Lecture - 6

Network Layer characteristics

- allows end devices to exchange data
- net. layer communication protocols
  1) IPV4 2) IPV6
- 4 basic operations
  1) addressing end devices
  2) encapsulation
  3) routing
  4) de-encapsulation

What is IP encapsulation?

- encapsulates the transport layer segment.
- use IPV4 or IPv6
- not affect layer 4 segment
- IP packets are examined by all layer 3 devices as the traverse the network.
- IP addressing remain unchanged from source to destination.

(1) IP connectionless:
- not establish a connection with the destination before sending the packet.

④ IP unreliable: can't manage/ fix undelivered or corrupt packets

② IP best effort: → not guarantee packet delivery.

③ IP media independent:
– not matter what the type of frame/media used at the data link and physical layers.

IPV4 packet header $\boxed{\text{fields}}$

1) version
2) differentiated services
3) header checksum
4) time to live (TTL)
5) protocol
6) source and destination IPV4 addresses

IPV6: overcome the limitation of IPV4

1 address depletion
2 increase network complexity
3. Lack of end to end connectivity

★ Soln: - increase address space (128 bit)
- improve packet handling
- eliminate need for NAT → Network Address Translation
- simplified compared to IPV4, with fixed 40 bytes length.

header $\boxed{\text{fields}}$: 1) traffic class 2) version 3) flow label 4) payload length 5) next header 6) hop limit 7) source and dest. IPV6 add.

IPv6 not do this

Fragmentation: layer 3 splits the IPv4 packet into smaller units.

result: latency

How a host routes?

→ packets created at host

each host devices

- set IP address based on LAN or not
  1) if local, same LAN
  2) if not local/ remote host
     → different LAN

- set default gateway
  ↳ router/layer 3 switch's IP address

Lecture 7 + Subnetting

Network Administration:

-- install / maintain network

- repair connectivity issues

Types of IP address: 2

IPv4	IPv6

total 32 bits

— 4 octets

— 8 bits in each octet

5 class:

A : N.H.H.H   1.0.0.0 to 126.0.0.0/8

B : N.N.H.H   128.0.0.0 to 191.255.0.0/16

C : N.N.N.H   192.0.0.0 to 223.255.255.0 /24

D : used for multicasting
224.0.0.0 — 239.0.0.0

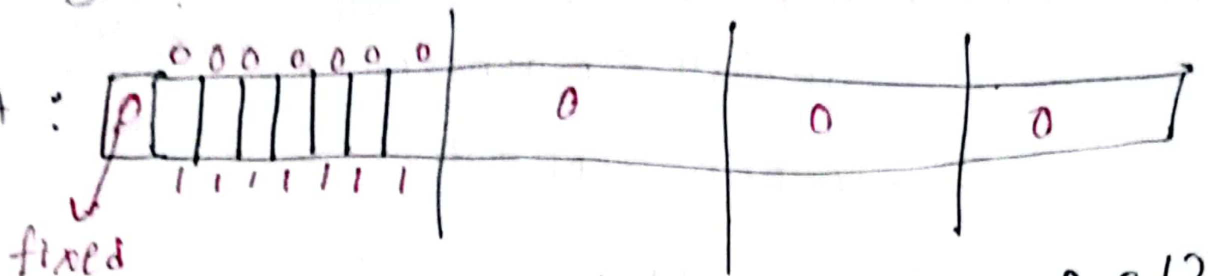
E : reserved for future..
240.0.0.0 — 255.0.0.0

N → networking bit 1

H → Host bit 0

Range:

A :



