Seg 4

Network Layer

## Congestion Control

a state occuring in network layer when the message traffic is too heavy that it slows down network response time

## For control it

* monitor the system - detect when & when occurs.
* pass info where action can be taken.
* adjust system operation for correct it.

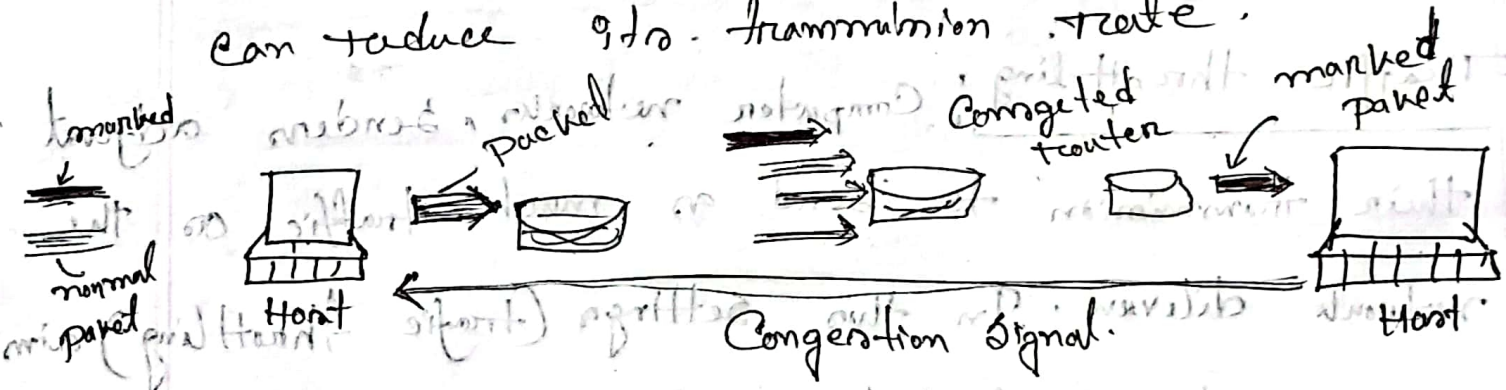
Control method → **Traffic throttling**: Computer networks, senders adjust their transmission to send as much traffic as the network can bear. In this settings (traffic throttling) aim to operate just before onset. Congestion. If felt. Congestion it tell senders to throttle back and transmission slow down

Choke packets → router congestion ला directly sender ला choke packet पाठवतो source host ला low rate वापरण्यास सांगतो source choke packet मिळाल्यावर traffic reduce करतो.

SP23

## Explict Congestion Notification with fig

ECN allows routers to mark packets instead of dropping them. When congestion occoured, the receiving device then informs the sender which can reduce its transmission rate.




When congestion occours, routers mark packets. router sets a specific ECN bit 0- no congestion
01- marked.

Then the sender receives the notifiy and adjust its transmission rate by throttling reducing send rate.

Au22

# Random Early Detection (RED)

RED works in routers and monitors the avg queue size

If queue grows large → Rtr, dropping pkt randomly

By droping pkt RED signals to the sender that

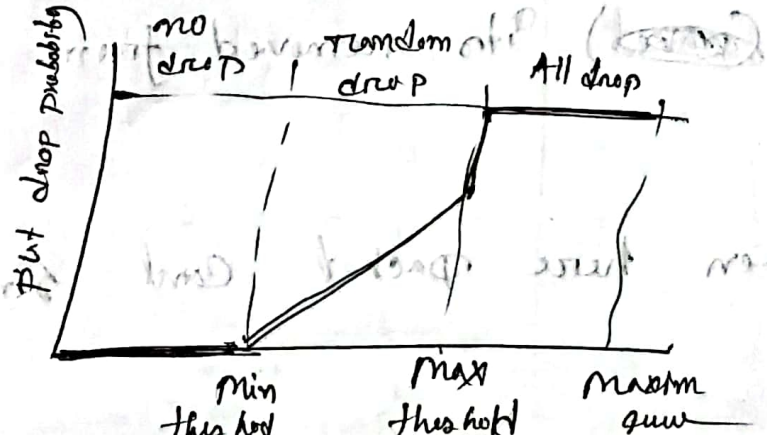
Congestion occour allow to sender slow down before

network becomes complatly congested.

