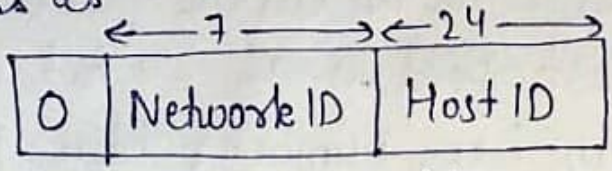
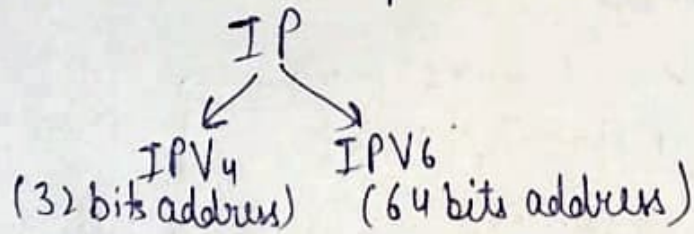
* Addressing : Internet address

IP refers to internet protocol. An IP address is the like an identity for a computer that is connected to a network. Each and every computer that is connected to network has unique IP address. The IP address is a network layer address and has no dependence on the data link layer address. A unique IP address is required for each host and network component that communicates using TCP/IP

→ All the IP address are 32 bit long and they are used in the source address and destination address fields of the IP headset. The formats used for IP address as



→ The first part of the address, called the network number and the second part called the Host ID.



IPV4

① It uses 32-bits address

② Address are written in decimal format such as 192.168.1.1

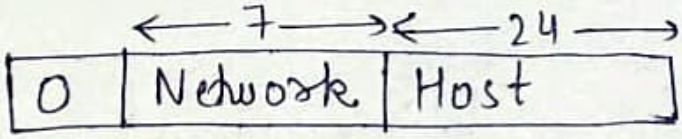
IPV6

① It uses 128-bits address

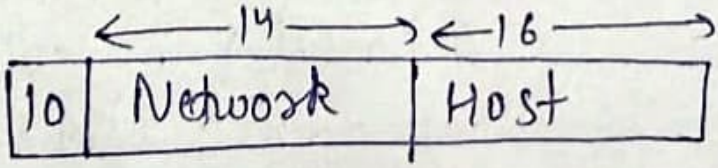
② Address are written in the Hexadecimal format, separated by colons like 2001:odb8:85a3:0000:0000:8a2e:0370:7334

③ Optional, not widely used.	③ Usually strongly recommended.
④ Usually one address per host.	④ Usually multiple addresses per interface.
⑤ Use of unicast, multicast and broadcast address types.	⑤ Broadcast addressing no longer used, for use of unicast, multicast and any cast address types.
⑥ It supports VLSM (Virtual length subnet mask).	⑥ It supports not to VLSM.
⑦ It has five classes A, B, C, D, E.	⑦ It has no classes.

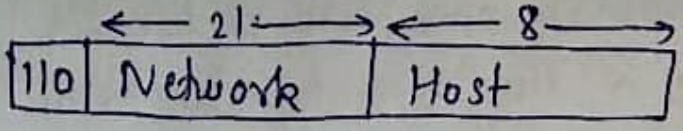
i) class A address : The Network field is 7 bit long and the host field is of 24 bit length. So the Network field can have numbers blw 1 to 126. The 0 in the first field identifies that it is a class A network address.



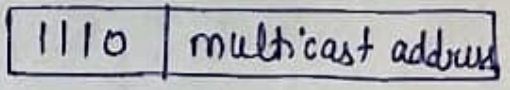
2) class B format: The class B address contains the first two fields identify the network and the no. in the first ~~two~~ field must be in the range 128 - 191.



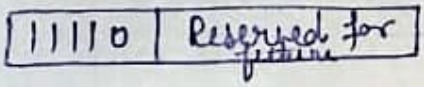
3) Class C format: The first block in class C covers addresses from 192.0.0.0 to 192.0.0.255 and last block covers addresses from 223.255.25.5.0 to 223.255.255.255



4) Class D format: The class format allow for up to 2 Million networks with up to 254 Hosts each and class D format allows the multicast in which a datagram is directed to multiple hosts.



