→ Bit oriented protocol

→ Byte oriented protocol

Point to point protocol

H.W

16.10.22

Network Layer Characteristics

Properties: performs 4 basic operation

IP encapsulation

(I) public ip → private ip are mapped

(II) does not change from source to destination

IP may be described as

(I) Connectionless → no need to create connection beforehand

(II) Best effort

→ try its best

→ no acknowledgement

→ handles whether device receives or not

(III) Media independent → data link / upper layer.

(IV) Unreliable → (I) doesn't inform pack loss/ discard

(II) doesn't reassemble

MTU → Maximum Transmission Unit

Fragmentation → IPV6 does not support fragment

IPV4 Packet

↳ primary ~~protocol~~ communication protocol

network layer header has many purposes

(I) ensuring the packet is sent in correct destination

(II) used by all layer 3 devices that handle the packet

Packet Header Fields

IPV6 overview

128 bit addressing

No NAT technology

↳ devices are connected end to end

Limitation of IPV4

→ IPV4 address depletion
→ Lack of end to end connectivity
→ Increased network complexity

EH Headers Characteristics

(I) payload

Forwarding 3 types

(I) Itself 127.0.0.1 (IPV4) :: 1 (IPV6)
(II) Local Host ⇒ destination to the same LAN
(III)

Default Gateway – kind of router

Host Routing Table

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NAT – Network Address Translation
PAT – Port Address Translation

Translation → translate ~~translate~~ from private IP to public IP

DHCP – Dynamic Host Configuration Protocol
↳ assigns private IP on request

Benefits of DHCP

- Reliable IP address configuration
- Reduced network administrator
- Mobility
- IP address optimization (best solution using least resource)
- ~~Efficiency~~ Efficient change management

Subnetting

Network is divided into some segments
sub networks / sub-nets.

→ managable
→ security

Lease time — automatically terminated.

Subnet
DNS — IP address Web address
mapped

20.10.22

Logical segmentation → subnet

A to C segments are used
D and E are reserved.

Easily controllable & mangable

135.70.3.□ ← number of user 1 to 254
network address

□.□.□.255 ← broadcast address
□.□.□.0 ← network address

IP address Class

5 class.
A class, B class, C class, D class, E class

for network → for host

Class A : 255.0.0.0
Class B : 255.255.0.0
Class C : 255.255.255.0

} natural mask / default submask

Range

Class A : 1.0.0.0 to 126.0.0.0

Class B : 128.0.0.0 to 191.255.0.0

Class C : 192.0.1.0 to 223.255.255.0

There are some reserved IP address.

Benefits

→ Reduce broadcost volume, network traffic
→ Enable work from home
→ Allow max no. of hosts.

Supernetting

combining multiple networks into large network.

→ all networks contagious
→ block size equal (permittable host number)
→ 1st Network ID should be divisible by whole size of supernet.

First IP 200.1.0.0

whole size of super net $4 * 2^8 = 2^{10}$

Benefits

→ Control and reduce network traffic

· Classless Inter-Domain Routing (CIDR)

Subnet Mask Calculator

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Reserved IP address

10.0.0.0 — 10.255.255.255

172.16.0.0 — 172.31.255.255

192.168.0.0 — 192.168.255.255

10.0.0.0/8 — First 8 bits from left are for networking
Those will be 1

NA Network address 192.168.10.0/24

SM Subnet mask 255.255.255.0

Broadcast → 255

Default gateway → 0

BA Broadcast address 192.168.10.255

LA Limit address 192.168.10.254

FA First address 192.168.10.1

Adv. of Subnet

→ Management
→ Traffic control
→ Security

/25 255.255.255.10000000 (128)

/28 255.255.255.192

/127 255.255.255.224

/29 255.255.254.248

$2^{\text{number of 1}}$	$2^{\text{no. of 0}} - 2$
# of subnets	# of hosts
2	126
4	62
8	30
32	6