- It helps taduce packet loss and congestation.
and improve network perfonmance

## RED Controls Congestion

- RED watch the router queue for signs congestion.
- when queue full signall to sender congestion.
- If queue size low Router don't drop packet
- sender slow down transmission rate



Control

## Congestion Algorithm

• Leaky Bucket: এটি bucket এর hole এর মতো
এর speed এর মতো Constant rate এর outflow
হয়। Same rate

① when host want to send packet তাহলে
thrown into bucket

② bucket Leaks Constant rate (network Interface
transmits Constant rate).

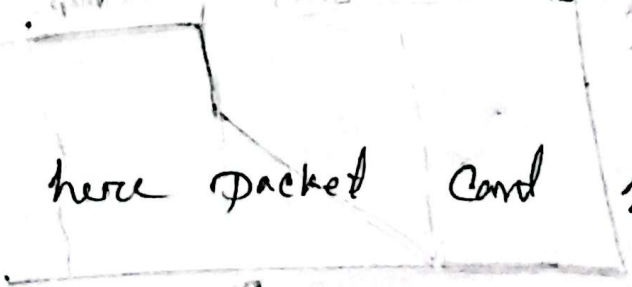
③ So bucket is finite que that outputs finite rate

• Token bucket Algorithm: এর মধ্যে bucket এ
token থাকবে।

① Token are thrown into bucket

② It has minimum capacity, If there is a
ready token (packet) তাহলে removed from bucket and
sent

If no token then packet Can't.



# Quality of Service (QoS)

It is a set of techniques used to manage network traffic efficiently, ensuring Application get the performance they need, even network is busy.

It is a traffic control mechanism that seek to either differentiate performance based on Application

## 4 step must be addressed to ensure QoS

1. what application need from the network.
2. How to regulate the traffic that enters network.
3. " " reserve resources at routers to guarantee performance
4. whether network can safely accept more traffic.

## Application QoS requirements

| Application | Bandwidth | Delay | Jitter | Loss |
|---|---|---|---|---|
| Email | L | L | L | M |
| remote login | L | M | M | M |
| web acess | M | M | L | M |
| file sharing | H | L | L | M |
| vedio demand | H | L | H | L |
| Telephony | L | H | H | L |
| Ved. conferencing | H | H | H | L |

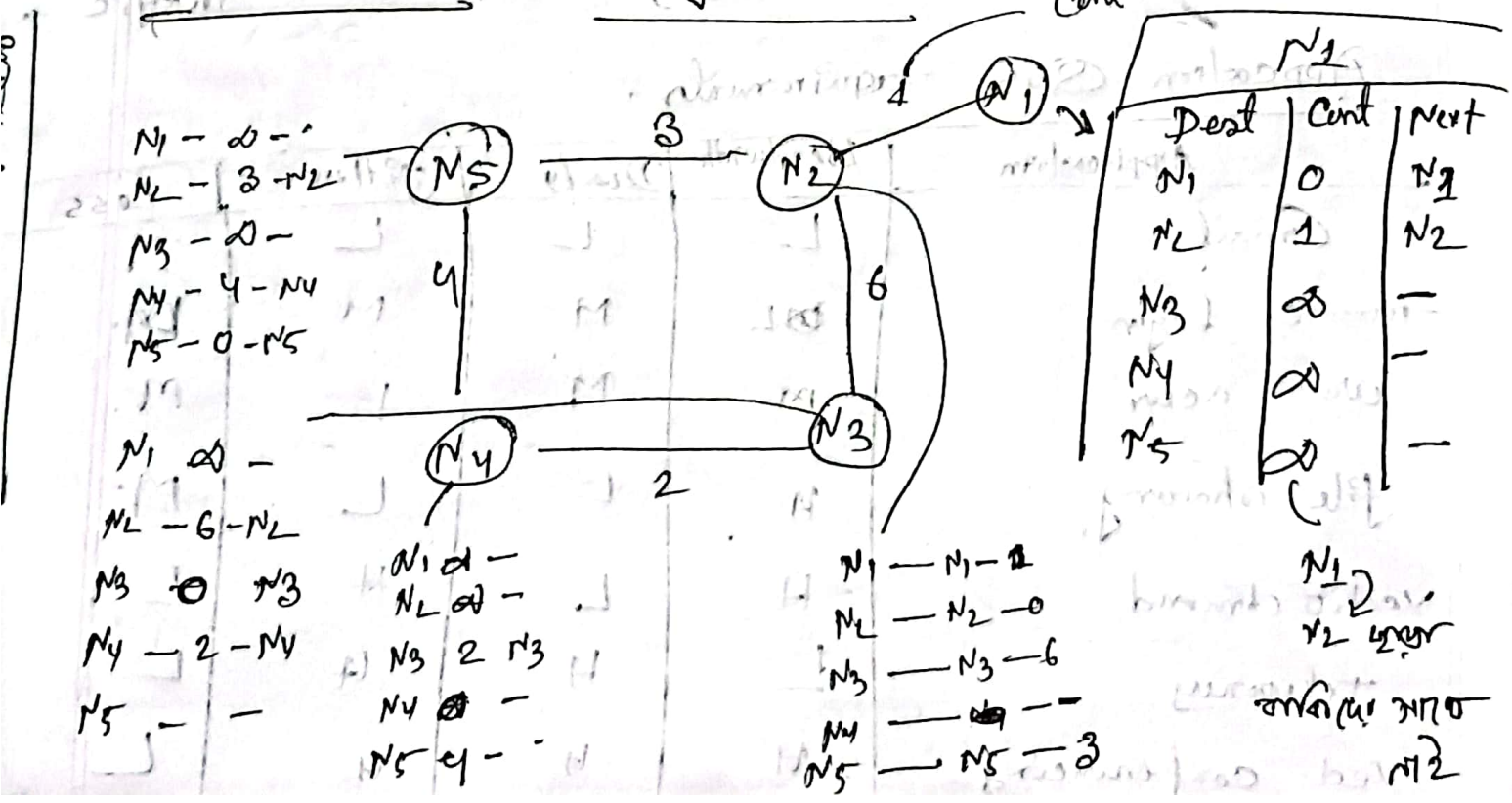
## Internet control message protocol (ICMP)

