Intercommunication with TCP/IP

(Computer N/w)

- IPv4 (Classless & Classful)
- NAT (Network Address Translation)
- TCP/~~IP~~ and UDP
- Router, Switch
- Router:- Network layer
  Switch:- Data Link layer
- DNS uses - UDP.
- Internet Quality of Service (QoS)
- Software Defined Networking (SDN).
- Books.

  Computer N/w: A Top-Down Approach, by Ames

- I/A. (*) → 30
  - mid-term: 15
  - presentation/ project : 10
  - attendance: 5

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- SMTP - Application layer protocol
  ↳ uses → TCP at transport layer.

  See Similar Questions..

*Jan 15/2025.

Frame: Data Link layer
Packet / Datagram : Network layer

Physical Address / Mac Address, (48 bits)   NIC: N/w interface Card

- A device can have 2 different IP addresses at same time. if connected with ethernet and wifi.

- A router with 4 interfaces, can have 4 different IP addresses.

DHCP: Dynamic Host Configuration Protocol

IPV4 → 32 bit

- Class C -

0xxx xxxx.

Class A - N/w → 8 bits Host → 24 bits

$2^7 - 2 = \# N/w$

Class B 10xx xxxx

Class C 110x xxxx

Class D 1110 xxxx

Class E 1111 xxxx

Class A = 0000 0000 . = 0.0.0.0.

N/w = 0111 1111, 1111 1111, = 127.255.255.255

Class B - 128.0.0.0 - 191.255.255.255 → 2^{14} # N/w

Class C - 192.0.0.0 - 223.255.255.255 → 2^{21} # N/w

Class D - 224.0.0.0 - 239.255.255.255.

Class E - 240.0.0.0 - 255.255.255.255.

	Host per n/w ID	# N/W	
class A	$2^{24}-2$	2^7	N H H H
B	$2^{16}-2$	2^{16}	N N H H
C	2^8-2	2^{24}	N N N H
D			
E			

125 . 68 . 72 . 1

0

16-01-2025.

64 32 16 8 4 2 1 → 1 2 6 0 → 0 1 1 1 1 1 0 1

0111 1101 . 0100 0100 . 0100 1000 . 0000 0001

1 2 4 8 16 32 64 128

125 . 68 . 72 . 1
AND 255 . 0 . 0 . 0
125 . 0 . 0 . 0 → N/W ID.

- use of classful or subnet mask :- if the router gets a request then it checks if the request is for a device in the same n/w, i.e. having same n/w ID.

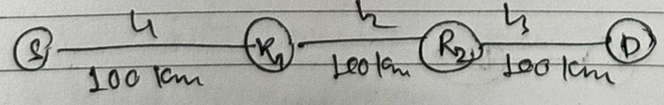
- propagation delay - signal travels through a medium, it travels through a speed.

$$\Rightarrow P.d = \frac{\text{distance}}{\text{Speed}}.$$

- transmission delay - Time to put the data from system to transmission media.
  depends on bandwidth.

$$\Rightarrow \frac{\text{packet size}}{\text{bandwidth}}$$

Amt of time to push all the packet bits to the media.



- Link bandwidth = 1Mbps
  Link speed = 10^8 m/sec.
  1000 packets, each of 1000 bits

$TD = \frac{P.S}{BW} = \frac{1000}{10^6} = 10^{-3}$ Mb ...

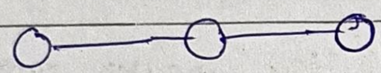
$1ms = \underline{3ms}$ S-D

for S-D - 3 hops = 3ms. - for 1 packet.

~~for 1000 packet = 3×10^3 m.sec = 3 sec~~

$TD = \cancel{3\cdot10^8} = \cancel{3ermsec} = \frac{10^5}{10^8} = 1ms.$

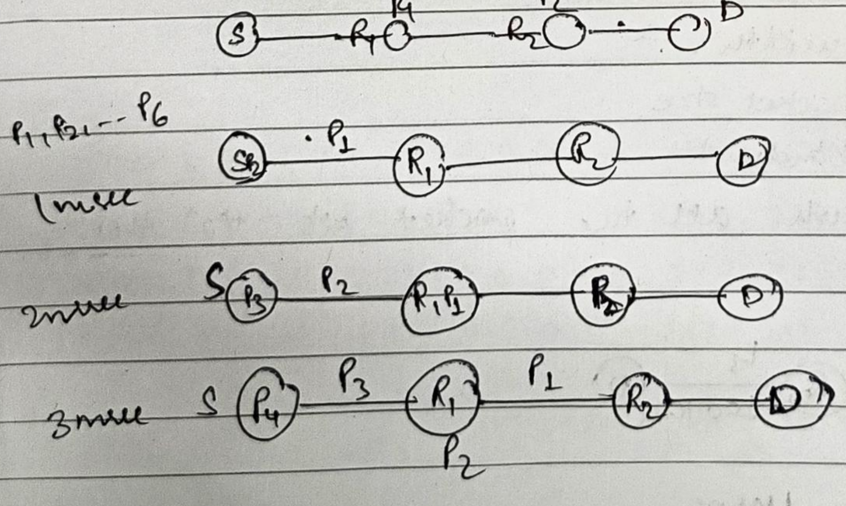
Total delay for 1packet = 3+3 = 6msec.