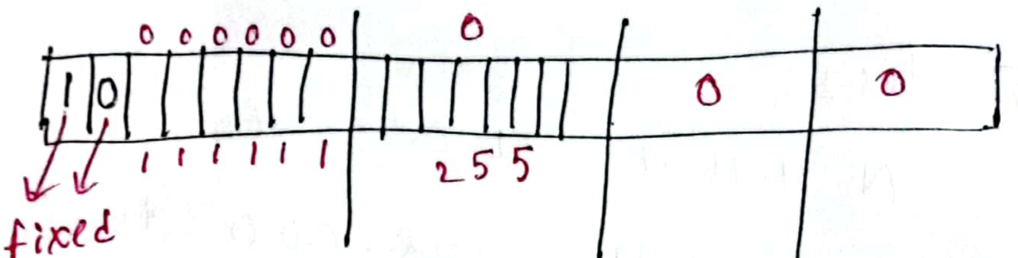
range for 1st octet: 127 − 0 = 127

∴ 0.0.0.0 to 127.0.0.0

not use — preserve for loopback

∴ So, 1.0.0.0 to 126.0.0.0

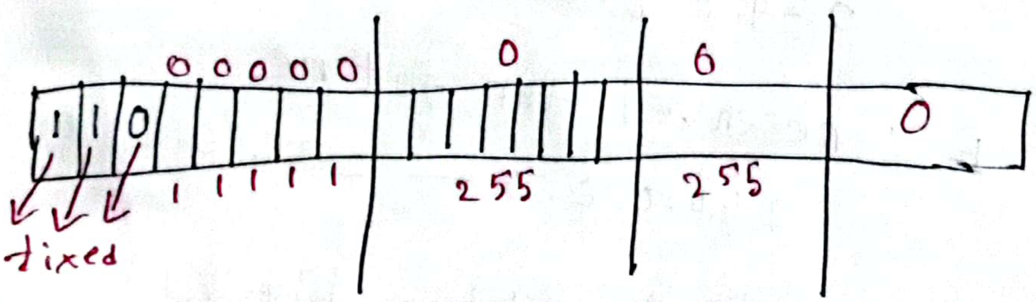
B :



1st octet: lowest : 10000000 → 128
highest : 10111111 → ~~223~~ 191

So, 128.0.0.0 to ~~223~~.255.0.0
191

C :



1st : low: 11000000 → 192
high: 11011111 → 223

So, 192.0.0.0 to 223.255.255.0

Number of Network and Host:

A : N. H. H. H

1 bit fixed remaining 7 bits.

$\therefore$ Total net. ID = $2^7 - 2 = 126$

not use 2 IP (1st and last)

Host bits = $3 \times 8 = 24$

$\therefore$ Host ID = $2^{24} - 2$

not accept when

— all bits 0

— all bits 1

B : N. N. H. H

Network ID = 2^{14} [1st 2 bits fixed remaining bits $= (2 \times 8 - 2) = 14$]

Host ID $= 2^{16} - 2$ → not acc all-1 or all-0

C : N. N. N. H

Net ID $= 2^{21}$ [1st 3 bits fixed remaining bits $= (3 \times 8 - 3) = 21$]

Host ID $= 2^{8} - 2$

$= 254$

Subnet Mask : 32 bit address

- differentiate net ID and host ID

types : 2

1) Default subnet mask
2) Custom "

class : 3

A : 255. 0. 0. 0
B : 255. 255. 0. 0
C : 255. 255. 255. 0

} default

Subnetting: goal — relieve network congestion → too crowded

Ex: IP Add : 192.168.20.0 } class C

Subnet mask : 255.255.255.(192)

fixed (custom)

1) Host per subnet
Block size (Range) = 256 − 192 = 64 or, $2^6 = 64$

H L

2) No. of subnets:

Subnet mask : 255.255.255.192

11111111.11111111.11111111.(11)000000

2 network bits

∴ subnets $= 2^2 = 4$

3) no. of valid host in each subnet:

2 network bits

∴ host bit = 6 (0)

valid host no. (each subnet) $= 2^6 - (2)$ $= 62$

1st for net id

last for broadcast ID

4) 1st and last valid host of each subnet:

P.T.O

1st Add. of Range/ Network ID

Subnet ID : 192.168.20.0 → 192.168.20.64 → 192.168.20.128

→ 192.168.20.192

(Range 64, 64 add each time

2nd add. of range

First valid host: (1^{st} x)

192.168.20.1 → 192.168.20.65 → 192.168.20.129

→ 192.168.20.193

last 2nd

Last valid host: 192.168.20.62 → 192.168.20.126

→ 192.168.20.190 → 192.168.20.254

Broadcast Add : 192.168.20.63 → 192.168.20.127

(Last add of Range) → 192.168.20.191 → 192.168.20.255

Ex: 192.168.2.10/27

a) what is the subnet mask ?

→ $\underbrace{11111111.11111111.11111111.111}_{27 \text{ bits}}00000$

dec : 255.255.255.224 (custom sub.mask)

b) no. of subnets : □.□.□.11100000

3 net. bits

∴ subnets = $2^3 = 8$

c) Block size / Host per subnet : 256 − 224

= 32

host bits — or, $2^{5} = 32$

d) Find out the $\boxed{\text{net. add}}$?