Icmp is a network protocol that allows devices to communicate errors and operational information. about network Communication. (used to test Internet)

## Math ** (1) Distance Vector Routing (DVR)

It is operates by having each router maintain a table (vector) giving shortest known path to each destination and which link to get there.

Node = router  edge = Link cost



Share only Distance Vector to Neighbours.

At $N_1$ → $N_2$

| $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ |
|---|---|---|---|---|
| 1 | 0 | 6 | ∞ | 3 |

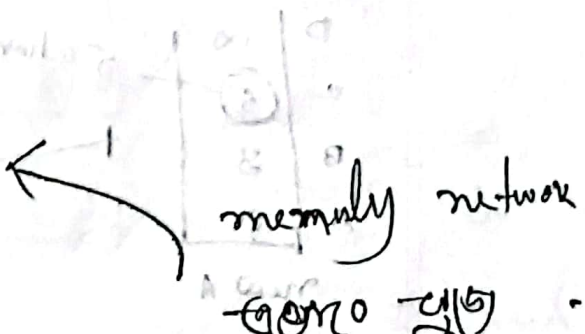
$N_1$ new Routing table

$N_1 - 0 - N_1$
$N_2 - 1 - N_2$
$N_3 - 7 - N_1 N_3$ ($N_1$ $N_3$ → $(1+6) = 7$)
$N_4$ ∞ — — ($1+\infty = \infty$)
$N_5$ 4 — $N_5$ ($N_1 + N_2 = 1$, $N_2 - N_5 = 3$ = (4))

At $N_5$ → $N_2$, $N_4$.

| | |
|---|---|
| 1 | ∞ |
| 0 | ∞ |
| 6 | 2 |
| ∞ | 0 |
| 3 | 4 |

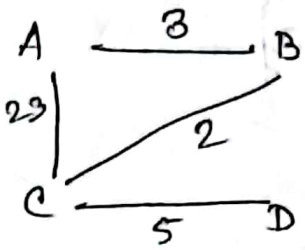
$N_5 \rightarrow N_1 = 3+1 = 4 \rightarrow N_2$ through.
$N_5 \rightarrow N_2 = 4 \rightarrow N_2$ thru
$N_5 \rightarrow N_3 = 4+2 = 6 \rightarrow N_4$ "
$N_5 \rightarrow N_4 = 4 \rightarrow N_4$ "
$N_5 \rightarrow N_5 = 0 \rightarrow N_5$




