Block is CIDR block

Representation of CIDR block

100.1.2.32 → Block Id
|
|
100.1.2.47 → DBA

2^4 → 4 bits for HID (No. of IP Address)
2^{28} → 28 bits for NID

→ No. of host $\boxed{2^4 - 2}$ ☆☆ Imp

100.1.2.33/28 → This shows or represent the particular IP Address and complete block too.

→ You can represent complete block by using just a single IP.

How to define a complete block using single IP Address?

Ans → 20.10.30.35/27

NID 3 bits

20.10.30.001|0 0011 → 35

Block ID HID

32 ← 00000
|
47 ← 11111

lies between range.

जितने bits हों Host ID में उससे Range बनाओ
0000...0 to 111...11 तक
अगर Consider किया हुआ No. Range में आएगा तो वो block का Part होगा।

→ During revision check it for one more IP Address by self considering $\boxed{\text{example}}$ → (100.1.2.35/20)

Subnetting and VLSM in CIDR

20.30.40.10/25

Host Id – 7 bits
NID – 25

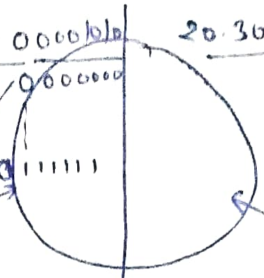
20.30.40 . 0 0001010
NID (or) Block Id — HID

① 20.30.40.0000|1010

0000000

fix

(0 – 63) 0111111



20.30.40.01000000
NID

1111111

(64 → 127)

20.30.40.0 to 20.30.40.63

20.30.40.64 to 20.30.40.127

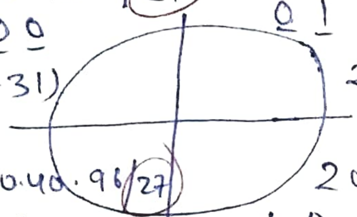
20.30.40.0/26
25+1 due to 0 as fix bit

20.30.40.64/26
1 bit adds in CIDR due to 1 as fix bit

20.30.40.10/25 Devide it into 4 subnets :-

20.30.40.0 0001010

2 bits requires for 4 subnets



20.30.40.0/27
00
(0-31)

01
20.30.40.32/27
(32-63)

20.30.40.96/27
11 (95-127)

10
20.30.40.64/27
64-95)

VLSM in CIDR

20.30.40.10/25

20.30.40·00001010
2^{25} 2^{7}

27 → 0000000 → 0
1111111 → 127

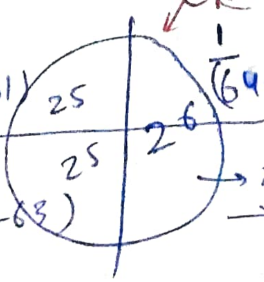
Internet Service Provider ← ISP → 27 Host

2^6 to company A

2^6

2^5 Company B

2^5 Reserved.



20.30.40.0/27
00
(0-31)
25

20.30.40.32/27
01
(32-63)
25

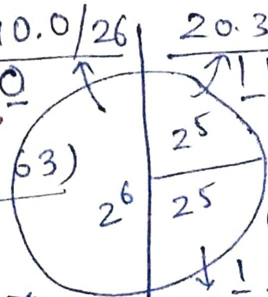
26

1
(64-127)

