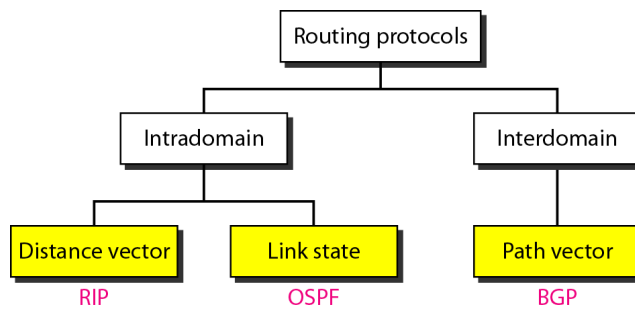


Network Layer: Part-4

Routing protocols

A routing table can be either static or dynamic. A static table is one with manual entries. A dynamic table is one that is updated automatically when there is a change somewhere in the Internet. A routing protocol is a combination of rules and procedures that lets routers in the Internet inform each other of changes.



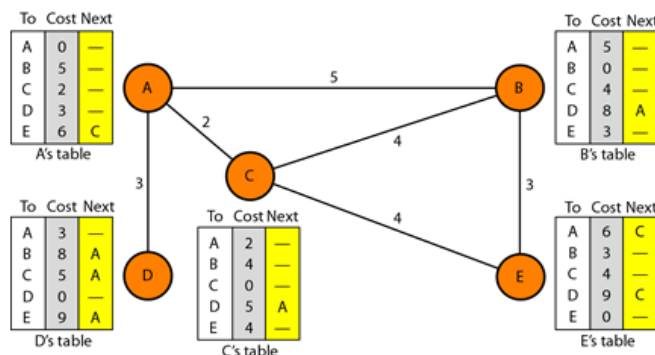
An autonomous system (AS) is a group of networks and routers under the authority of a single administration. Routing inside an autonomous system is referred to as intra-domain routing. Routing between autonomous systems is referred to as inter domain routing.

Distance Vector Routing

In distance vector routing, the least-cost route between any two nodes is the route with minimum distance. In this protocol, as the name implies, each node maintains a vector (table) of minimum distances to every node. The table at each node also guides the packets to the desired node by showing the next stop in the route (next-hop routing).

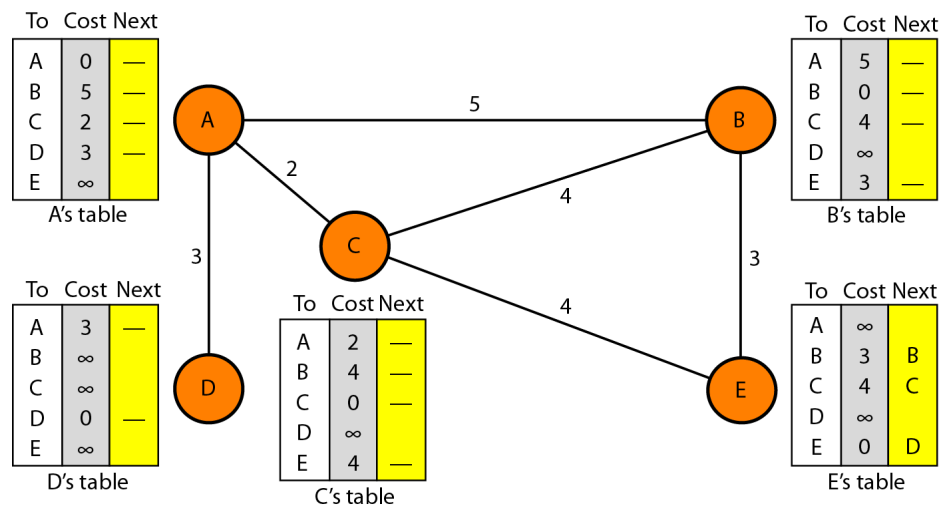
- Implementation has been done in the RIP.
- The distance will be stored in the form of hop count.