কিভাবে কাজ করে।

Main কথা Shortest path কে কিভাবে

# Construct routing table of Station (A).




## Initialization

| | A | B | C | D |
|---|---|---|---|---|
| A | 0 | 3 | 23 | ∞ |
| B | 3 | 0 | 2 | ∞ |
| C | 23 | 2 | 0 | 5 |
| D | ∞ | ∞ | 5 | 0 |

**Event 1** A receives copy from B, Q

A → B

| | |
|---|---|
| D | ∞ |
| C | (5) |
| B | 3 |
| A | 0 |

new A

5 change to 23

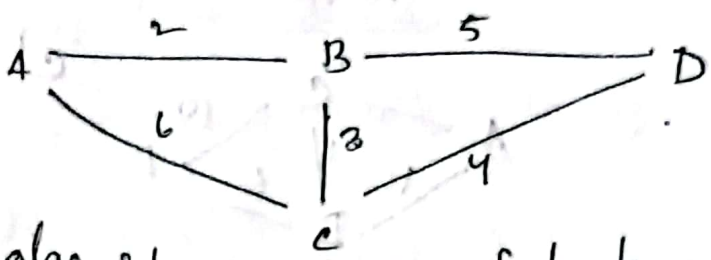
**Event 2** A → C.

| | |
|---|---|
| P | 10 |
| C | 5 |
| B | 3 |
| A | 0 |

A - B → C - D = 10
3 +2 +5

update করে আগের মত.

Math




Q. Routing for B; algo if A crash what happn.

Ans

| | A | B | C | D |
|---|---|---|---|---|
| A | 0 | 2 | 6 | ∞ |
| B | 2 | 0 | 3 | 5 |
| C | 6 | 3 | 0 | 4 |
| D | ∞ | 5 | 4 | 0 |

for B routing B receive in A, D, C.

for B→A


| | |
|---|---|
| A | 2 |
| B | 0 |
| C | 3 |
| D | 5 |

no chang

for B → C

| | |
|---|---|
| A | 2 |
| B | 0 |
| C | 3 |
| D | 5 |

no change

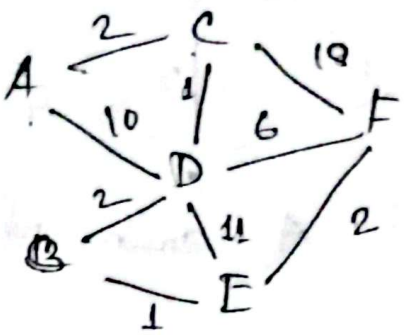
for B → D.

| | |
|---|---|
| A | 2 |
| B | 0 |
| C | 8 |
| D | 5 |

If router A crash & should be broken link. In protocal A crash other B, C, D aware. In DVR takes some time. takes some update time. B recorded as ∞ by all routers

# DVR

## Math




calculate for D

## Initial

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| A | 0 | ∞ | 2 | 10 | ∞ | ∞ |
| B | ∞ | 0 | ∞ | 2 | 1 | ∞ |
| C | 2 | ∞ | 0 | 1 | ∞ | 18 |
| D | 10 | 2 | 1 | 0 | 11 | 6 |
| E | ∞ | 1 | ∞ | 11 | 0 | 2 |
| F | ∞ | ∞ | 18 | 6 | 2 | 0 |

In D here D → A, D → B, D → C, D → E, D → F routes

New D | A | B | C | D | E | F | 10 | 2 | 1 | 0 | 11 | 6 | (copy A) 10+?

New D | A | B | C | D | E | F | 10 | 2 | 1 | 0 | 3 | 6 | copy B 2+?

New D | 3 | 2 | 1 | 0 | 3 | 6 | copy C 1+?

New D | 3 | 2 | 1 | 0 | 3 | 5 | copy E 3+ (update)

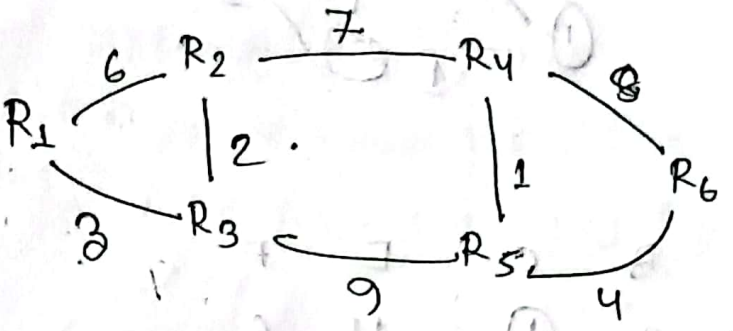
New D | 3 | 2 | 1 | 0 | 3 | 5 | copy F 5

final.

