Routing Algorithms

The main function of n/w layer are

* Routing
* congestion control
* Internetworking

1) **Routing** :- It is the process of forwarding a packet in a network so that it reaches its intended destination.

→ main goal of Routing Algorithms

1. correctness :- Routing should be ~~~~ done correctly to the intended destination.
2. simplicity :- routing should be done in a simple manner.
3. Robustness :- The ability to withstand the system over a years (adapt to new changes also).
4. stability :- routing algorithm should be stable under all circumstances.
5. Fairness :- Every node connected to the n/w should get a fair chance of transmitting their packets.
6. optimality :- optimal in terms of throughput and minimizing ~~mean~~ mean pkt delays.

Routing classification

Adaptive Routing (dynamic)

- changes routes dynamically
- gathers information at runtime.
  - locally
  - from adjacent routes
  - from all other routers
- changes routes
  - every delta 'T' seconds
  - when load changes & when topology changes

Non Adaptive Routing (static)

- Choice of route is computed in advance, offline and downloaded to the router when the n/w is booted.

→ **Different Routing Algorithms**

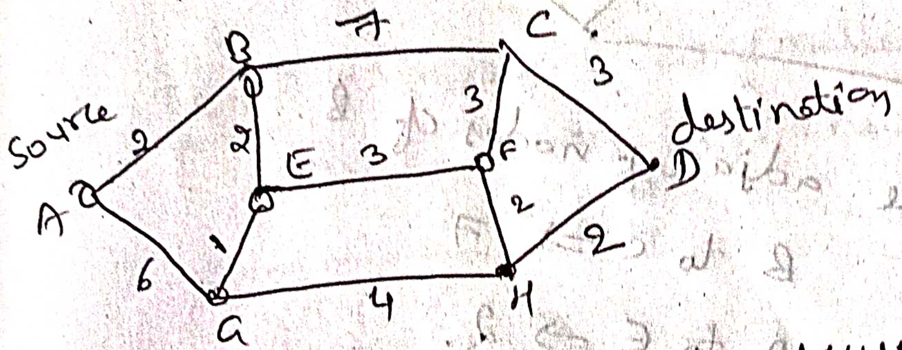
1. Static Routing Algorithm
   - Shortest path Routing
   - Flooding
   - Flow based Routing
2. Dynamic Routing Algorithm
   1. Distance vector Routing
   2. Link state Routing
3. Hierarchical Routing
4. Routing for mobile host
5. Broadcast Routing
6. multicast Routing

1) Shortest path Routing

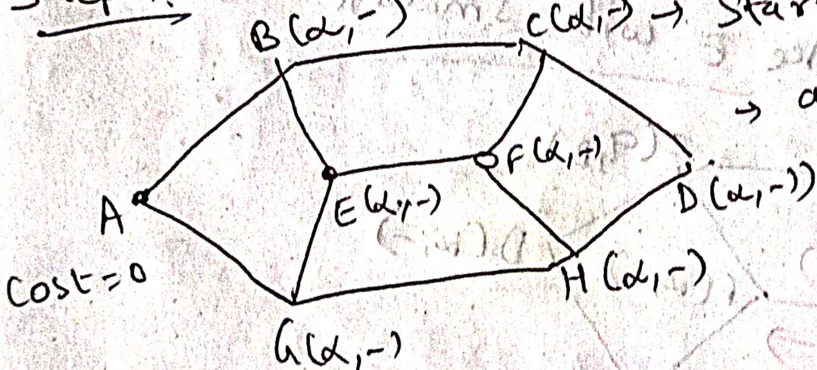
Finds the shortest path between a given pair of routers.