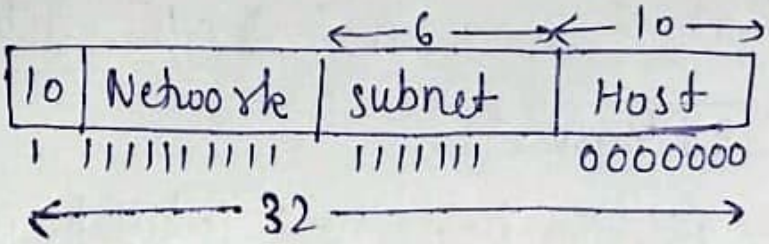
(5) Class E address format: The address begins with 11110 which shows that it is reserved for the future use



* Subnetting: All the hosts in a network must have the same network number. But, this ~~number~~ property of IP addressing can be problematic as the network size increase for ex: a company initially may have only the LAN but as the time passes by it end up with many LAN's each one having its own router and each one work with own class C network number. With in C in the no of distinct local networks, their manage-ment becomes a problem. Every time a network gets installed, the system administrator has to contact NIC to get a new network no. and then this number is to be announced worldwide.

→ Another problem is that if a machine is to be moved from one LAN to the other, then its IP address needs to be changed. and its modified IP needs to be changed, and then this no. is to be announced world wide. The sol" to be this problem is that the network is split into several smaller networks internally but it acts like a single network to outside the world. The smaller parts of a network are called subnets.

* let's take an example: The growing company should start up with class B address instead of class C address and if it can no. hosts from 1 to 254 when a second lan is to be installed it can split the 16 bit host no. into a 6 bit subnet no. and 10 bit host no.



* Routing Algorithms:

The main functions of the network layer is to route the packets from source machine to the destination machine. So the algorithms that they used are a [that choose the routes & data structures]

major area of network layer design.

→ The routing algo. is that part of the network layer software responsible for deciding the which output line an incoming packet should be transmitted on.

→ If the subnet uses datagram internally, this decision

must be made a new for every arriving data packets. If the subnet uses Virtual circuits internally, routing decision are made only when a new Virtual circuits is being set up.

Classification

1) Dynamic Algorithms: It uses current topology load, delay etc to select routes. It changes in the topology and traffic as well. These get their routing info. from adjacent routers or from all routers.

2) Static algorithms: Routes never change once initial routes have been selected. Also called non-adaptive routing. These algo have the route to be taken one node to the other and is computed in advance. These algo do not have their routing decision on measurement or estimation of current traffic and topology.

* Shortest path algorithm :-

This algo is based on the simplest and most widely used principle a graph of subnet is built in which each node representing the router and each arc representing a link. Hence as to choose a path blw a pair of routers, this algo is simply finds the shortest path blw them.

The Dijkstra algo. creates a shortest path tree from a graph. The algo divides the nodes into two sets : initiative, examination and if they pass the criteria make them permanent

Working of Dijkstra algo :-

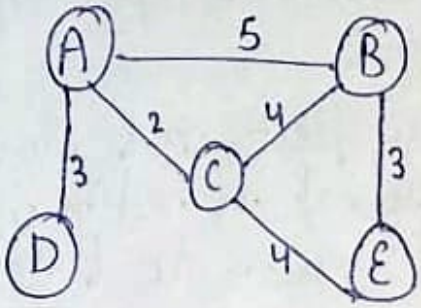
1) Initialisation: Assign a tentative distance ~~between~~ value to every node. set the initial node's distance to 0 and all other node's dist to infinity.
- Set the initial node as the current Node.

2) Visit neighbours: For the current node, consider all its neighbours and calculate their tentative distances through the current node.
- Compare the newly calculated tentative dist. to the current assigned value and assign the smaller one

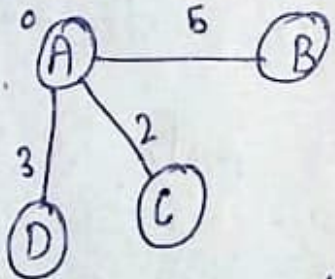
3) Mark Visited: After considering all neighbours of the current node as visited.

4) Select next node: Select the Unvisited node with the smallest tentative dist., set it as the new 'current node' and go back to step 2.