(A) 1005 ms; ⇒ 999 + 6ms.

first packet takes 6ms to reach D.
while first packet was reaching D, other packets must have proceeded in parallel.

• 6 packets. 6+5 = 11 msec



IP Address with special meaning.

0.0.0.0 → The lowest address
→ Host address
→ N/W address

1.1.1.1 → Broadcast on local N/W.

N/W	111 — 111

← Broadcast to a distant N/W.

127	Anything

← loopback (source & destination are same machine).

- Host address:- used by devices when they are booting up and do not have assigned IP.

- Q. Create broadcast N/W on a given network,

→ using SUBNET find host bits and set them to 1.

Check. 127.0.0.1 vs 127.1.2.3 local host addresses.
127.X.X.X

(IPv6 – 2^{128}) 128 bits

Private Networks.

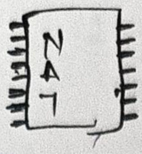
NAT is used to reuse IP addresses.

- private IP addresses are non-routable addresses.
- An IP address not directly connected to internet.
- 10.0.0.0 – 10.255.255.255
-
- NAT (Network Address Translation).

2^{16} – 65536 port.

- layer 3 device
- installed on Routers.
- NAT has a translation table.

$\boxed{\text{SOCKET} = \text{IP ADDRESS (Device)} + \text{PORT (Process)}}$



→ Private
- IP address
- Port
- (80)

NAT can be implemented in 2 ways

(i) Private IP → Public IP address
(ii) Private IP + Port ⟹ Public IP + some port

Uses of NAT.

① Pooling of IP addresses.
- A corporate has many hosts but only a small number of public IP addresses.

NAT Solution.
- corporate n/w is **managed with a private address space**

② Supporting migration b/w n/w service providers.
- In CIDR, IP addresses in a corporate n/w are obtained from the service provider.

- migration merely requires ~~an~~ update of the NAT device.

③ IP Masquerading

NAPT: n/w address and PORT translation.

PORTS: $2^{16} = 65536$ (1024) reserved

$$\begin{array}{r} 65536 \\ -\ 1024 \\ \hline 64512 \end{array}$$

Objections

- ~~me~~ violates the architectural model of IP.
- NAT breaks the end-to-end connectivity model of the Internet.

- NAT changes the internet from a connectionless n/w to a peculiar kind of connection-oriented n/w.

Source	Source IP	~~NAT assigned IP (Public IP)~~ Source port	NAT assigned IP address (Public)	NAT assigned PORT

- NAT violates the most fundamental rule of ~~protocol~~ protocol layering.

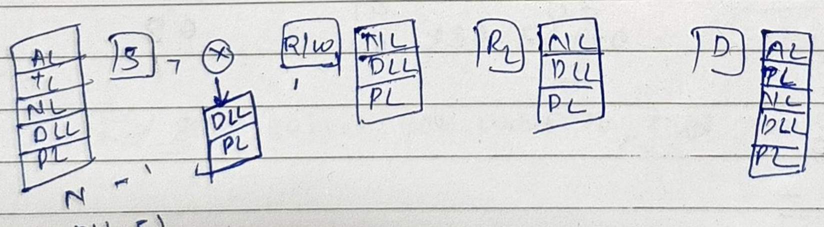
NAT destroys independences.

Summary

- It blocks unsolicited incoming packets by default.

Trans / N/W / DL / P — layer-4 firewall – look at all protocols headers up to the transport layer.

N/W / DL / P — layer-3 firewall – ______________ . N/w layer.



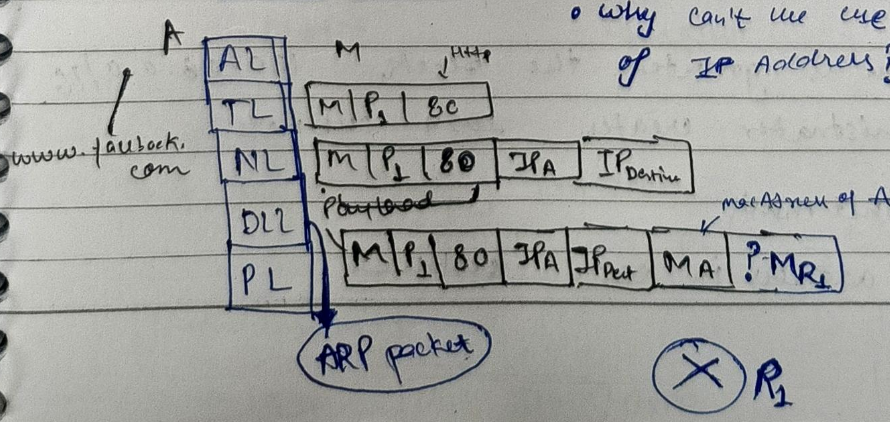
28/01/2025 (Tuesday).