Q. 172.16.0.0/16

subnet mask

255.255.11111110.0

255.255.254.0

# of subnets	# of hosts
128	510

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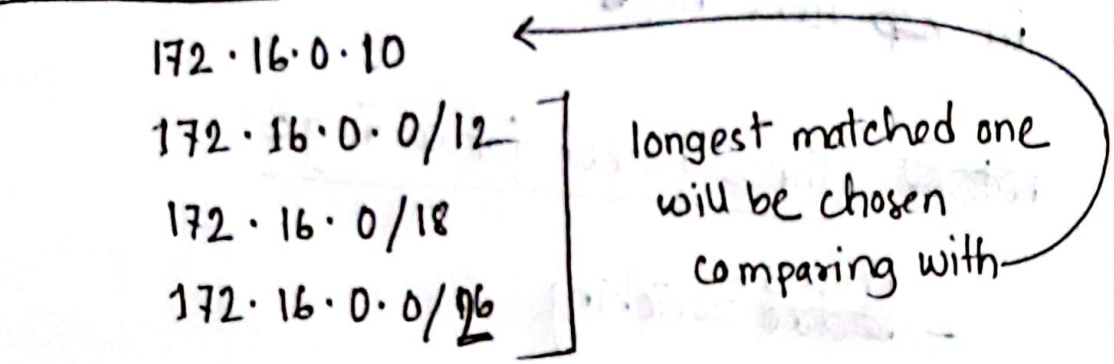
Build the Routing Table

- Directly connected networks
- Remote networks
  - static route
  - dynamic route

Default route is used if specific address is not known

- Default route (/0) is used as suffix.

Longest match :



/18

10101100. 00010000. 00000000 . 00001010

network address

/12

longest matched subnet will be chosen.

2001:db8:c000::99

2001:db8:c000::/40

2001:db8:c000::/48 ✓ longest match

2001:db8:c000:5555::/64

→ When no match is found, packet is dropped.

Packet Forwarding

encapsulation, framing is done before forwarding in next hop.

Three packet forwarding:

- Process switching
- Fast switching
- Cisco Express Forwarding

Process switching: when no match is found, packet is dropped

Fast switching:
dynamically update route. Keeps store of the route. If again crosses the path. information

is taken out and no further elaborated steps are ~~Infor~~ needed.

Cisco Express Forwarding:

08/11/22

Lecture #8. Network Layer

ICMP

Ping and Traceroute Test

127.0.0.1 Lookback address

Traceroute → test the path betn host

Lecture #9. Transport Layer

⇒ Tracking
⟹ Segmenting
⟹ Multiplexing

Datagram delivery → Best effort delivery

UDP → connectionless [Quick delivery, Data minimal]

TCP → connection oriented.

TCP features

Flow control is process to process in Transport layer.

Device to device flow control in data link layer

Application of UDP

→ live video and multimedia
→ request/reply app
→ app that handles reliability

Porting Numbering

Socket – IP address + port number of source/destination

Port Number Group

Well know
Registered
Private

Lecture #10

TCP Connection Process.

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Network Transmission Quality

Packet Loss

Network Traffic Trend.

Voice Traffic

14/11/12

QoS

Prioritizing Traffic

data is queued in memory. QoS is applied for packets maintaing quality in queue.

Sometimes some data are dropped.

In transport layer, queue maintainence is done.

In network layer. the quality is measured by

→ Bandwidth – no. of bits sent per unit of time

→ Congestion – the more the congestion, the more the delay

→ Delay – time needed up to destination

→ Jitter – uneven delay

Delay Type

Code - time takes to ~~compare~~ compress data

Packetization - time takes to encapsulate a packet

~~Delay~~ Queuing - time ~~takes to~~ a frame/packet waits

Serialization - time takes to transmit a frame

Propagation - travel time from source to destination

De-jitter - time takes to buffer a flow of packets

If loss is more than $\frac{1}{2}$ min no. of packets, then the service downfalls.

Queuing Algorithm

FIFO (First In First Out)

Weighted Fair Queuing (WFQ)

Class Based Weighted Fair Queuing (CBWFQ)

Low Latency Queuing (LLQ)

Tunnelling – preprocess the data
Encryption