SHORTEST PATH ROUTING (OR) DIJKSTRA'S ALGORITHM

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1. The idea is to build a graph of the subnet, with each node of the graph representing a router and each arc of the graph representing a communication line or link

2. To choose a route b/w a given pair of routers, the algorithm just finds the shortest path b/w them on a graph.

   a) Start with the local node (router) as the root of the tree. Assign a cost of '0' to this node and make it the first permanent node.

   b) Examine each neighbour of the node that was the last Permanent node

   c) Assign a cumulative cost of each node and make it tentative

   d) Among the list of tentative nodes

      ⇒ Find the node with the smallest cost and make it Permanent

      ⇒ If a node can be reached from more than one route then select the route with the shortest cumulative cost

   e) Repeat steps from a to d until every node becomes Permanent

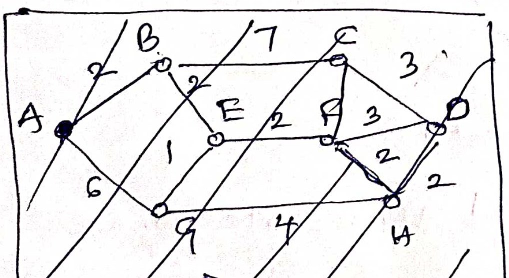

fig a,

Probability paths are as follows

A → Source ; H → Destination

A, B, C, D, E, F, G, H.

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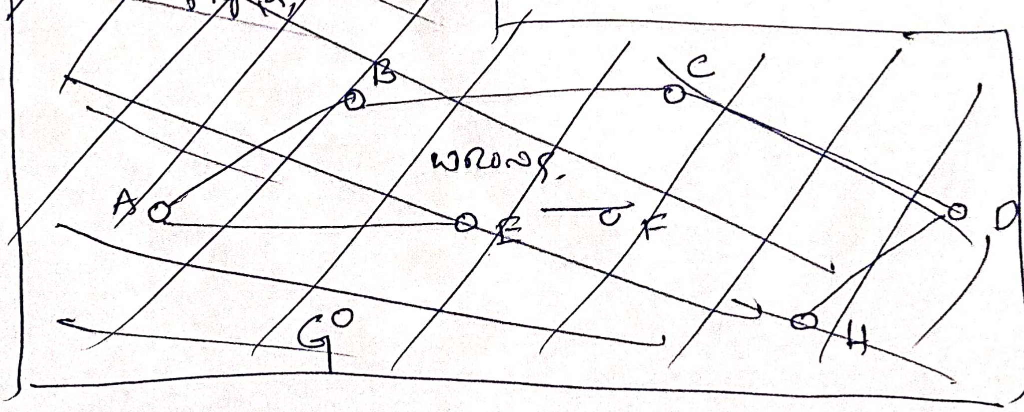

A → B → C ↓ D ↓ E ↓ F → G → H

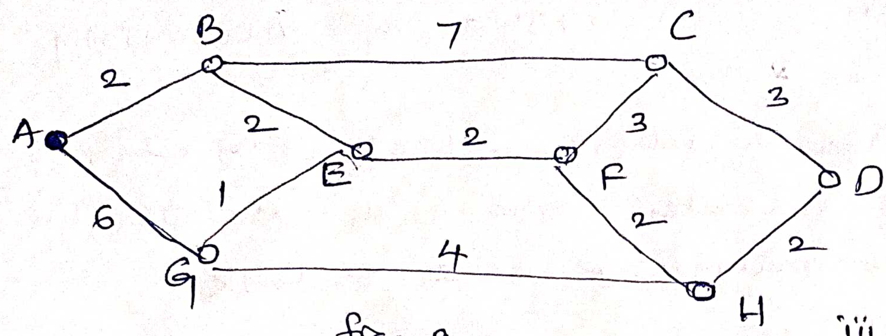

fig (a)

Probability paths are as follows

i, $A \xrightarrow{2} B \xrightarrow{7} C \xrightarrow{3} D$

ii, $A \xrightarrow{2} B \xrightarrow{2} E \xrightarrow{2} F \xrightarrow{2} H$

iii, $A \xrightarrow{6} G \xrightarrow{1} E \xrightarrow{2} F \xrightarrow{2} H$

iv, $A \xrightarrow[6]{} G \xrightarrow[4]{} H \xrightarrow[2]{} D$

v, $A \xrightarrow[2]{} B \xrightarrow[2]{} E \xrightarrow[1]{} G \xrightarrow[4]{} H$