ARP → Address Resolution Protocol

ARP response is unicasted

- why can't we use MAC address on place of IP Address?

Source Machine.



29/01/2025:-

10.105.1.113 — 10.105.1.91

255.255.255.0 — 0

10.105.1.0 — 10.105.1.0

113 →

255.255.255.128

10.105.1.128 — 01110001 — 113

10000000

0

192 → 11000000

01110001

01000000

.64

.64

255.255.255.224

255 − 224 = 31

16 + 8 = 24

11000000

01011011 — 91

01000001

01110001

.11100000

01100000

.96

32 + 64 = 96

91, 64

11100000

01011011

0100000

.64

113 − 64 = 49

64 + 49

64 + 32 + 16 + 1

192 − 128 = 64

91

64 + 32 = 96

64, 1

91 − 64 = 27

27 − 16 = 11

8, 2, 1

64, 16, 8, 2, 1

31: 16, 8, 4 → 28, 1, 2 → 31

Q An organization is granted the block 130.56.0.0/16. Now the administrator creates 1024 subnets

(a) find the subnet mask

(b) find the # address in each subnet

130.56.0.0/16

128
64
192

Subnet ⇒ 255.255.0.0

1024 = 2^{10}.

(a). subnet 255.255.255.192.

(b). # address in each – 2^6.

(i) Find the first & last address in subnet 1.

first: 130.56.0.0/26 – n/w ID of subnet 1

last: 130.56.0.63/26 – broadcast address subnet 1.

(ii) Find the first & last address in subnet 1024.

255
63
192

first: 130.56.255.192/26.

last: 130.56.255.255/26 – N/W rep

Starting Address = Base Address + (N−1) × Address per subnet

= 130.56.0.0 + (1024−1) × 64

N → that subnet you want to find address of.

Feb-13/2025.

What is routing?

Routing Tables

Static

Dynamic

Frozan-slides.

22-3 Unicast Routing Protocols

Routing protocols

Intradomain

Interdomain

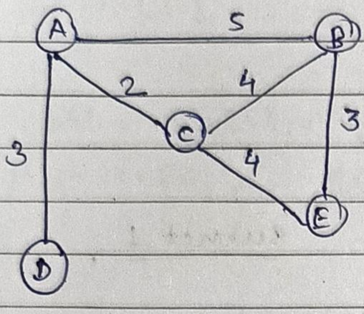
Distance vector RIP

LINK STATE OSPF

Path Vector BGP

◦ Bellman-Ford/

Distance Vector Routing Tables



A	Cost	Next
A	0	A
B	5	B
C	2	C
D	3	D
E	∞	—

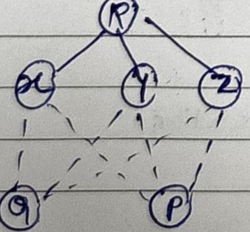
After B

E	8	B

B	Cost	Next
A	5	A
B	0	B
C	4	C
D	∞	—
E	3	E

◦ each node shares its routing table with its immediate neighbours periodically and when there is a change.

Q. Count to infinity problem??



Find S. path from
(i) R to P
(ii) R to Q

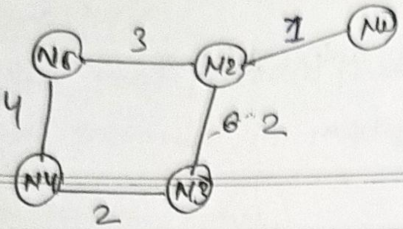
R measures
$x \to 3$
$y \to 2$
$z \to 5$

Router Q:
$x \to 4$
$y \to 6$
$z \to 8$

Router P:
$x = 7$
$y = 6$
$z = 5$

R to P = $R \to y + y \to P = 2 + 6 = 8$

R to Q = $R \to x + x \to Q = 3 + 4 = 7$



N1(0, 1, 7, 8, 4)

~~N2~~ (1, 0, 6, 7, 3)

N3(7, 6, 0, 2, 6)

N4(8, 7, 2, 0, 4)

N5(4, 3, 6, 4, 0)

After next round of update ~~cost~~ new D vector at Node N3.