① Both are correct ②

→ 20.30.40.64/26

or



20.30.40.0/26
0
(0 – 63)
26

20.30.40.64/27
10
64-95
25

25
(96-127)
11
20.30.40.96/27

Ex-2 40.30.10.10/20

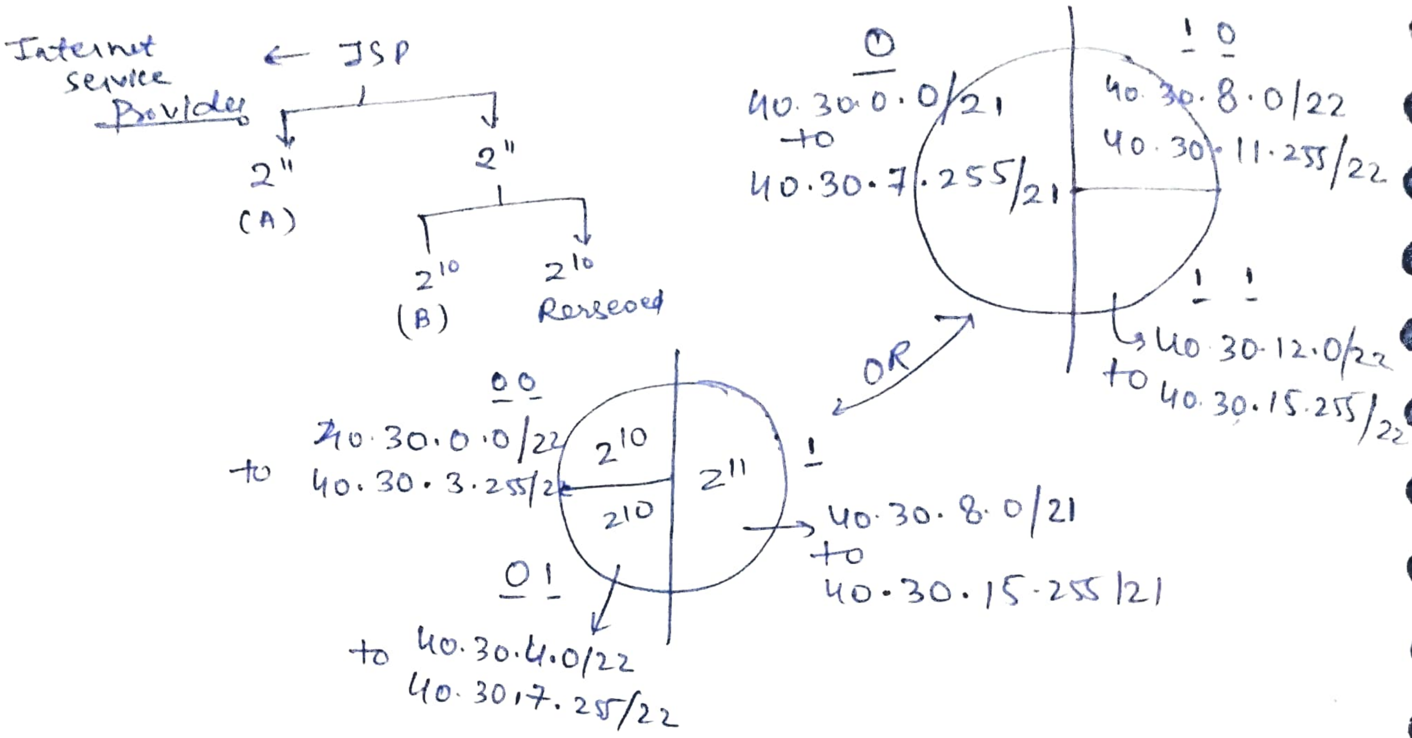
$\underbrace{40.30.0000}_{NID}\underbrace{1010.00001010}_{Host\ ID}$

0000.00000000 → 40.30.0.0

|

1111.11111111 → 40.30.15.255

] Range



Problems on Subnet Mask

→ Subnet mask also called as Network Mask

→ Bitwise AND of Subnet mask and IP Address gives network Id.

→ Subnet mask helps internal router to find perfect address.