∴ from the above cases we find the cost of each node in the subnet graph is as follows

i, from A → D the cost is $2+7+3 \Rightarrow 12$

ii, from A → H the cost is $2+2+2+2 \Rightarrow 8$ ✓

iii, from A → H the cost is $6+1+2+2 \Rightarrow 11$

iv, from A → D the cost is $6+4+2 = 12$

v, from A → H the cost is $2+2+1+4 = 9$

∴ the shortest path cost is as follows

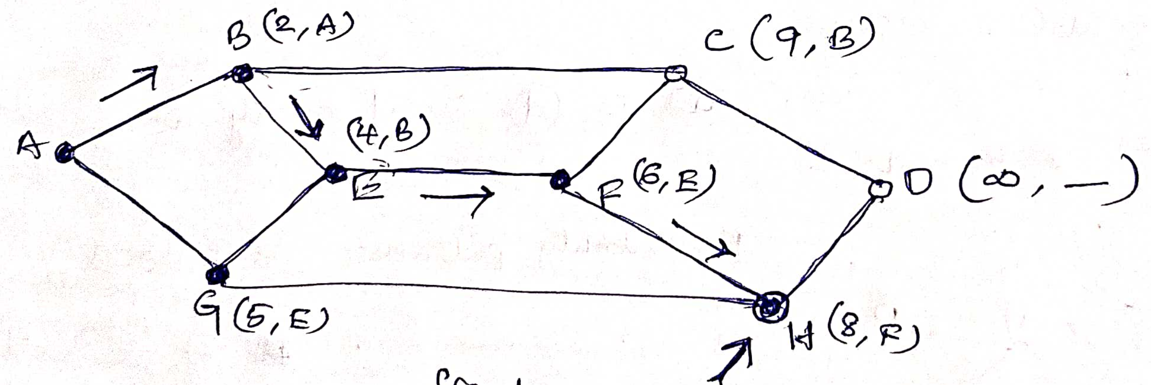

fig (b), is the final representation of shortest path.

THE Count-to-Infinity Problem:-

A	B	C	D	E	
	•	•	•	•	Initially
	1	•	•	•	After 1 Exchange
	1	2	•	•	After 2 Exchanges
	1	2	3	•	After 3 Exchanges
	1	2	3	4	After 4 Exchanges

fig (a), Initial Representation of Count-to-Infinities

A	B	C	D	E	
	1	2	3	4	Initially
	3	2	3	4	After 1 Exchange
	3	4	3	4	After 2 Exchanges
	5	4	5	4	After 3 Exchanges
	5	6	5	6	After 4 Exchanges
	7	6	7	6	After 5 Exchanges
	7	8	7	8	After 6 Exchanges
	⋮	⋮	⋮	⋮	
	•	•	•	•	

fig (b) Represents the Count-to-Infinity after Exchanges

HIERARCHICAL ROUTING

As Networks grow in size, the router routing tables grow Proportionally. Not only is router memory consumed by ever increasing tables, but more CPU times is needed to scan them and more bandwidth is needed to send status reports about them.

At a certain point, the network may grow to the point where it is no longer feasible for every router to have an entry for every router, so the routing will have to be done hierarchically, as it is in the telephone network.

When Hierarchical routing is used, the routers are divided into what we call regions. Each router knows all the details about how to route packets to destinations with in its own region but knows nothing about the internal structure of other regions for huge networks a two-level hierarchy may be insufficient, it may be necessary to group the regions into clusters, the clusters into zones, the zones into groups and so on.. until we run out of names for aggregations.