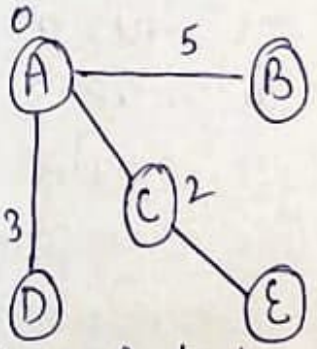
→ If all the nodes have been visited, the algo is complete



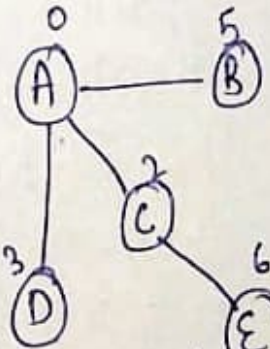
Root



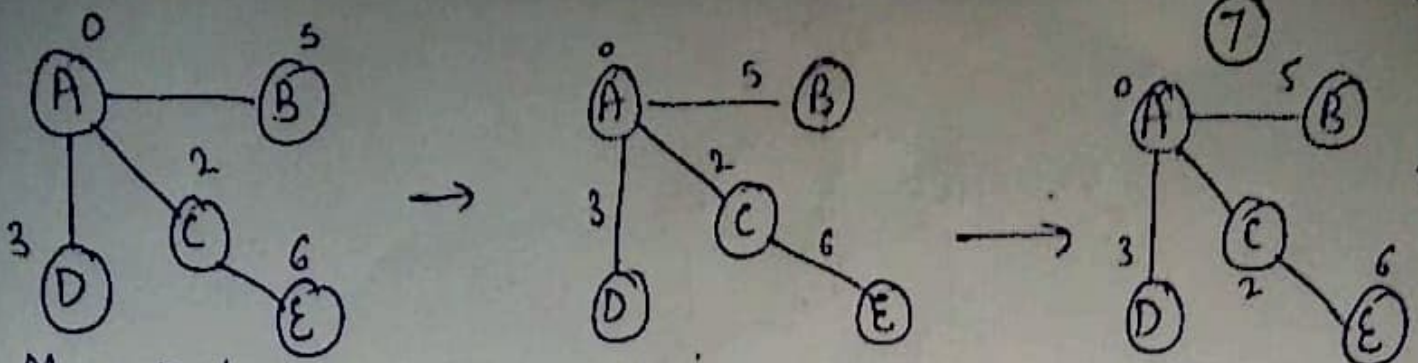
Set Root A and move A to tentative list.



Move A to permanent list and add B, C, D to tentative list.



Move C to permanent and add E to tentative list



Move D to permanent list.

Move B to permanent list

Calculation of routing table from shortest path tree:

Node	Cost
A	0
B	5
C	2
D	3
E	6

Flooding:

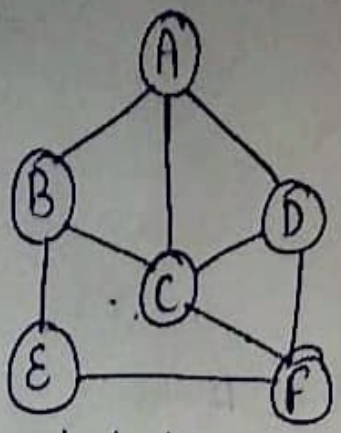
It is another static algo. which every in coming packet is sent out an every outgoing line on which it has arrived. One disadvantage of flooding is that it generates a large no. of duplicate packets it produces infinite no. of duplicate packets

Unless we somehow damp the process. There are various damping techniques as under:

(i) Using a hop counter

ii) To keep the track of which packets have been flooded

iii) Selective flooding.



Using flooding technique:

- An incoming packet to A, will be sent to B, C, D.
- B will send the packet to C and E
- C will send the packet to B, D and F
- D will send the packet to C and F
- E will send the packet to F.
- F will send the packet to C and E

Types of flooding:

1) Uncontrolled flooding: Here each, router unconditionally transmits the incoming data packets to all its neighbours.

2) Controlled flooding: They use some methods to control the transmission of packets to the neighbouring nodes. The two popular algo for controlled flooding are sequence No. controlled flooding (SNCF) and reverse path forwarding (RPF).

3) Selective flooding: The routers don't transmit the incoming packets only along those paths which are heading towards approx. in the right direction, instead of every available paths.

Advantages: ① It is very simple to setup and imple-ment.

2) The shortest path is always chosen by flooding
3) It is extremely robust. Even in case of malfunction-ing of a large no. routers, the packets find a way to reach the destination.

* Distance Vector Routing Algorithm

In this algo. each router maintains a table called vector such a table gives the best known distance to each destination and the info about which line to be used to reach there. In this, each router maintains as routing table. It contains each entry for each router is the subnet. This entry has two parts:

(i) The first part shows the preferred outgoing line to be used to reach the destination and
(ii) Second part gives an estimate of the time or distance to the destination.

Info. kept by Distance Vector router —

- Each router has an ID
- Associated with each link connected to a router there is a link cost (static or dynamic)
- Intermediate hops.