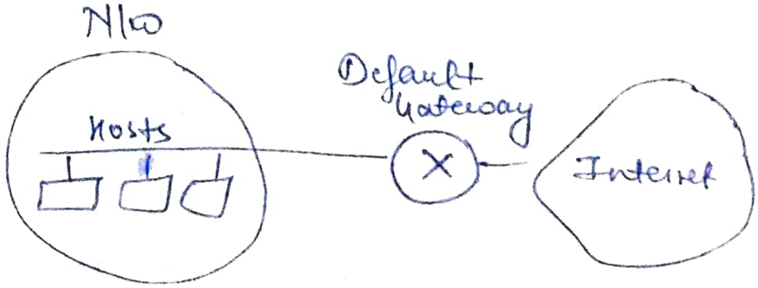
Internet Service Provider provides

① IP Address (IPv4, IPv6)

② Default Gateway

③ Subnet Mask

④ DNS



Using subnet mask we can identify that we have need to send message to another host that exists in same network of sender or in different N/w.

If in different N/w send it through router.

Host A : IpAddress : 200.1.2.10 Host B : 200.1.2.130
Subnet Mask : 255.255.255.128

A knows only IP of B and wants to send a message
Identify the location of B (inside same n/w or not)

SM_A AND IPA

11001000.00000001.00000010.00001010 – IPA

& 11111111.11111111.11111111.10000000 → SNA

200 . 1 . 2 . 0

200.1.2.0 ← N/w Id of A according to A

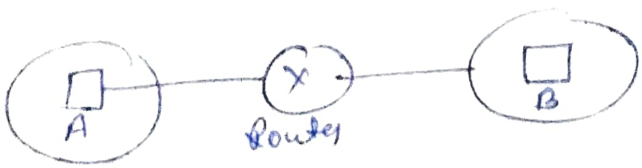
Means 200.1.2.0 belong to.

then IPB AND SMA

200.1.2.130
& 255.255.255.128

200.1.2.128 NIDBA → N/w Id of B according to A

→ NIDAA ≠ NIDBA So, B is not present in same network. So it will send to router first and then to B from A.



IA : 200.1.2.10 IB : 200.1.2.69
SA : 255.255.255.126 SB : 255.255.255.192

& IA
SA

NIDAA 200.1.2.00

& IB
SA

200.1.2.0 → NIDBA

] According to A both are in same network

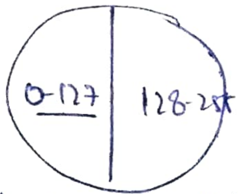
IB
& SB
NID DBA: 200.1.2.64

IA
& SB
200.1.2.0

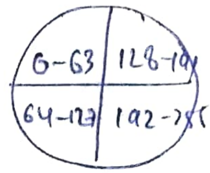
According to B both are in different network

According to A only two subnets

but !. According B there are 4 subnets



So both 10 and 69 lies in same subnet



So both 10 and 69 are in different subnets

→ So, subnet mask is just a perception not a reality. It is not always necessary that subnet mask is correct.

→ Make subnet mask of each system as 255.255.255.255 then and AND with IP each time we get the system IP and if you want to sent packet to another IP it will sent through router as

IA	IB
SM	SM
IA	IB

Both will different so always through router.

Q NID and subnet mask from DBA.

Ex 200.1.15.255

11001000 . 00000001 . 00001111 . 11111111

HID

Any of them can be HID

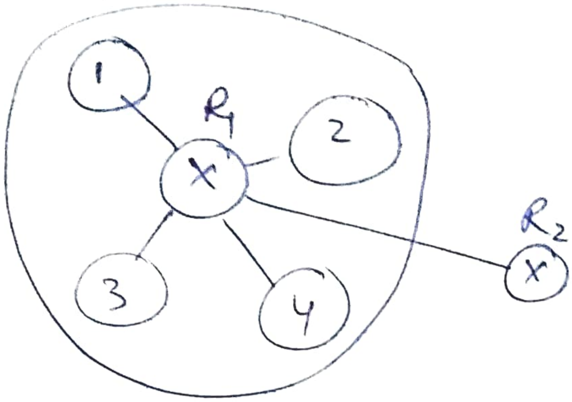
In DBA all 1's represent HID Part

So possible subnet mask can be of

NID /20
/21
/22
|

Supernetting or aggregation

Combine multiple subnets to form a single supernet. It can be done to reduce the size of routing tables



for R_1 (1, 2, 3, 4) are different network but for R_2 all belongs to same network