→ IP : 192 : 168 . 2 . 10

$\underbrace{11000000.10101000.00000010.000}_{27 \text{ net. bits}}\underbrace{01010}_{\text{host bits}}$

host bits — make it 0

$\boxed{\text{same}}$. $\boxed{5}$. $\boxed{5}$. 00000000

net add 192, 168. 2. 0 ✓

e) Find out the $\boxed{\text{broadcast}}$ address ?

→ 192 . 168 . 2 . 10

11000000 . 10101000 . 00000010 . 000$\underbrace{01010}_{\text{host bits}}$

→ make all 1

□ . □ . □ . 00011111

→ 192 . 168 . 2 . 31 (broadcast add.)

f) Last valid host : ?

→ Before broadcast : 192.168.2.30

g) 1st valid host : 192.168.2.1

Ex: IP add: 172.16.2.0/18 (class B)

1) what is the subnet mask?

$$\rightarrow \underbrace{11111111.11111111.11}_{18}\overbrace{000000.00000000}^{14}$$

255. 255. 192.0

2) no. of subnets: 2 bits net

$\therefore 2^2 = 4$

3) no. of valid host per subnet:

$2^{14} - 2$

4) what is the $\boxed{\text{net. IP}}$ add.?

→ 172.16.2.0

10101100.00010000.00000010.00000000

14 host bits → make 0

□.□.0.0

172.16.0.0

5) find Broadcast add

□.□.00111111.11111111

172.16.63.255

6) Last valid host: 172.16.63.254

7) First " " : 172.16.0.1

Ex: class (B) IP : 172.16.0.0/16

You've to create 4 new subnets.

1) what's the new subnet mask ?

Given, sub. mask.

→ 11111111.11111111.00000000.00000000 /16

Now, we need 2 net bits in host to create $2^2 = 4$ subnets.

∴ new sub. mask = 11111111.11111111.$\boxed{11000000}$.00000000

255.255.192.0/18

2) no. of usable host = $2^{14} - 2$

(in each new sub. mask)

3) Find out each network ID, usable host ID range and each broadcast ID.

→ Net: 172.16.0.0 → 172.16.64.0

→ 172.16.128.0 → 172.16.192.0

Host ID range : 172.16.0.1 – 172.16.63.254
(usable)

172.16.64.1 — 172.16.127.254

172.16.128.1 — 172.16.191.254

172.16.192.1 — 172.16.255.254

fix (11)111111 . Fixed

Range = (11)000000 . 00000000 → 64 | 3rd octet calc. → in class B

3rd 4th

Broadcast ID : 172.16.63.255 → 172.16.127.255
→ 172.16.191.255 → 172.16.255.255

Ex: class B IP : 10.2.0.0/20

1) what's the sub. mask? (12) host bits
→ 11111111.11111111.(1111)0000.00000000
255.255.240.0

2) no. of subnets? $= 2^{4} = 16$

3) no. of valid host per subnet?
→ $2^{12} - 2$

4) block size? → 2^{12}
host per subnet

5) Net. add? → IP given : 10.2.0.0
→ 00001010.00000010.0.0

After making 0, same
→ 10.2.0.0

6) Broad. add : 10.2.15.255

7) 1st valid host : 10.2.0.1
last " " : 10.2.15.254

3rd octet
Range : (1111)0000 – (1111)1111 $= 2^4 = 16$
fix fix

Till now, we have read about FLSM
Fixed Length Subnet Mask

VLSM — Variable Length Subnet mask

VLSM using class (C) IP:

Given, IP : 192.168.1.0/24
A → 120 hosts, B → 30 hosts, C → 50 hosts

$2^7 - 2 = 126 \geq 120$

A : Net Add = ?
120

Sub. mask : 11111111.11111111.11111111.0|0000000
make host bit
255. 255. 255. 0

→ ☐.☐.☐.1,$\underbrace{0000000}_{7}$
255. 255. 255. 128

∴ Net Add : 192.168.1.0/25

C: For A, Range = 256 − 128 = 128
50
or, $2^7 = 128$

$2^6 - 2 = 64 \geq 50$

∴ Net. Add : 192.168.1.128/26
Sub mask : 11111111.11111111.11111111.
11$\underbrace{000000}_{6}$
→ 255.255.255.192

Range = 256 − 192 = 64
or, $2^6 = 64$

$2^5 - 2 \geq 30$

B : Net. Add : 192.168.1.192/27
30

Sub. mask : 11111111.11111111.11111111.111$\underbrace{00000}_{5}$

→ 255.255.255.224

Pros: wastage of IP address - reduce

assign IP address according to host number

work from high to low (host no.)