→ The cost of link may be a function of
- distance
- bandwidth
- avg traffic
- communication cost
- delay etc.

example:- Dijkstra's algorithm



step 1:-

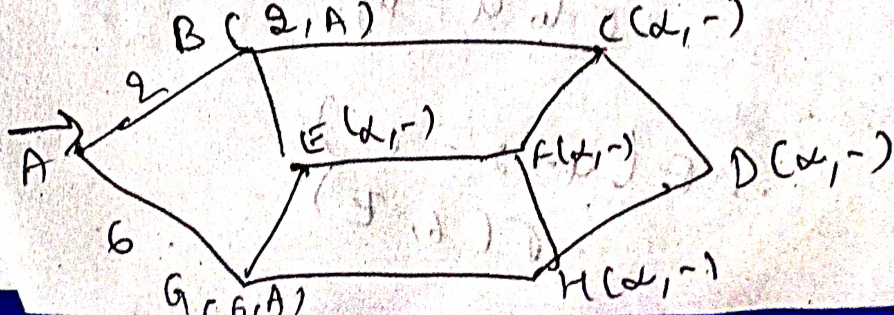


Assume.
→ Starting node cost is '0'
→ all other nodes are 'α'

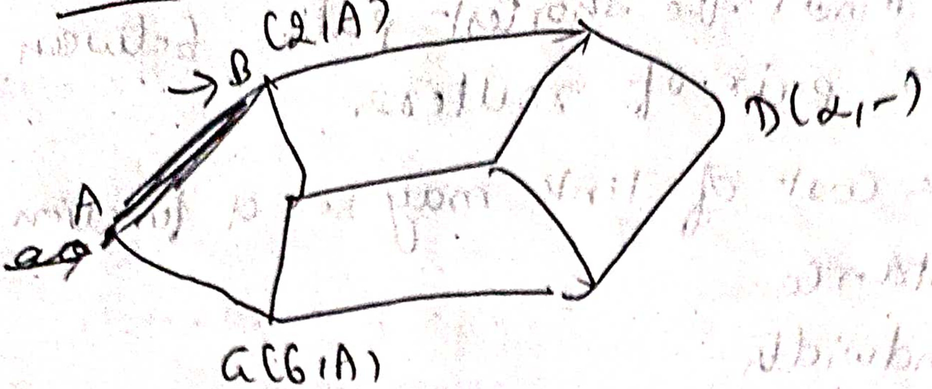
step 2:- examine adjacent nodes of A.

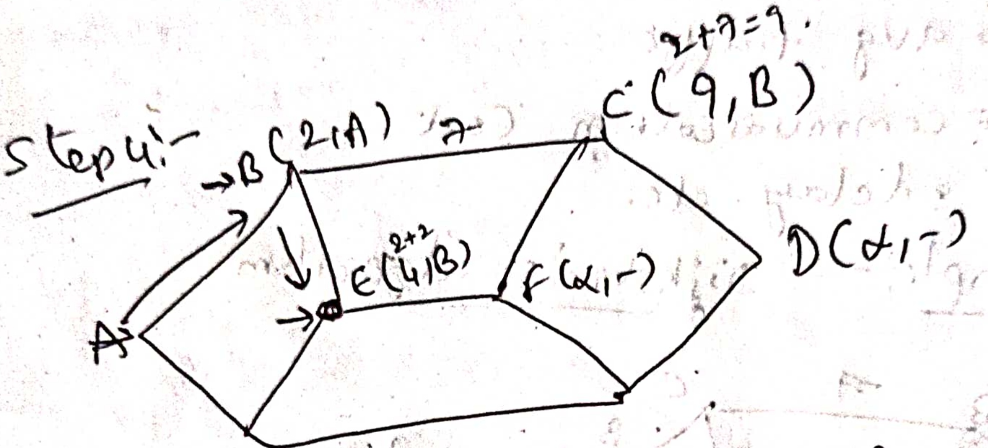
A to B ⇒ 2

A to G ⇒ 6



step 3 :- we make B as with smallest label. B is the new working node.



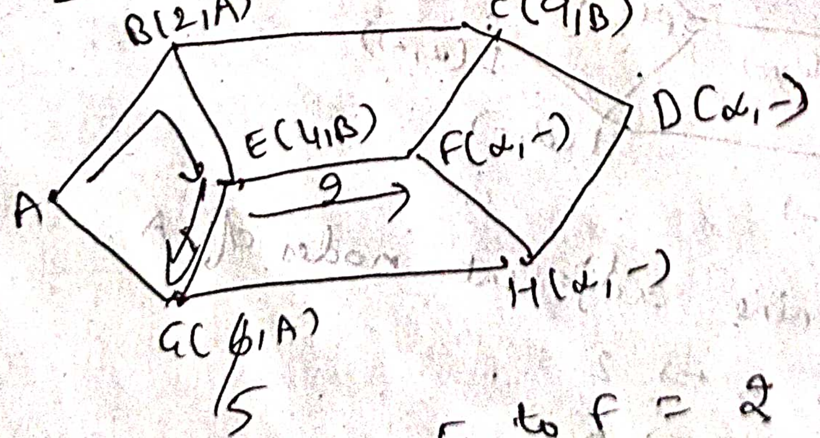


examine adjacent nodes of B.