All the networks are not suitable for aggregation

Rules
① Size of all networks should be of same size and power of 2
② first network Id should be divisible size of ~~block~~. supernets
③ All IP Address must be contiguous

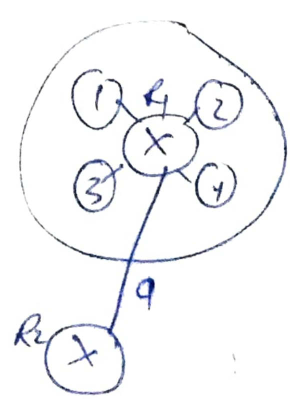
Ex → ① 200.1.0.0/24   Size → 2^8
② 200.1.1.0/24
③ 200.1.2.0/24   ←same→
④ 200.1.3.0/24

→ All are contiguous and of same sized (2^8)

Size of supernet $= 4 \times 2^8 = 2^{10} = 1024$ networks in block

At router R2

NID	SM	Interface
200.1.0.0	255.255.255.0	a
200.1.1.0	same .0	a
200.1.2.0	same .0	a
200.1.3.0	same .0	a



Since R_2 have need to sent packet to R_1 not to 1,2,3 or 4 so, it can hold just a single supenet Id and using that Id R_2 sent the package to R_1 and let R_1 holds the responsibility to sent it to 1,2,3,4.

<u>Supernet Mask</u>: 32 bit Number

1's → fixed part

0's → variable part

200.1.000000|00.00000000 → ①
          0 . 0

200.1.000000|01.00000000 → ②
          1 . 0

200.1.000000|10.00000000 → ③
          2 . 0

200.1.000000|11.00000000 → ④
          3 . 0

← fixed part (All 1's) → ← variable part (All 0's) →

255.255.11111100.00000000

$\boxed{255.255.252.0}$ /22 → Supernet Mask for all 4 subnets

To get NID AND (Bitwise) any IP from given 4 with supernet mask

255.255.252.0
200.1.0.0
―――――――――
200.1.0.0 → NID (It can be ↓ Supernet Id)

Trick → The Network Id of first network should always be the supernet Id of networks.

② ~~To~~ get subnet mask take the size of all 4 networks and sum them

$2^8 + 2^8 + 2^8 + 2^8$ (bcoz 8 bit of HID)

$= 2^{10}$

means subnet mask will contains 10 0's from LSB and all other 22 one ones (1's)

$\underbrace{255 \cdot 255 \cdot 111111}_{22}\underbrace{00 \cdot 00000000}_{10}/22$

Reduce router table at R_2 as

SuperNID	Supernet Mask	Interface
200.1.0.0	255.255.252.0	9

→ But at router R_1 there will be "No" supernetting possible.

Private IP Address → Just remember the range for Gate exam. Reserved in number

* 10.0.0.0 to 10.255.255.255 | (from class A 2^{24})
* 172.16.0.0 to 172.16.255.255 | (from class B $2^{16} \times 16$
* 192.168.0.0 to 192.168.255.255 | (from class C 2^{16})

→ IP Address use to communicate internally not externally.

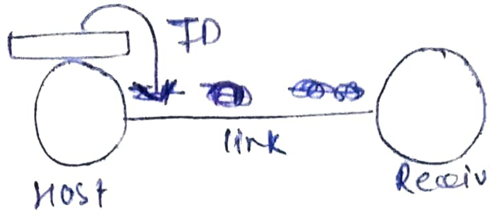
→ These IP Address are reserved for private communic by IANA and anyone can use them.

→ External router discard the message packets from private IP Addresses.

(D-2)

Delays in Computer Network

① Transmission Delay:



Time taken in sending packet from host to ~~receiver~~ transmitting link.