Figure 22.14 Distance vector routing tables



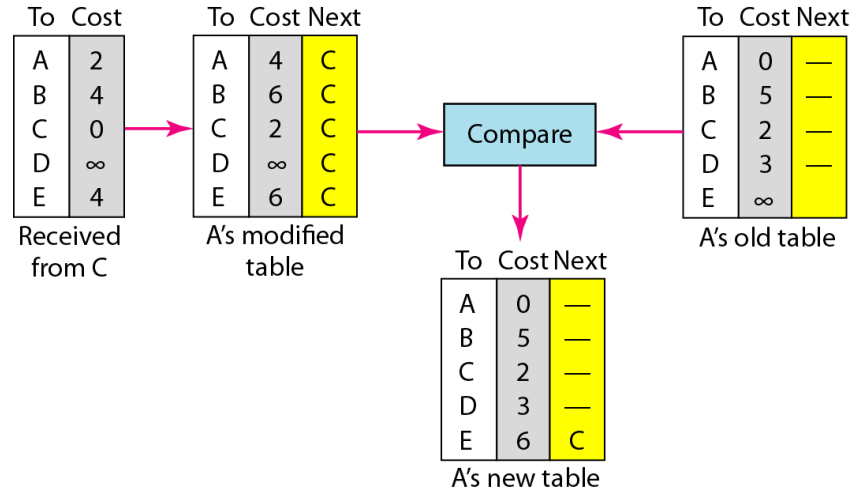
Initialization

Each node can know only the distance between itself and its immediate neighbors, those directly connected to it. If the destination is not directly connected to the router, cost will be set to infinite.



In distance vector routing, each node shares its routing table with its immediate neighbors periodically and when there is a change.

Updation



In this updation can be done periodic update or triggered update

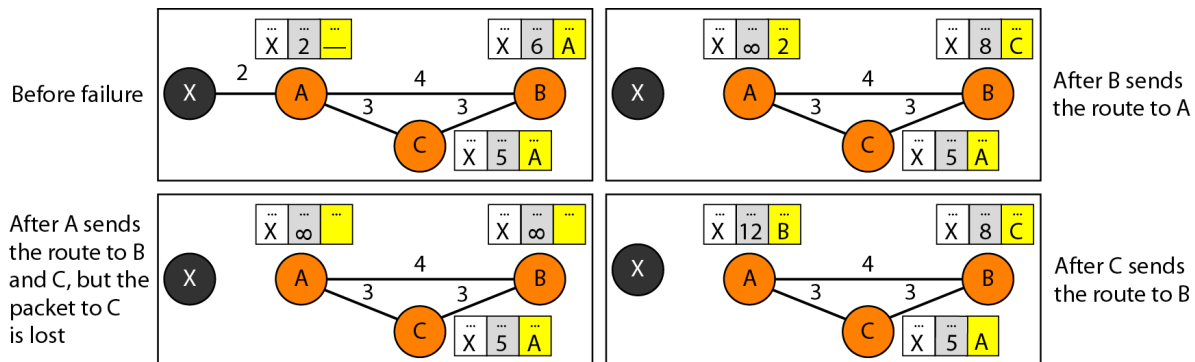
Periodic update – a node sends its routing table normally 30 seconds in a periodic table

Triggered update – when a node receive a routing table or a node detect some failure in the neighbouring link.

Count –to-infinity problem

Suppose, after finding that X is not reachable, node A sends a packet to B and C to inform them of the situation. Node B immediately updates its table, but the packet to C is lost in the network and never

reaches C. Node C remains in the dark and still thinks that there is a route to X via A with a distance of 5. After a while, node C sends to B its routing table, which includes the route to X. Node B is totally fooled here. It receives information on the route to X from C, and according to the algorithm, it updates its table, showing the route to X via C with a cost of 8. This information has come from C, not from A, so after a while node B may advertise this route to A. Now A is fooled and updates its table to show that A can reach X via B with a cost of 12. Of course, the loop continues; now A advertises the route to X to C, with increased cost, but not to B. Node C then advertises the route to B with an increased cost. Node B does the same to A. And so on. The loop stops when the cost in each node reaches infinity.



