IPv4 ADDRESSING

Basics of IP addressing

$2^1 = 2$	$2^{40} = 1T$ (Tera)
$2^2 = 4$	$2^{50} = 1P$ (Peta)
⋮	$2^{60} = 1E$ (Exa)
$2^9 = 512$	$2^{70} = 1Z$ (Zetta)
$2^{10} = 1024 = 1K$ (Kilo)	$2^{80} = 1Y$ (Yotta)
$2^{20} = 1024 \times 1024 = 1M$ (Mega)	
$2^{30} = 1G$ (Giga)	

Conversions:

1 Byte = 8 bits	1 PB = 1024 TB (Tera Byte)
1 KB = 1024 Bytes	1 EB = 1024 PB (Peta Byte)
1 MB = 1024 KB (Kilo byte)	1 ZB = 1024 EB (Exa Byte)
1 GB = 1024 MB (Mega byte)	1 YB = 1024 ZB (Zetta Byte)
1 TB = 1024 GB (Giga byte)	

2 bit	3 bit
00	000
01	001
10	010
11	011
	100
	101
	110
	111

(fixed bit)

1 bit → 2 parts = 2^1 part

2 bit → 4 parts = 2^2 parts

⋮

K bit → 2^k parts

← n bit →

k	n−k

↓ 2^k parts ↓ 2^{n-k} (Size of each part)

2^k parts → 2^n

1 part → $\frac{2^n}{2^k} = 2^{n-k}$

← 3 bit →

2	1

↓ 2^2 parts ↓ $2^1 = 2$ (size of each part)

II. Semantics: The word semantics refers to the meaning of each Section of bits.

III. Timing: The term timing refers to two characteristics when data should be sent and how fast they can be sent.

eg:: if a sender produces data at 100 mbps but reciever can process data at only 1 mbps, the transmission will overload the reciever and some data will be lost.

② Identification Problem: To send a packet from source to destination, we need 3 identification steps

a. Identify the network

b. Identify the host with in the network i.e among all computers one computer is identified.

c. Identify the process within the host.

Note: Whenever we have all 0's in the HID part of any IP address, that IP address represent the NID of entire network, this is the reason we can't assign this IP address to any host (computer)

a. Solution for identification of network is IP address or logical address. Now we get destination IP using DNS

b. Solution for identification of Host within the Network is physical address or MAC Address, given an IP address we get MAC address using ARP (address resolution protocol).

c. Solution for the identification of process within the Host is Port Number.

	IP. Addr.	Mac Addr.
ARP Request	10.32.15.73	?

* ARP request is broadcasting
* ARP reply is Unicasting

Subnetting Category 2

Subnet Mask: It is a 32-bit number used to indicate number of bits borrowed from host-id and their positions were used on the following rules:

* Rule 1: No. of 1's in the subnet mask indicate NID+SID
* Rule 2: No. of 0's in the subnet mask indicate HID part

Default Subnet mask:	For Class A:
Class A: 255.0.0.0	255.0.0.0
Class B: 255.255.0.0	11111111.00000000.00000000.00000000
Class C: 255.255.255.0	NID+SID = 8, HID = 24
	SID = 0

Q1. If NID = 200.200.200.0 and Subnet mask = 255.255.255.192 then identify:

1. No of bits borrowed from host id: 2
2. No of subnets possible and their subnet ids: 4
3. No of Host/Subnet: 62

255.255.255.192

200.200.200.0 - Class C

No. of 1^s = 26

NID+SID = 26, SID = 2 bit

No. of subnets possible = $2^2 = 4$

Hosts/Subnet = $2^6 - 2$

= 62

Subnet ids = 200.200.200.- - - . - - - - -

AD Rule

128 64

00 - 0

01 - 64

10 - 128

11 - 192

200.200.200.00.000000 → 200.200.200.0

200.200.200.01.000000 → 200.200.200.64

200.200.200.10.000000 → 200.200.200.128

200.200.200.11.000000 → 200.200.200.192

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Q1. IP address in a block = 125.200.100.90 and the Subnet mask = 255.252.0.0 then find:
(i) 3rd host in 2nd Subnet: 125.4.0.3
(ii) 4th host in 3rd Subnet: 125.8.0.4
(iii) 1st host in 4th Subnet: 125.12.0.1

Ans
255. 111111 00. 00000000. 00000000
SID. HID.