(सभी के Shortest path मिल गए।)

# Link State Routing (LSR)

In LSR each router maintains a complete and up to date map of the network topology. (using shortest path).




# Link State flooding হলে সবার কাছে packet send
So Bandwith high.

এখানে (R1) থেকে বাকি R1 → R2 R3 R4 R5 R6 shortpath.

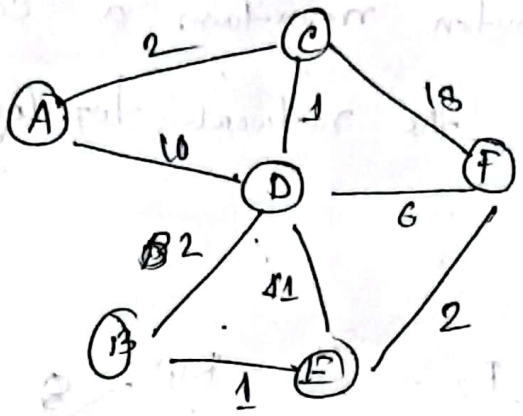
| R1 | R2 | R3 | R4 | R5 | R6 |
|---|---|---|---|---|---|
| | 6 | 3 | ∞ | ∞ | ∞ |
| R1, R3 | 5 | 3 | ∞ | 12 | ∞ |
| R1 R3 R2 | 5 | 3 | 12 | 12 | ∞ |
| R1 R3 R2 R4 | | | | 12 | 21 |
| R1 R3 R2 R4 R5 | | | | | 16 |

Dijkstra Algo তে এটা shortest path.

Routing table (R1)

| Destination | Shortest | via |
|---|---|---|
| R1 | 0 | R1 |
| R2 | 5 | R1 |
| R3 | 3 | R1 |
| R4 | 12 | R3, R2 |
| R5 | 12 | R3 |
| R6 | 16 | R3 R5 |

# LSR Math




Construct for (D)

## For D

| | A | B | C | E | F |
|---|---|---|---|---|---|
| D | 10 | 2 | 1 | 11 | 6 |
| DC | 3 | 2 | 1 | 11 | 6 |
| DCB | 3 | 2 | 1 | 3 | 6 |
| DCBEA | 3 | 2 | 1 | 3 | 5 |
| DCBEAF | 3 | 2 | 1 | 3 | 5 |

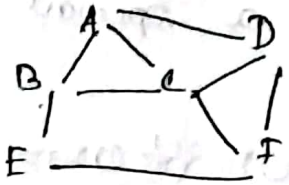
(smaller)

## Routing table D

| | Distance | Via |
|---|---|---|
| A | 3 | C |
| B | 2 | D |
| C | 1 | D |
| D | 0 | D |
| E | 3 | B |
| F | 5 | B, E |

# Flooding technique

when A packet arrive router, it is sent to all the outgoing links except the one it has arrived on.




here A → B C D / C → B, D, F | F = D, C.
B → E, C / D → A, F, C | E = B, F.

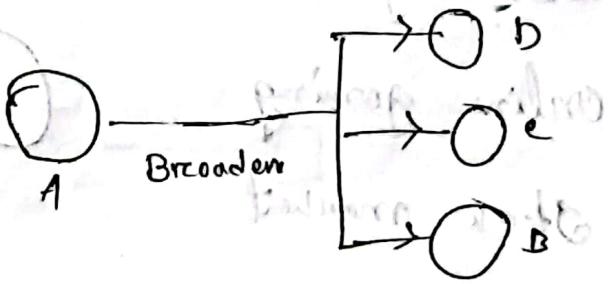
# Broadcast Routing

Send data to all devices on a network using a special broadcast Address. It sending data packets all devices on the network

Broadcast Routing Algorithms. Flooding, Spanning tree protocol.

It is good for large scale distribution.