B to C ⇒ 7

B to E → 2.

step 5 :- make E with smallest label.



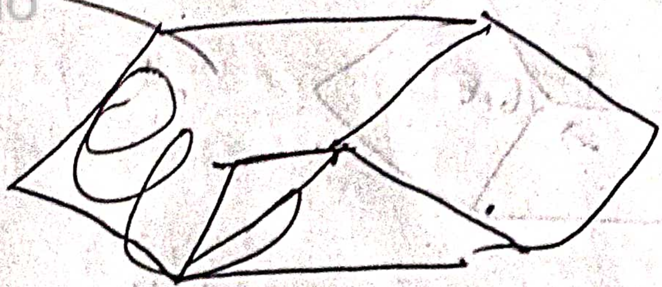
E to F = 2

E to G = 5.

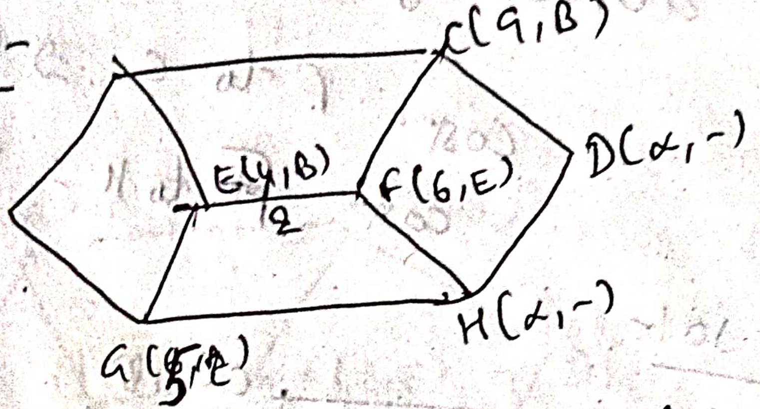
∴ F (4 + 2 = 6)

F (6, E)

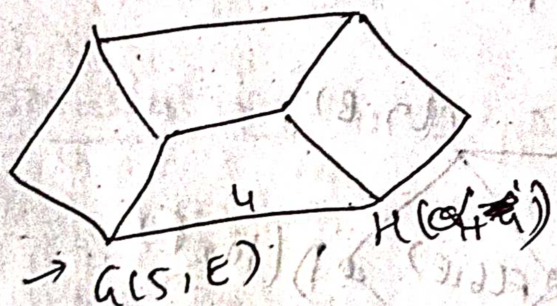
Step 6:-



Step 6:-

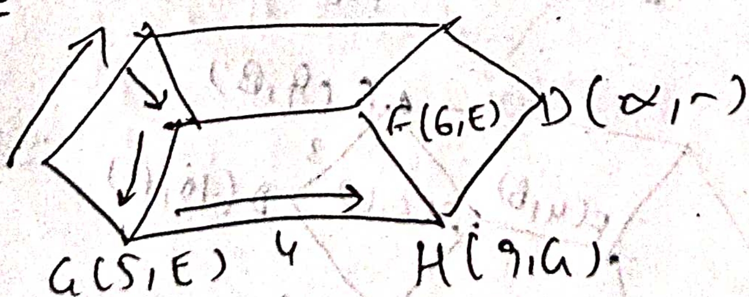


Step 7:- make G as smallest label & mark it as permenent.