Packet को link पर रखने में लगने वाला समय

Ex: Bandwidth : 1 bit per sec (1 bps)
Data : 10 bits

TD: → $10 \times 1 = 10$ sec [$(\text{Bandwidth})^{-1} \times \text{Data}$]

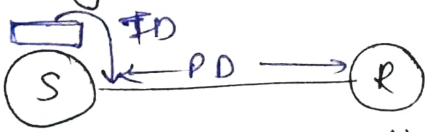
$$\boxed{TD = \frac{\text{Data}}{\text{Bandwidth}}} = \boxed{\frac{L}{B}}$$

Remember

Incase of Data: $1K = 1024$, $1M = 2^{20}$, $G = 2^{30}$
Bandwidth: $1K = 1000$, $1M = 10^6$, $G = 10^9$

* It is bcoz data measure in bits and bandwidth in decimal.

② Propagation Delay



PD depends on length of link and velocity of packet.

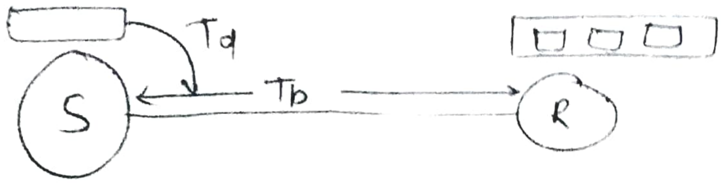
$$\boxed{T_p = \frac{d}{v}}$$

$v = 3 \times 10^8$ (incase of c)
$v = 3 \times 10^8 \times 0.7$
$= 2.1 \times 10^8$ m/s
↳ optical fibre

$d = 2.1$ km
$v = 2.1$ m/s $T_p = \frac{2.1 \times 10^3}{2.1}$
$= 10^3$ sec

→ 1 msec $= 10^{-3}$ sec   → 1 nsec $= 10^{-9}$ sec
→ 1 μsec $= 10^{-6}$ sec

$\boxed{\text{Total time} = T_d + T_p}$



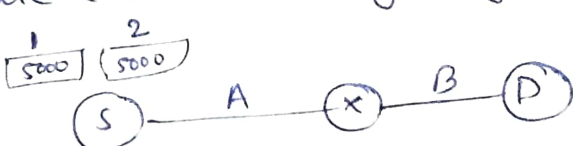
No any packet processed directly at the destination. It first enters in a queue.

<u>Queing Delay</u>:- Time spent in queue.
→ It can't be calculate there is no formula for that.

<u>Processing Delay</u>:- Packet extract from Queue and ready for processed.
→ It also doesn't have any formula.

→ Queing and Processing delay depends on processor speed. So these two consider as 0 in numericals otherwise given in question.

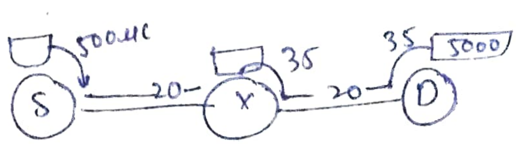
<u>Questions on Delay</u> → Gate 2015 [Do it by self]



sent packet 1 by one

$L = 5000$ bits

$T_t = \frac{5000}{10^7}$ sec
$= 500\,\mu s$



$T_p = 20\,\mu s$

Processing delay $= 35\,\mu s$

$T_1 : 0 \rightarrow P_1$ Transmit its 1st bit

$T_2 : 500\,\mu s \rightarrow$ last bit on link of P_1 / Complete P_1 on link

$T_3 : 500 + 20\,\mu s$ complete P_1 at switch / first bit of P_2 on link just to enter on switch

$T_4 : 500 + 20 + 35 \rightarrow$ first bit of P_1 on link B / P_2 start to be on switch

$T_5 : 500\,\mu s + 500\,\mu s \rightarrow$ last bit of P_1 to be on link B

$T_6 : 1000 + 20 \rightarrow P_2$ on

→ Must do the question at revision time