Application
- Emergency alerts
- network wide updates



# Anycast Routing

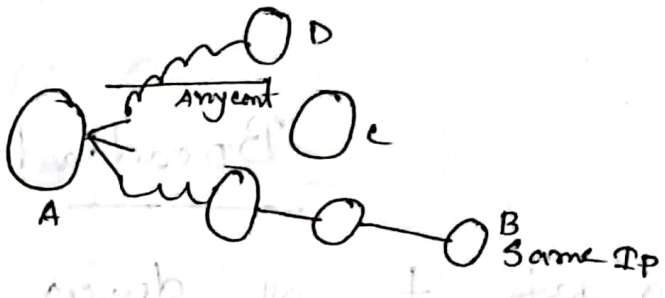
Sends data to the nearest device from a group of devices using a special anycast address.

~~key characteristics → one to one communication.~~

~~Point to point~~

Application

Load blancing
Content distribution
Server Redunecy

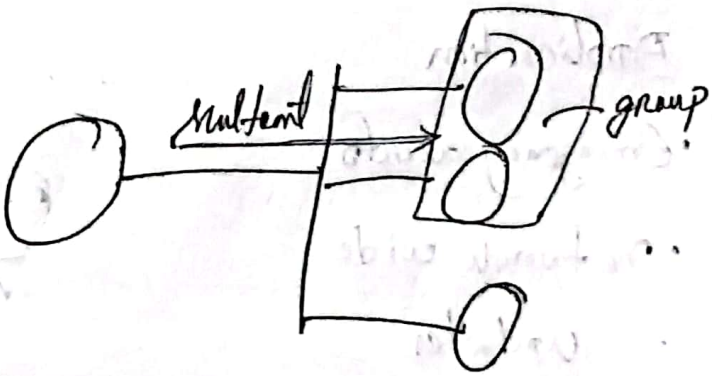



Multicast Routing: Sends data to a specific group of devices using multicast address. Ito associated with grp of devices.

Ito more efficient than broadcast routing.

Application

Vedio Conference
Online gaming
Stock market



Unicast Routing: It is the process of sending network traffic from a single source to a single destination over a network. each data have specific address to reaching with, one to one, point to point. Communication

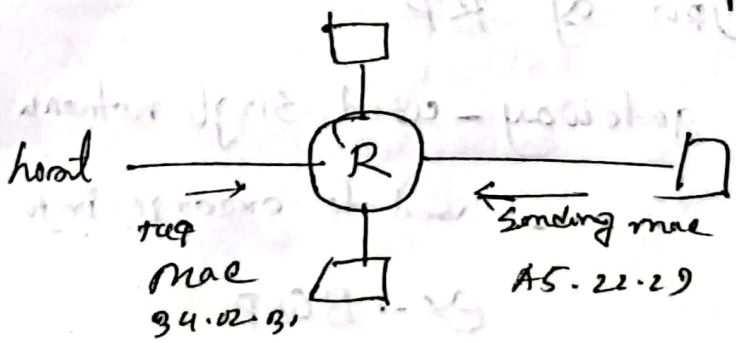
Application → web browsing, Email, Database queries

## ARP (Address Resolution protocol)

ARP maps and IP address to MAC address on a local network (LAN). It used when device needs to send data to another device on the same network only know its ip

Process ① device ask "who has this IP" all network device

② ARP reply with matching IP with MAC



## # RARP

Reverse Address Resolution Protocol.

RARP network protocol used to map a Mac Address to an Ip address on a Local network..

It is opposite to the ARP

Process ① know Mac but doesn't know Ip addrss.
Send RARP Request

② RARP brodcast to ask "Who has this Mac" and "what ip for this"

③ RARP Server reply IP.

## # Routing Protocol

Set of rules that help routers determine the best path for data to travel across a network. Types of RP

① Intorior gateway - used single network (RIP, OSPF)

② Exterior n - used to excange info different Networks
Ex - BGP

# Routing Information protocol (RIP)

It is oldest Distance Vector Routing protocol used for find best path for data within a network based on hop count.