Solution of this problem

- Defining infinity
- Split horizon
- Split horizon and poison reverse

RIP

The Routing Information Protocol (RIP) is an intradomain routing protocol used inside an autonomous system. It is a very simple protocol based on distance vector routing. RIP implements distance vector routing directly with some considerations:

1. In an autonomous system, we are dealing with routers and networks (links). The routers have routing tables; networks do not.
2. The destination in a routing table is a network, which means the first column defines a network address.
3. The metric used by RIP is very simple; the distance is defined as the number of links (networks) to reach the destination. For this reason, the metric in RIP is called a hop count.
4. Infinity is defined as 16, which means that any route in an autonomous system using RIP cannot have more than 15 hops.
5. The next-node column defines the address of the router to which the packet is to be sent to reach its destination.

Link State Routing

In link state routing, if each node in the domain has the entire topology of the domain the list of nodes and links, how they are connected including the type, cost (metric), and condition of the links (up or down)-the node can use Dijkstra's algorithm to build a routing table.

- OSPF is an implementation of link state protocol
- The topology must be dynamic, representing the latest state of each node and each link. If there are changes in any point in the network (a link is down, for example), the topology must be updated for each node.

Building Routing Tables

In link state routing, four sets of actions are required to ensure that each node has the routing table showing the least-cost node to every other node.

1. Creation of the states of the links by each node, called the link state packet (LSP).
2. flooding of LSP s
3. Formation of a shortest path tree for each node.
4. Calculation of a routing table based on the shortest path tree.

In this routing most of the time triggered update message sent.

Step1: Prepration of LSP

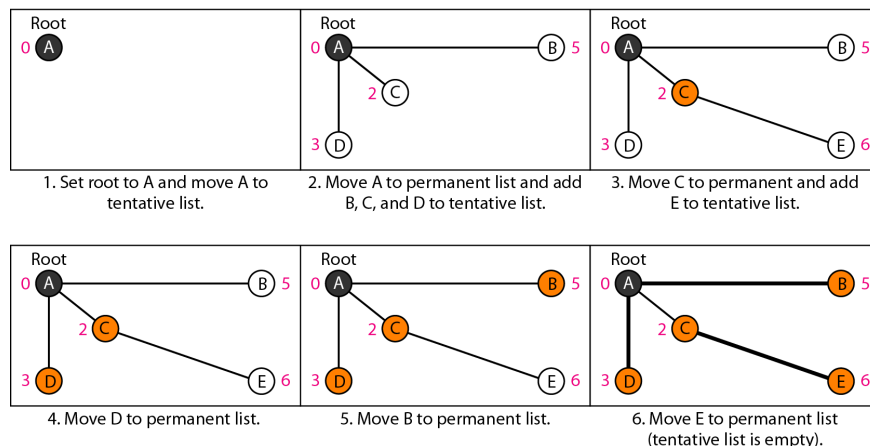
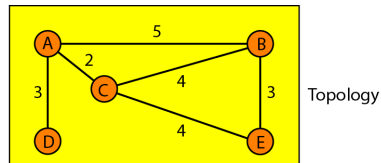
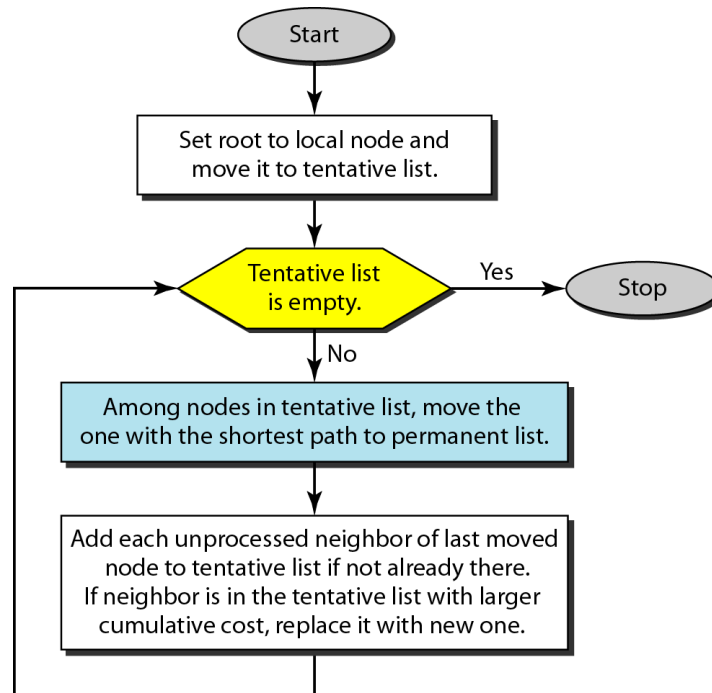
A link state packet can carry a large amount of information. For the moment, however, we assume that it carries a minimum amount of data: the node identity, the list of links, a sequence number, and age. The first two, node identity and the list of links, are needed to make the topology. The third, sequence number, facilitates flooding and distinguishes new LSPs from old ones. The fourth, age, prevents old LSPs from remaining in the domain for a long time. LSPs are generated on triggered update.