N3 (3, 2, 0, 2, 5). Justify in exam. ☹

N4 (5, 4, 2, 0, 4).

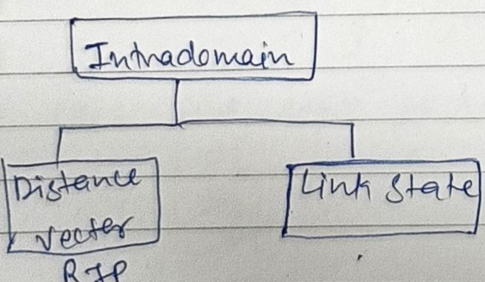
- **Two node instability.**

25-Feb-2025.

- Unicast Routing protocols
- Multicast Routing protocols

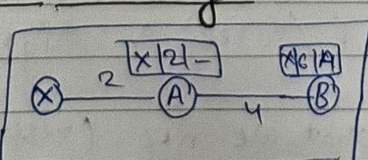
Autonomous System:- A system under one administrator.

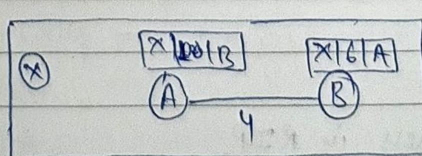
RIP - Intradomain Routing Protocol



- **Two node instability:**

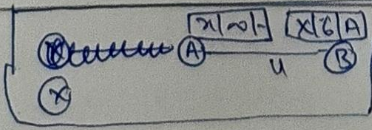
Before failure





After A receives update from B

After failure



Solution:

(1) In RIP $\infty = 16$, i.e. its stops after 16 hops assuming that there is some problem.

(3) • Split horizon:-

It is prohibiting a routes from advertising a route back onto the interface from which it was learned.

Split horizon with poison reverse:
send with weights $= \infty$ or -ve.

Three Node instability. (Forouzan - Fig- 22.18).

RIP(Routing Information Protocol). (Book-pg-283) 4th ed
used inside an ~~[illegible]~~ autonomous system.

• RIP Message Format (lab - GNS-3). (simulator / emulator)
RIP NG. e
RIP-V1 - (Not for classless addressing).
RIP-V2

Requests and Responses.
Two types of requests
- Request for all (N/w: 0.0.0.0)
- Request for some

Respons:
- Solicited - corresponding to a request
- Unsolicited - periodic (/30 sec) or triggered

Timers in RIP
- periodic (25-35 sec)
- Expiration
- Garbage Collection (120 sec)

Q: What are RFC (request for comments)

Feb-27/2025.

RFC says periodic timer should be 30 sec, to avoid collision we transmit in 25-35 sec.

Expiration timer

180 sec, after 180 sec hop counts = ∞,
if I don't get hello message from neighbouring routers.

Garbage collection timer

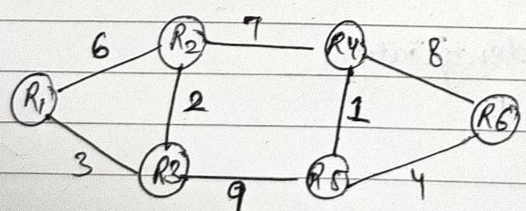
120 sec wait for invalid entry to delete.
(it will send 4 (30x4) times ∞ value to neighbours).

RIP version-2. Header

N/w address	Subnet Mask	Next Hop address

It supports classless addressing.

11.5 Link-State Routing



Step 1. Link state packet

R3	
seq	
Age TTL	
R2	2
R5	9
R1	3

Similarly for every router.

Step-2: Flood the LSPs in the n/w.

	R2	R3	R4	R5	R6
R1	5	3	12	12	16

every router will run its own dijkstra's Algo. and create its routing table.

Building Routing Table.

- shortest path tree
- Routing table

LSR - is used in OSPF and IS-IS

- **OSPF**

3 versions

OSPF v1 (1989) - x

OSPF v2 (1998) - used for IPv4 n/w

OSPF v3 (2008) - used for IPv6 or IPv4.

→ Areas:

Divide autonomous n/w into areas.

Area 0 (Backbone) → Primary Area.

Area Border Router

In Area 0 we will have a boundary router, that will connect to other autonomous systems.

every area has area identification.

The id of backbone is 0.

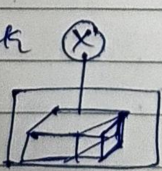
Metric

minimum delay, ~~min delay~~, maximum throughput.

Types of links

point to point link

Stub link



Sub network

n/w connected to only one router.

Packet go & come only through this router.

* Ex: Default gateway

Virtual link

if a link breaks, a longer link is created.

book- tcp-ip-protocol-suite Forouzan.

Types of OSPF packet :-

- OSPF common header