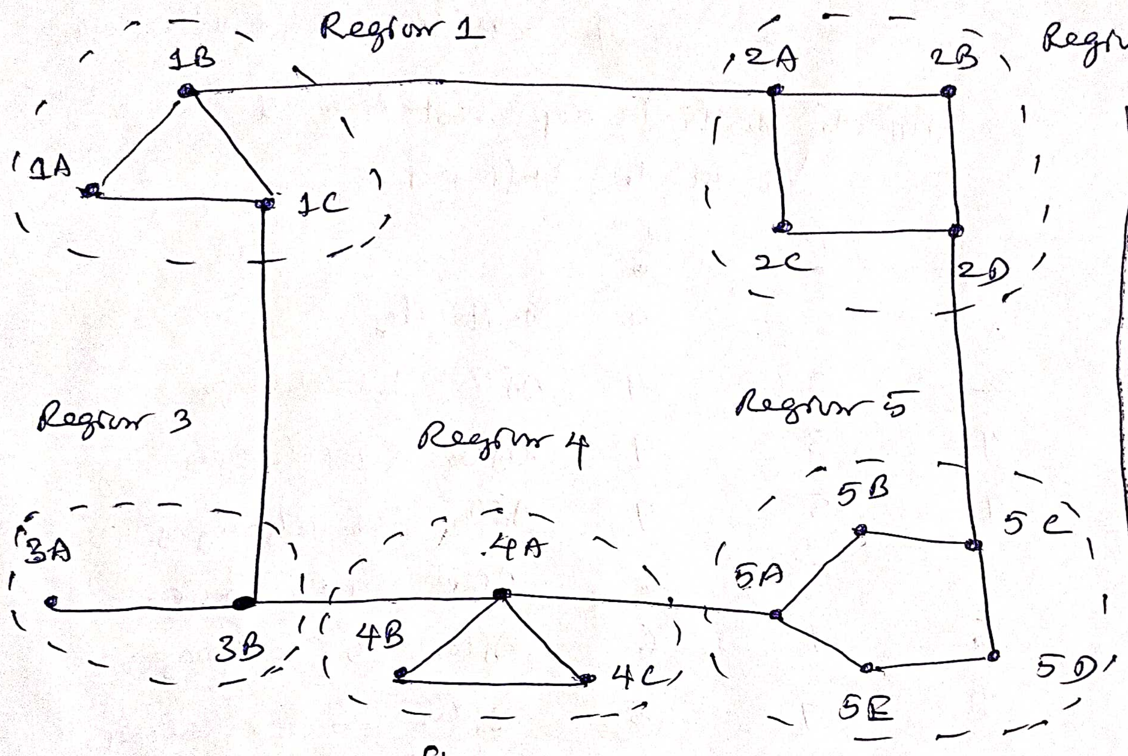

fig a,

Note :-
fig a, rep's cluster Regions
fig b, rep's Routing table with line & No. of Hops.
fig c, rep's table for 1A

Full table for 1A

Destination	Line	Hops
1A	—	—
1B	1B	1
1C	1C	2[illegible]
2A	1B	2
2B	1B	3
2C	1B	3
2D	1B	4
3A	1C	3
3B	1C	2
4A	1C	3
4B	1C	4
4C	1C	4

5A	1C	4
5B	1C	5
5C	1B	5
5D	1C	6
5E	1C	5

fig b,

finally Hierarchical table for 1A

Destination	Line	Hops
1A	—	—
1B	1B	1
1C	1C	1
2	1B	2
3	1C	2
4	1C	3
5	1C	4

fig c

LINK STATE ROUTING ALGORITHM

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① Distance Vector Algorithm was used in ARPANET until 1979 when it was replaced by linkstate Routing, Two Primary Problems caused its demise. first, the delay metric was queue length, it didnot take line bandwidth into account when choosing routes.

② Initially all the lines were 56 kbps so line bandwidth was not an Issue, but after some lines had been upgraded to 230 Kbps and others to 1.544 Mbps.

③ the second Problem also existed namely, the algorithm often took too long to converge. ie, the count-to-infinity Problem for these reasons, it was replaced by an entirely new algorithm, now it is called as link state routing algorithm

④ It Consists of 5 parts

a) Discover its neighbours and learn their n/w addresses
b) Measure the delay or cost to each of its neighbours
c) construct a packet telling all its has just learned
d) send this packet to all other routers
e) Compute the shortest path to every other routers

⑤ learning about neighbours

a) when the router is booted, its first task is ~~booted~~ to learn who are its neighbours. It accomplishes its goal by sending a special HELLO Packet on each ~~Pt~~ point_to_point line. the router on the other ~~e~~ end is expected to send back a reply telling who it is.

b) these names must be globally unique because when a distinct router later hears that three routers are all connected to F, it is essential that it can determine whether all the three mean the same 'F'

From fig i,
c) Here LAN consists of three routers A, C & F are directly connected. Each of these routers is connected to one or more additional routers.