G to H ⇒ 5+4=9

Step 8:-

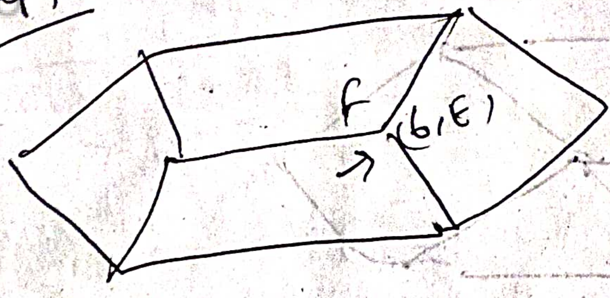


Step 9:- cost of F = 6

cost of H = 9

∴ Make F as smallest label.

Step 9:-

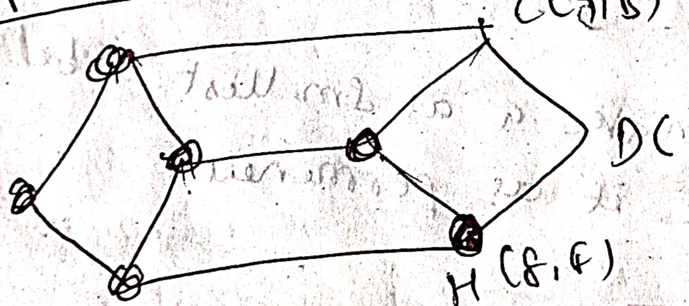


adjacent of F ⇒ C & H

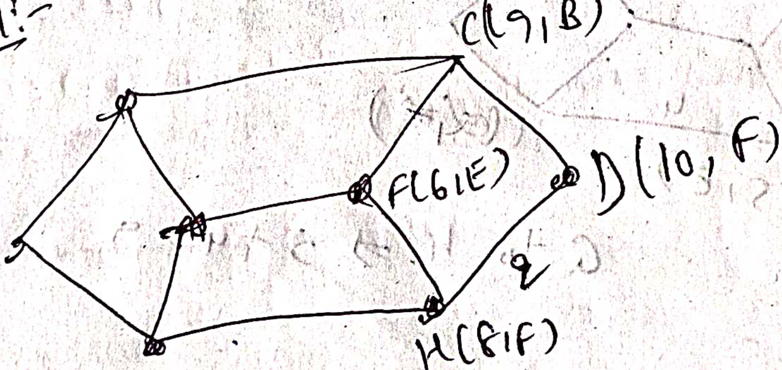
cost - F to C ⇒ 3 (6+3) = 9

cost F to H = 8 (6+2) = 8

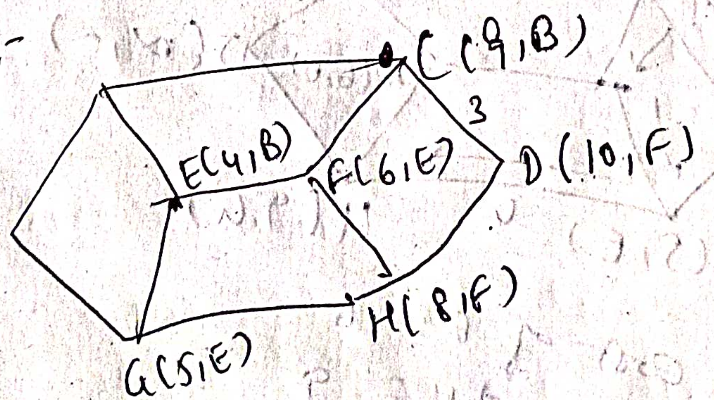
Step 10:-



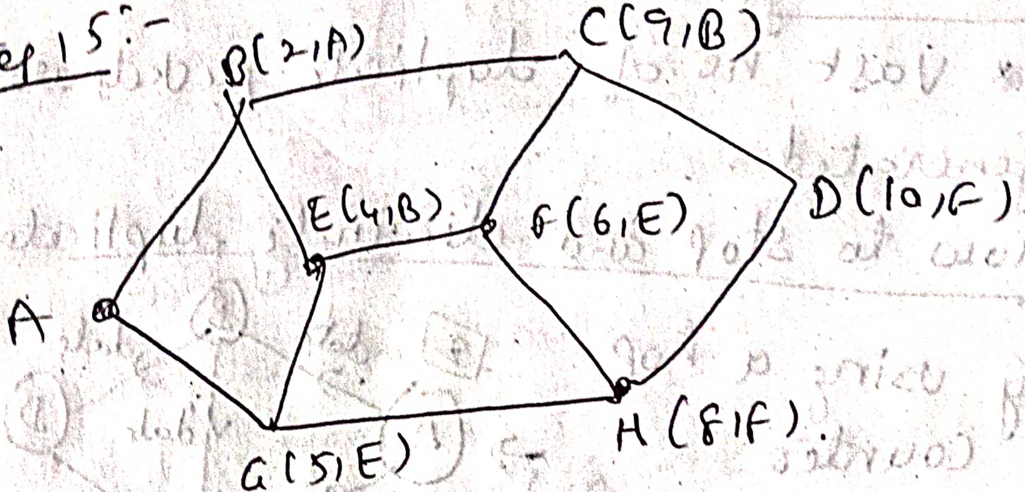
Step 11:-



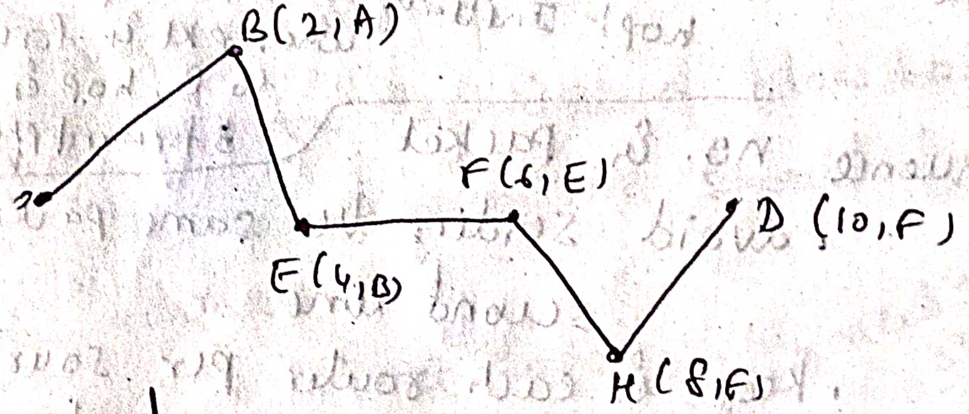
Step 12:-



step 15:-



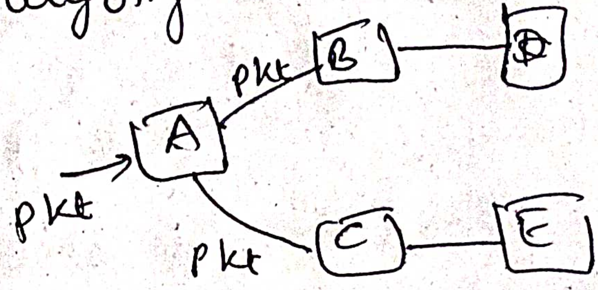
smallest path (or) shortest path:



2nd method

(2) Flooding

Every incoming packet is sent out on every outgoing line except the one it arrived on.

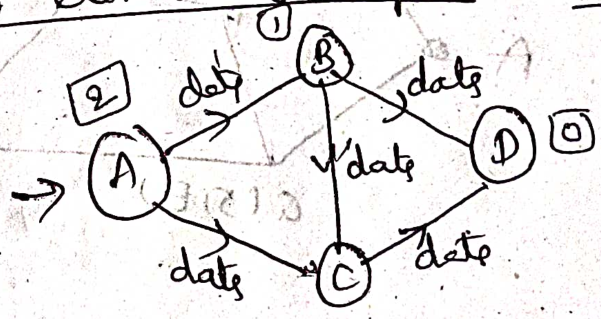


disadvantage:-

* Vast no. of duplicate packets are generated.

→ How to stop and eliminate duplicate packets

(1) By using a hop counter



- decrement in each router
- discard packet if counter is 0.

hop:- Initially at A hop is 2. when pkt is forwarded to B, hop is 1, B forward pkt to D, hop at D is 0

(2) sequence no. in packet.