2nd Subnet. 3rd host: 255. 00000100 . 00000000. 00000111
= 125. 4. 0. 3.
4th host in 3rd Subnet: 125. 00001000. 00000000. 00000100
= 125. ~~16~~ 8. 0. 4
1st host in 4th Subnet = 125. 00001100. 00000000. 00000001
= 125. 12. 0. 1.

Q2. IP address in a block = 157. 157. 100. 90 and the subnet mask = 255. 255. 224. 0 then find
i. 3rd host in 2nd subnet = 157. 157. ~~64~~ 32. 3.
ii. 4th host in 3rd Subnet = 157. 157. 64. 4
iii. 1st host in 4th Subnet = 157. 157. 128. 1.

Ans
Sm = 255. 255. 11100000. 00000000
SID. 2nd subnet → dec value (1). then Calculate.

HW

Q3. IP address in a block = 200. 200. 200. 90 and the Subnet mask = 255. 255. 255. 240 then find
(i) 3rd host in 2nd Subnet :
(ii) 4th host in 3rd Subnet :
(iii) 1st host in 4th Subnet :

Sm: 255. 255. 255. 1111 0000
SID.

(III) 202.61.64.0/21, NID = 21 bit, HID = 11 bit
202.61. 01000000.00000000 / 2^{11} (true)

(IV) 202.61.104.0/21, NID = 21 bit, HID = 11 bit
202.61. 01101000. 00000000 / 2^{11} (true)

Ans = II and III

Q9. An internet Service provider (ISP) is granted a block of addresses starting with 162.72.0.0/16. The ISP needs to distribute these addresses to three groups of customers as follows:
The first group has 128 Customers, each need 256 addresses
The Second group has 128 Customers, each need 64 addresses
The third group has 64 customers, each need 128 addresses.
Find the last address of 6th customer of the 2nd group and how many addresses are still available with ISP after these allocations.

Ans 162.72.0.0/16 NID = 16 bit, HID = 16 bit
No. of IP addresses available in the block = 2^{16} = 65,536

I. First Group = 128 Customers each need 256 Addresses
$128 \times 256 = 2^7 \times 2^8 = 2^{15}$ Addresses

II. Second Group = $128 \times 64 = 2^7 \times 2^6 = 2^{13}$ Addresses

III. Third Group = $64 \times 128 = 2^6 \times 2^7 = 2^{13}$ Address

IP addresses available $= 2^{16} - (2^{15} + 2^{13} + 2^{13})$
$= 2^{16} - (2^{15} + 2^{14})$
$= 2^{16} - 2^{14}(2^1 + 1) = 2^{16} - 3 \times 2^{14}$
$= 2^2 \times 2^{14} - 3 \times 2^{14}$
$= 4 \times 2^{14} - 3 \times 2^{14} = 2^{14}$

00000 —2 bit error→ 11000
01100
00110
⋮
} Invalid code word

Note: All 2 bit error detected.

00000 —3 bit error— 11100 Invalid code word
Can detect 3 bit error

00000 —3 bit error— 01011 Valid code word
Can't detect 3 bit error

Note: * All 3 bit error can't be detected.
* If minimum hamming distance = 3.

* All one bit error detected
* All two bit error detected
* All three bit error can't be detected.

Min H.D = 3. Valid Codeword —1 bit error→ Invalid Code word —1 bit error→ Invalid Code word —1 bit error→ Valid Codeword

Can't detect all 3 bit error.

* If minimum hamming distance = d
then we can detect (d-1) bit error.
* To detect 'd' bit error minimum hamming distance required is (d+1)

Linear Block Codes:
* A linear block code is a code in which the XOR of two valid codewords create another valid code word.
* Today almost all error detection codes are linear block codes:

2. Given the generator function G(x) and the message function m(x) as follows:

$G(x) = x^4+x+1$, $r=4$

$m(x) = x^7+x^6+x^4+x^2+x$.