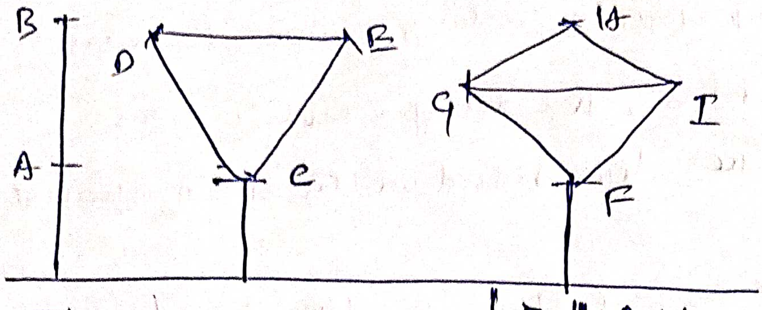

fig i, rep's 9 routers and LAN

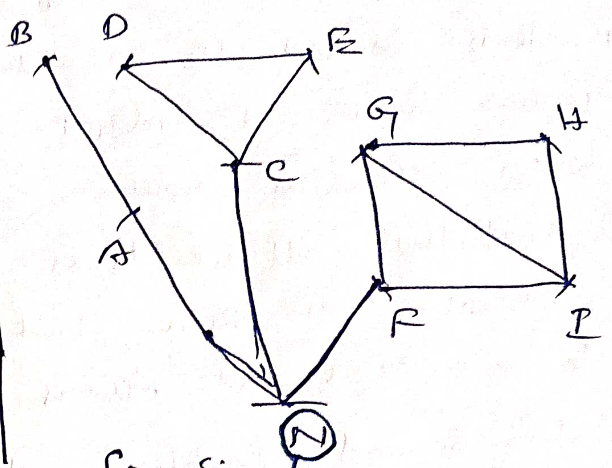

fig ii, rep's agraph model of A.

⇒ From fig ii, we introduced anew artificial node N to which A, C, F are connected. The fact that is possible to go from A to C on the LAN is represented by the path ANC

Definition of link state Routing :- A routing method in which each router shares its knowledge of changes in its neighbourhood with all other routers.

(LSP) Link state Packet :- By link state Routing adatabase common to all routers and made LSP information

Measuring line cost :- i, The link state routing algorithm requires each router to know or at least have areasonable estimate of the delay to each of its neighbours the most directway to determine this delay is to send over the line aspecial ECHO Packet that the otherside is required to send back Immediately.

ii, By measuring the round trip time and dividing it by two, the sender router can get areasonable estimate of the delay. For even better results, the test can be conducted several times and the average is used.

iii, An Eniteresting issue is whether to take the load into account when measuring the delay. to factor the load in the round trip time must be started when ECHO Packet is "queued"

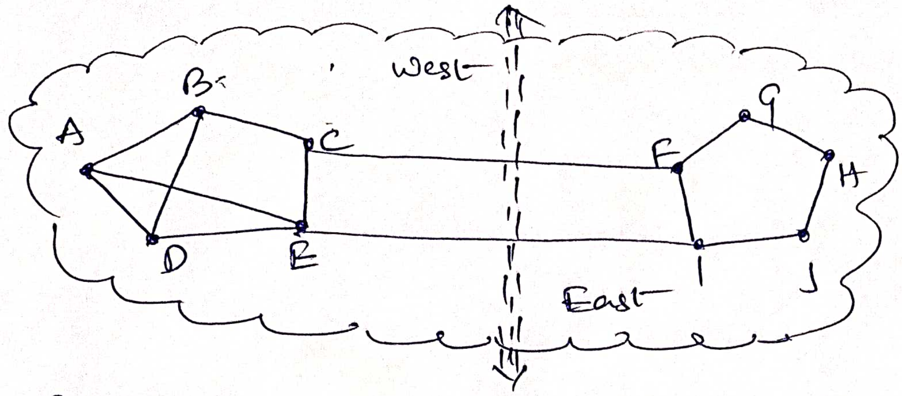

fig rep's the SUBNET in which EAST & WEST parts are connected by two lines.

BUILDING LINK STATE PACKETS :-

① Once the information is needed for the exchange has been collected, the next step is for each router to build a packet containing all the data.

② The packet starts with the identification of the sender, followed by a sequence number, Age and list of neighbours.

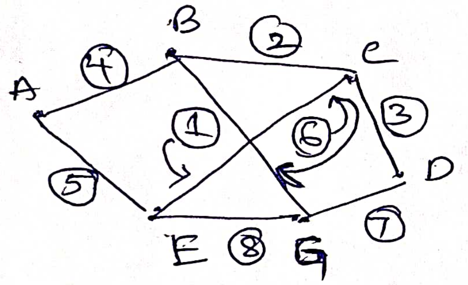

fig i, SUBNET

Link State Packets

A	
SEQ	
AGE	
B	4
E	5

B	
SEQ	
AGE	
A	4
C	2
G	6

C	
SEQ	
AGE	
B	2
D	3
E	1

D	
SEQ	
AGE	
C	3
G	7

E	
SEQ	
AGE	
A	5
C	1
G	8

G	
SEQ	
AGE	
B	6
D	7
E	8

fig's rep's the link state packets from the following SUBNET

③ Building the link state packets is easy. The hard part is determining when to build them.

④ One possibility is to build them periodically i.e, at regular intervals, another possibility is to build them, when some significant event occurs, such as a line or neighbours