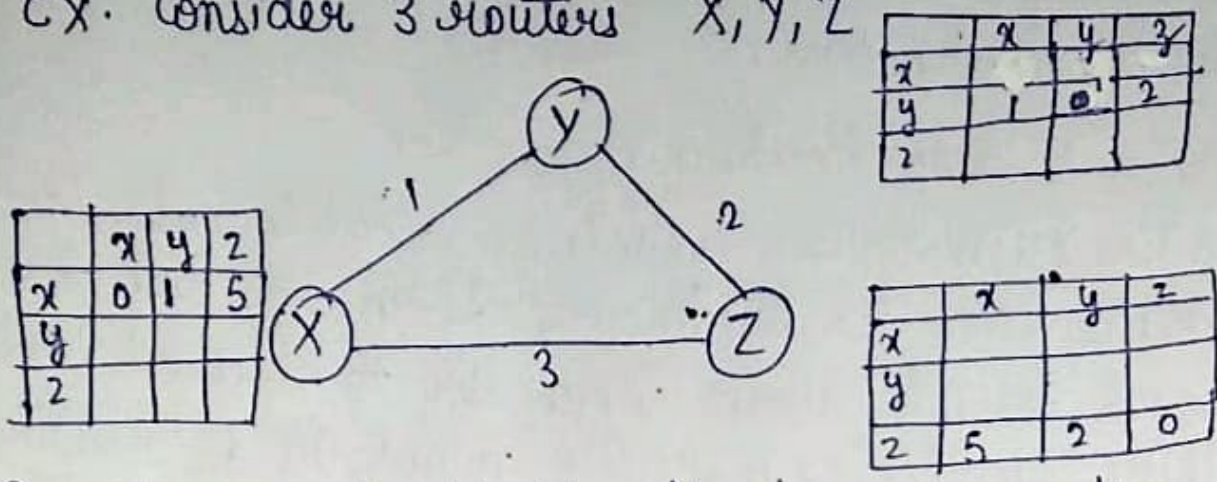
Distance Vector Algorithm:

1) A router transmits its distance vector to each of its neighbours in a routing packet.
2) Each router receives and saves the most recently received distance vector from each of its neighbours.
3) A router recalculates its distance vector when:
   - It receives a distance vector from a neighbour

containing diff ~~from~~ info than before

- It discovers that a link to a neighbour has gone down.

Ex. Consider 3 routers X, Y, Z



	x	y	z
x			
y	1	0	2
z			

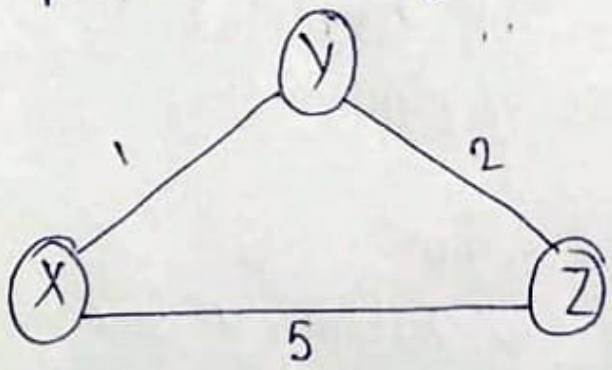
	x	y	z
x	0	1	5
y			
z			

	x	y	z
x			
y			
z	5	2	0

Consider router X, X will share its routing table to neighbours and neighbours will share it routing table to X and dist from node X to destination will be calculated by using bellman-ford eq^n.

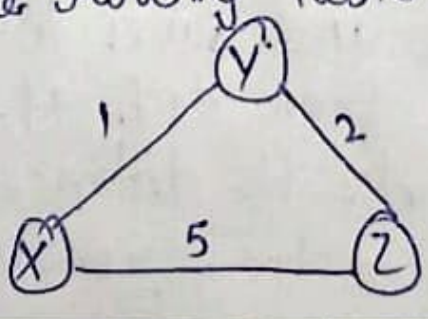
$$D_x(y) = \min\{C(X,V) + D_v(y)\} \text{ for each node } y \in N$$

As we can see that dist will be less going from X to Z when Y is intermediate node (hop) so it will be update in routing table X.



	x	y	z
x	0	1	3
y	1	0	2
z	5	2	0

Finally the routing table for all -



	x	y	z
x	0	1	3
y	1	0	2
z	3	2	0

	x	y	z
x	0	1	3
y	1	0	2
z	3	2	0

	x	y	z
x	0	1	3
y	1	0	2
z	3	2	0

* Link State Routing:

Distance vector routing was used in ARPANET upto 1979. After it was replaced by the link state routing. Variants of this algorithm are now widely used. The link state routing is simple and each router has to perform the following five operations:

(i) Each router should discover its neighbours and obtain their network addresses.