Calculate the transmission function T(x)

$$x^4+x+1 \,\big)\, x^{11}+x^{10}+x^8+x^6+x^5 \,\big(\, x^7+x^6+x$$

$$x^{11}+x^8+x^7$$

$$x^{10}+x^7+x^6+x^5$$

$$x^{10}+x^7+x^6$$

$$x^5$$

$$x^5+x^2+x$$

$(x^2+x) \rightarrow$ Remainder

Codeword $= x^{11}+x^{10}+x^8+x^6+x^5+x^2+x$

HW

3. The message 11001001 is to be transmitted using the CRC polynomial x^3+1 to protect it from error. The message that should be transmitted is:

4. A computer network uses polynomial over GF(2) for error checking with 8 bits as info bits and uses x^3+x+1 as generator. In this network the message 01011011 is transmitted as

Ans Generator $= x^3+x+1$
$= 1011$

```
1011 ) 01011011000 (
        1011
        ------
         011000
          1011
         ------
           1110
           1011
         ------
           0101
```

Transmitted data = 01011011101

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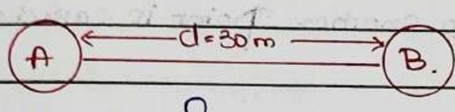
FLOW CONTROL

Delay in Computer Network.

Bandwidth = Bandwidth represent the rate at which number of bits placed on the link in one second.

Velocity: Velocity represent the rate, at distance covered in one second



100 bits transfer from A to B.

B = 1 bps = 1 bits/sec

V = 10m/sec

Total time = 100 sec + 3 sec

= 103 sec

Delay:

1. Transmission delay (Td)
2. Propogogation delay (Pd)
3. Queuing delay (Qd)
4. Processing delay (Prd)

Transmission delay: Amount of time taken to transfer a packet on to the outgoing link is called as transmission delay.

eg:: 1

Packet size = 1000 bits

Bandwidth = 2bps = 2 bits/sec

$Td = \frac{1000 \text{ bits}}{2 \text{ bits/sec}}$

= 500 sec

$$Td = \frac{L}{B}$$

eg:: 2

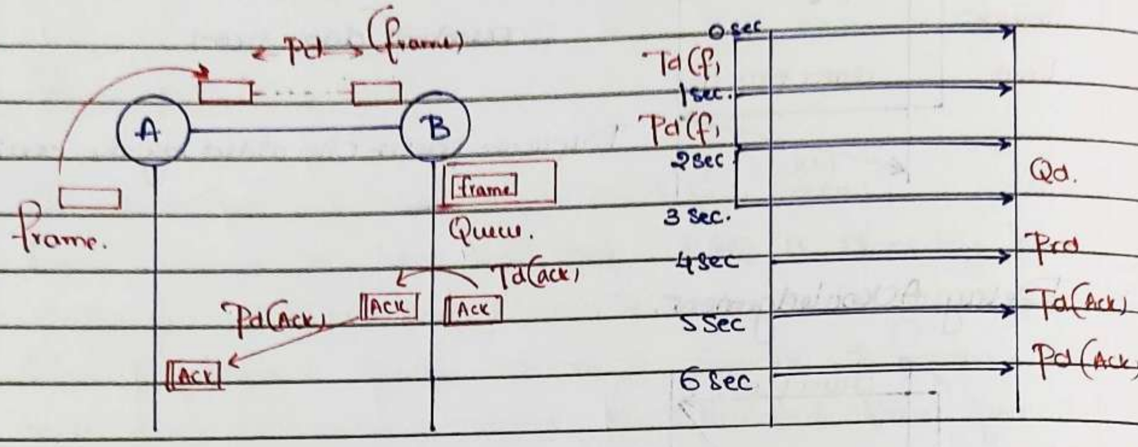
Packet Size = 100 bits

Bandwidth = 10bps = 10 bits/sec

Transmission delay = $\frac{100 \text{ bits}}{10 \text{ bits/sec}}$

= 10 sec

Efficiency / Line utilization / Link utilization / Sender utilization:



Total time = Td (frame) + Pd (frame) + Qd + Prd + Td(Ack) + Pd(Ack)

Total time is also called as "Round Trip Time."