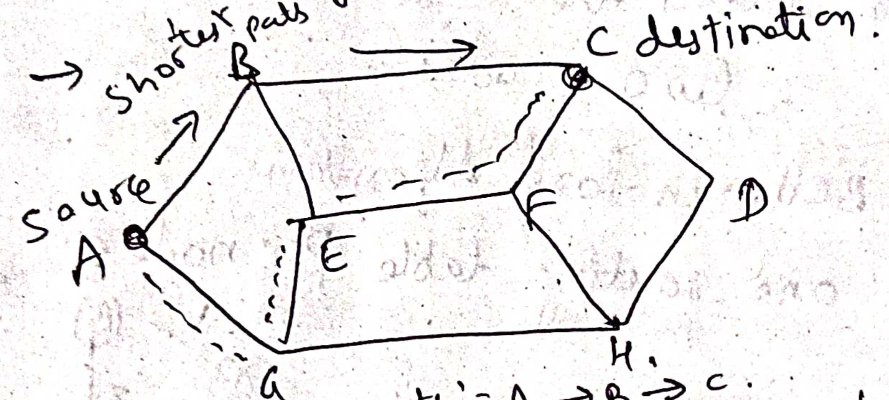
- avoid sending the same packet second time
- keep in each router per source a lists of packets already seen.

(3) selective flooding

- use only those lines that are going approximately in right direction.

(5) Flow Based routing (static)

→ This is a static algorithm which uses topology & load condition (traffic) for deciding a route.



Shortest path:- A → B → C.

Assume from B → C, traffic is more, then choose another route.

from

A --→ G → E → F → C.

<u>Aim</u>:- The packet has to reach destination quickly there should no be traffic congestion.

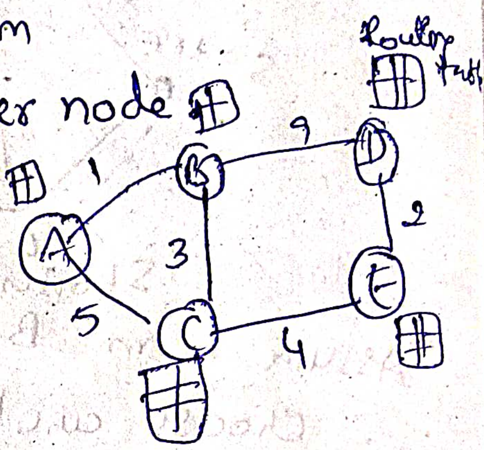
→ To use the technique of flow based routing, The following information should be known is advance.

1. subnet topology → need to know all other routes
2. Traffic Matrix → in which nodes more traffic is there, which node traffic is low
3. Line capacity matrix
   ↓
   bandwidth of each line.

(1) Dynamic Routing Algorithm

→ (2) Distance vector Routing

* selects the least cost between two nodes
* Bellman-ford Algorithm
* one routing table per node



Bellman ford Algorithm

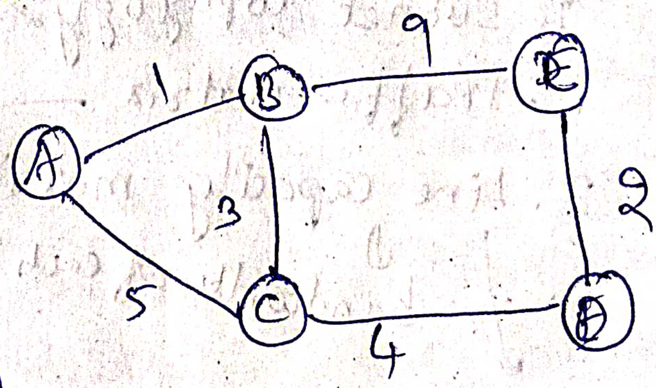
* defines distance at each node

$d_x(y)$ = cost of least cost path from x to y.
↓ source ↓ destination

* update distances based on neighbours

$d_x(y) = \min\{cost(x, v) + d_v(y)\}$
↓ source ↓ destination ↓ source ↓ intermediate node.

eg:-



Consider B as source

(1) B to A, B→A ⇒ 1 ✓ minimum
B→C–A ⇒ 3+5 = 8
B–E–D–C–A ⇒ 9+2+4+5 = 20

DVR (Distance vector Routing) table for B:

② B to C

Destination	Cost	next hop
A	1	A

B-C ⇒ 3 ✓

B-A-C = 1+5=6

B-E-D-C ⇒ 9 + 2+4 = 15

③ B to D

B-A-C-D ⇒ 1+5+4=10

B-C-D ⇒ 3+4 = 7 ✓

B-E-D ⇒ 9+2=11

④ B to E

B-E ⇒ 9 ✓

B-C-D ⇒ 3+ 4+2 = 9

B-A-C-D-E = 1+5+4+2=9.