VLSM using class B IP :

Given, IP = 172.15.0.0/16

Host no, A → 508, B = 225, C = 1010

C → A → B

C : Net. Add : 172.15.0.0/22 $2^{10} - 2 = 1022 \geq 1010$
1010

Sub. mask : 11111111.11111111.111111$\underline{00}$.00000000

255.255.252.0

Range = 256 − 252 = 4 or, 2^2 (calc. 3rd part)

A : Net. Ad : 172.15.4.0/23 $2^9 - 2 = 510 \geq 508$
508

Sub. mask : 11111111.11111111.
1111111$\underline{0}$.00000000

→ 255.255.254.0

Range = 2^1 = 2

$2^8 - 2$
$= 254 \geq 125$

B: Net. Add: 172.15.6.0/24

Sub. Mask: 11111111.11111111.11111111.00000000

→ 255.255.255.0

VLSM from any given IP:

A = 250 B = 60 C = 30

Ex: 192.15.5.16/27

→ 11000000.00001111.00000101.00|010000 make host

→ □.□.□.$\overbrace{00000000}^{8\text{ bits}}$

A: → 192.15.5.0/24 (Net. Add.)

Class C

sub. mask:

11111111.11111111.11111111.00000000

→ 255.255.255.0

$2^8 - 2$
$= 254 \geq 250$

B: A, range = 256 − 0 = 256

Net. Add → 192.15.5.0 /26

Sub. mask → 11111111.11111111.11111111.11000000

→ 255.255.255.192

$2^6 - 2$
$= 62 \geq 60$

B, range = 2^6 = 64

C: Net. add → 192.15.6.64/27

Sub mask → 11111111.11111111.11111111.11100000

→ 255.255.255.224

$2^5 - 2$
$= 30 \geq 30$

Lecture - 9

Transport layer :

- responsible for logical communications between applications running on different hosts
- acts as a link between application layer and lower layers responsible for network transmission.
- functions / responsibilities
  1) tracks individual conversations
  2) segments and reassembles data
  3) adds header info
  4) manages multiple conversations through segmentation and multiplexing

Transport layer protocols : (Def.)

- specify how to transfer messages between hosts and are responsible for managing reliability requirements of a conversation

TCP - Transmission Control Protocols

TCP Basic Operation :

1) number and track data segments
2) acknowledge received data
3) retransmission of unacknowledged data
4) sequencing data
5) Efficient data transmission

UDP chanactenistics (4)

1) connectionless : no dedicated connection before data submission

2) Best effont delivery → not guanantee that data neceived at dest

3) low ovenhead. → minimal headen size

4) suitable fon nequest and neply application

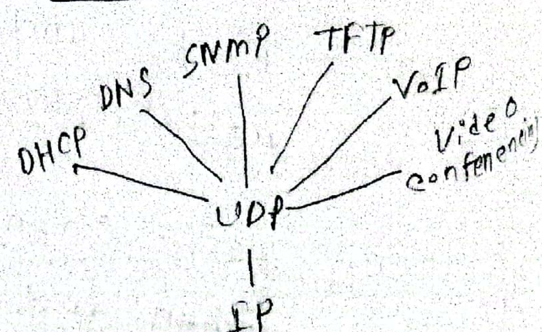
TCP	UDP
— neliable deliveny	— not neliable
— data annives ~~and~~ at connect onden	— not connect onden
— connected	— connectionless
— suppont flow ctnl	

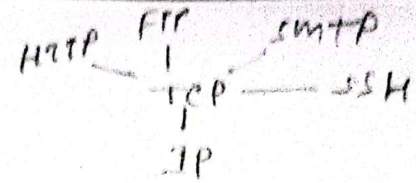
20 bytes

Sounce pont 16		Dest. pont 16	
Sequence no. 32			
Acknowledgement no 32			
Headen 4 Length	Resenved 6	ctnl Bit 6	window 16
Checksum 16		Ungent 16	
Options (0 on 32)			
App. Layen data (size vanies)			

8 byte

Sounce pont 16	dest pont 16
length 16	checksum 16
vanies size App. layen data	





Applications that use (TCP):

- handle all tasks associated with dividing the data stream into segments,
- reliability
- reorder segments
- ctrl data flow

Port Group	Range
Well-known	0-1023
Registered	1024-49151
Private or Dynamic	49152-65535

TCP 3 way handshake control bit flags:

SYN - Synchronize
ACK - Acknowledgement

1) SYN
2) SYN - ACK
3) ~~SYN~~ - ACK