RTT = Td (frame) + 2 (Pd) + Td (Ack)

Ack Size < Frame Size

Td(Ack) < Td (frame)

RTT / Total Time = Td (Frame) + 2 * Pd + Qd + Prd + Td (Ack)

Efficiency of stop and wait protocol:

$$\text{efficiency } (\eta) = \frac{\text{useful time}}{\text{total time}}$$

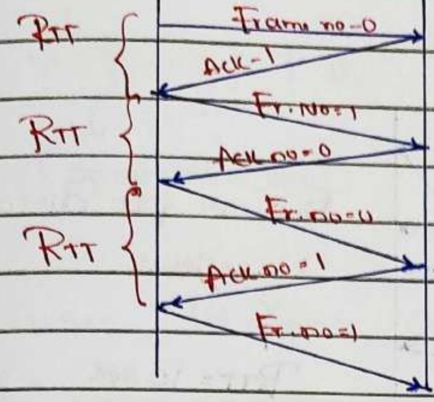
$$\text{efficiency} = \frac{Td(\text{frame})}{Td(\text{frame}) + 2 * Pd + Qd + Td(Ack)}$$

* If Qrd = Prd = Td(Ack) = 0

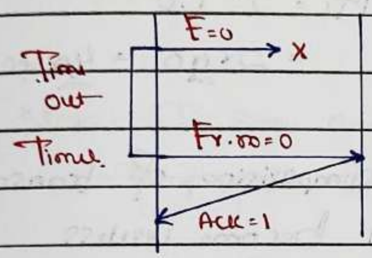
then Total time = Td (frame) + 2 * Pd + Qd + Prd + Td (Ack)

Total time = Td (frame) + 2 * Pd

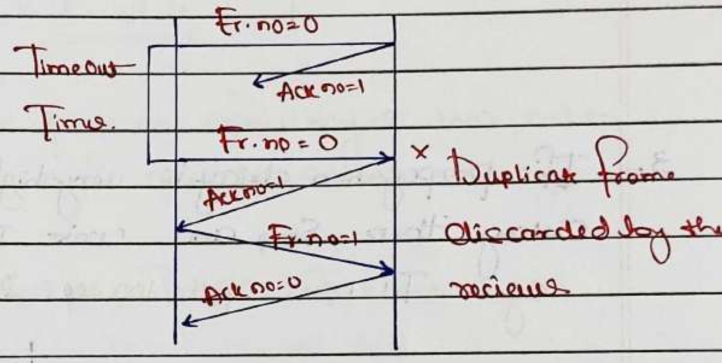
$$\text{efficiency} = \frac{\text{useful time}}{\text{total time}}$$



<u>Lost data packet.</u>

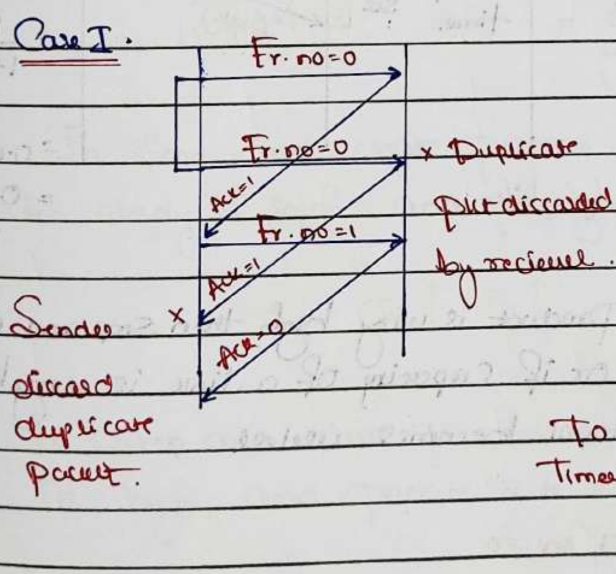


<u>Lost Acknowledgement.</u>



<u>Delay in Acknowledgement.</u>

<u>Case I.</u>



<u>Case II</u>