All ~~are~~ have same value 9, we have to consider B-E path Because there are no intermediate node.

Routing table for ~~B~~ hop B

B →

Destination	min Cost	next hop
A	1	A
C	3	C
D	7	C
E	9	E

→ when B wants to send packet to ~~destination~~ A, it checks the routing table, destination and takes decision to check the route and forwards packet.

Hierarchical routing

→ In hierarchical routing, routers are classified in groups known as regions.

→ Each router has only the information about the routers in its own region and has no information about routers in other regions.

→ Routers just save one record in their table for every other region.

→ Routers only contains the record of their immediate neighbors in the table.

→ In three-level hierarchical routing, the network is classified into a number of clusters.

→ Each cluster is made up of a number of regions, and each region contains a number of routers.

→ In this method, it will route first to the region then to the IP prefix within the region, hide details within a region from outside of the region

Broadcast Routing

→ Host need to send messages to many or all other hosts.

ex)- Live radio programs

stock market updates.

→ sending a packet to all destinations simultaneously is called broadcasting

Methods

① ~~broadcasting~~ Distinct point-to point routing :-

In this, sends a distinct packet to each destination.

So, it is waste of bandwidth, but it also requires the source to have a complete list of all destination.

② Flooding :- In this, sends a packet on every outgoing line except the line on which it arrived.

drawback:- more bandwidth, more duplicates

③ multi Destination Routing :-

→ In this, each packet contains either a list of destinations or a bit map indicating the desired destinations.

→ when a packet arrives at a router, the router checks all the destinations to determine the set of output lines that will be needed.

③ Spanning tree

we use sink tree for the router willing to broadcast a packet.

→ A spanning tree is a subset of the subset that includes all the routers but contains ~~no~~ loops

Γ

δ

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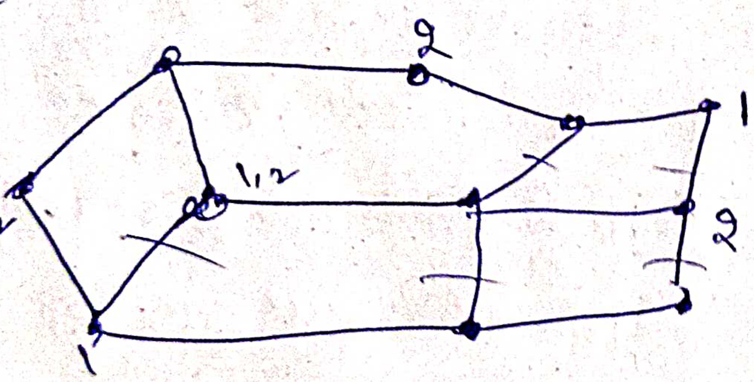
multicast Routing

- Sending a message to a group is called multicasting, and its routing algorithm is called multicast Routing.
- multicasting requires group management. need to create and destroy groups, and to allow processes to join and leave groups.
- To do multicast routing, each router computes a spanning tree covering all other routers.

eg:-



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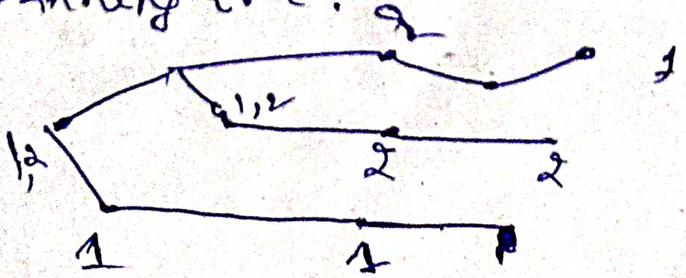
Spanning tree

removing loops we get spanning tree.



Divide the group into two groups, group1 & group 2.

group1 spanning tree | group2 spanning tree