Key features

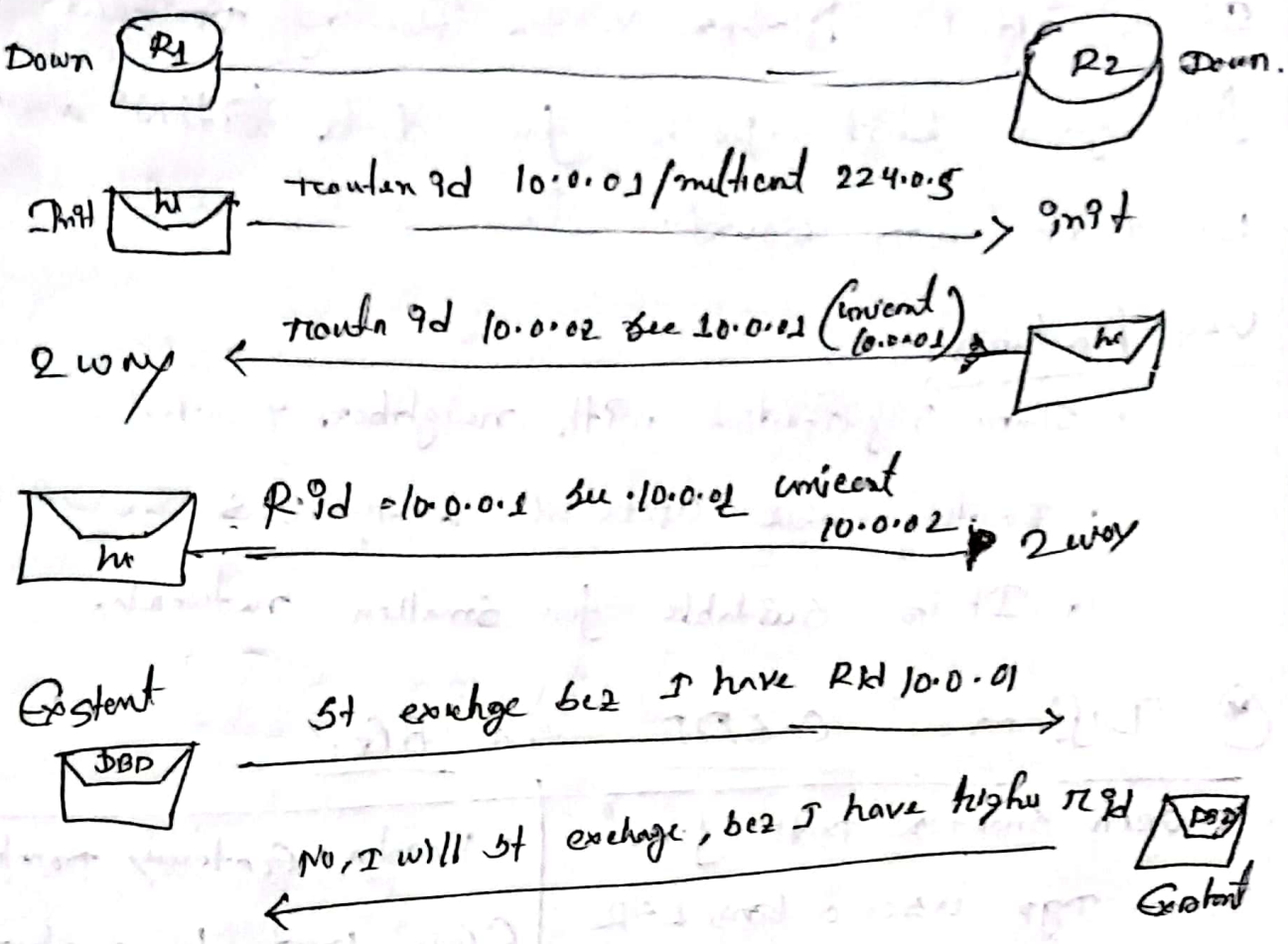
- Share information with neighbors routers.
- Routing table updated every 30s
- It is suitable for smaller network.

(*) Difference OSPF & BGP

| | |
|---|---|
| • open shortest path first is an Igp uses a LSR to determine best path | • Border Gateway protocol is EGP used to exchange routing info between different System |
| share entire topology | shares only the reachable network. |
| Easily Implement | hard Implement (complex |
| Dijkstra Algo used here | Best path Algo used here |
| protocol is IP | Tcp Protocol used |
| easier to manage | Complex advance features for traffic control. |

Sep 22

# How Link state database built?




Steps

① Each Router Create an entry in its LSDB with Id, Link to negeibours, Link Cost

② Routers Send LSA to share network info.

③ based on Recived LSA Routers update LSDB's update, delete entries.

④ This process Continue untill routers have same Constant network view