(ii) Then it should ~~discover its neighbours~~ measure the delay or cost to each of these neighbours.

(iii) It should construct a packet containing the network address and the delays of all the neighbours.

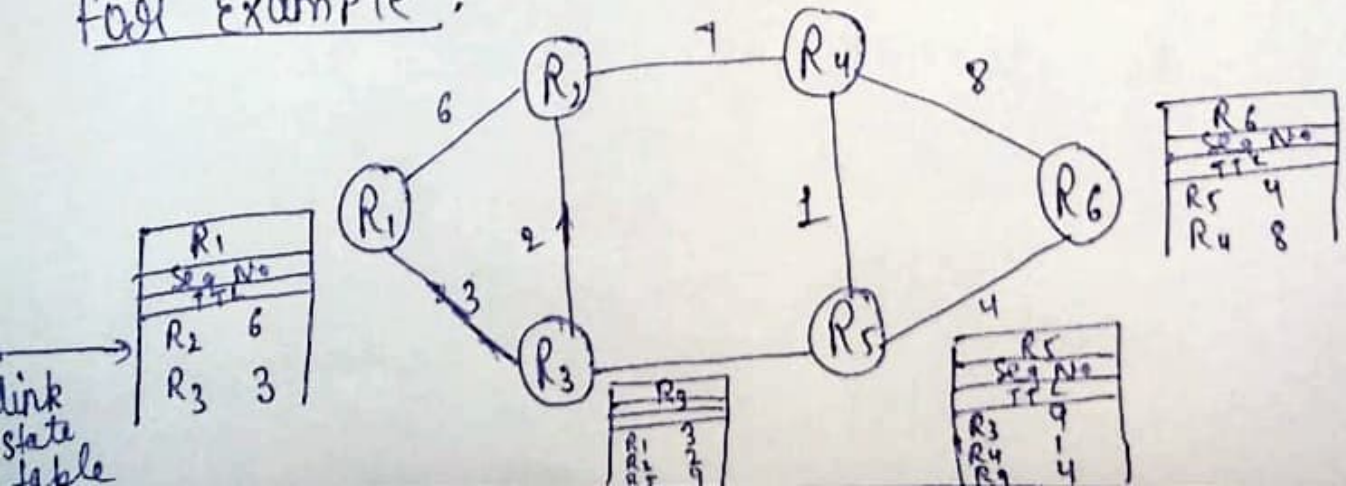
(iv) Send this packet to all other routers.

(v) Compute the shortest path to every other router.

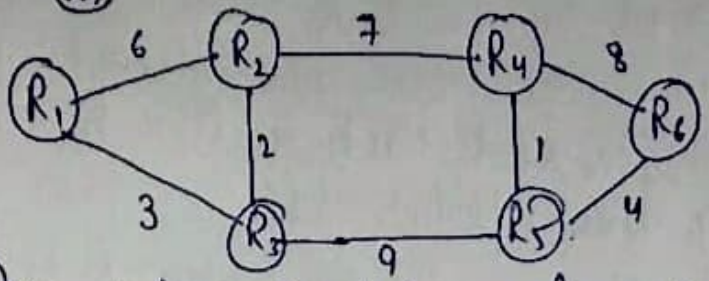
The complete topology and all the delays are experimentally measured and this information is conveyed to each & every router. Then a shortest path algo. such as Dijkstra's algorithm can be used to find the shortest path to conveyed every other router.

Protocols: The OSED protocol which is used in the Internet uses the link state algorithm. And Intermidates stem is the other protocol which uses the link state algorithm.

For Example:



After making link state table at each router (12) then using flooding it floods this info all over the graph
At (R1)



Then using Dijkstra's algo we find the shortest path to every router.

	R_2	R_3	R_4	R_5	R_6
R_1	6	(3)	∞	∞	∞
R_1R_3	(5)	(3)	∞	12	∞
$R_1R_3R_2$			(12)	12	∞
$R_1R_3R_2R_4$				(12)	21
$R_1R_3R_2R_4R_5$					16

Then finally we make a router table:

		Via
R_1	0	R_1
R_2	5	R_1
R_3	3	R_1
R_4	12	$R_1R_3R_2$
R_5	12	R_1R_3
R_6	16	$R_1R_3R_5$