Step 2: Flooding of LSPs After a node has prepared an LSP, it must be disseminated to all other nodes, not only to its neighbors. The process is called flooding and based on the following:

1. The creating node sends a copy of the LSP out of each interface.
2. A node that receives an LSP compares it with the copy it may already have. If the newly arrived LSP is older than the one it has (found by checking the sequence number), it discards the LSP. If it is newer, the node does the following:
 - a. It discards the old LSP and keeps the new one.
 - b. It sends a copy of it out of each interface except the one from which the packet arrived. This guarantees that flooding stops somewhere in the domain (where a node has only one interface).

Step 3: Formation of Shortest Path Tree: Dijkstra Algorithm

A tree is a graph of nodes and links; one node is called the root. All other nodes can be reached from the root through only one single route. A shortest path tree is a tree in which the path between the root and every other node is the shortest. What we need for each node is a shortest path tree with that node as the root.



Calculation of Routing Table from Shortest Path Tree Each node uses the shortest path tree protocol to construct its routing table. The routing table shows the cost of reaching each node from the root. Table 22.2 shows the routing table for node A.

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

Open Shortest Path First or OSPF

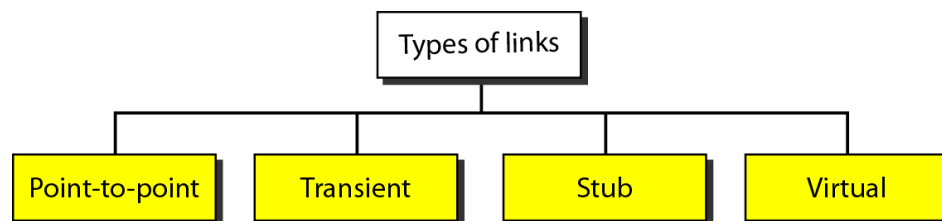
The Open Shortest Path First or OSPF protocol is an intradomain routing protocol based on link state routing. Its domain is also an autonomous system. Areas To handle routing efficiently and in a timely manner, OSPF divides an autonomous system into areas. An area is a collection of networks, hosts, and routers all contained within an autonomous system. An autonomous system can be divided into many different areas. All networks inside an area must be connected. Routers inside an area flood the area with routing information. At the border of an area, special routers called area border routers summarize the information about the area and send it to other areas. Among the areas inside an autonomous system is a special area called the *backbone*;

The routers inside the backbone are called the backbone routers. Note that a backbone router can also be an area border router. If, because of some problem, the connectivity between a backbone and an area is broken, a virtual link between routers must be created by an administrator to allow continuity of the functions of the backbone as the primary area.

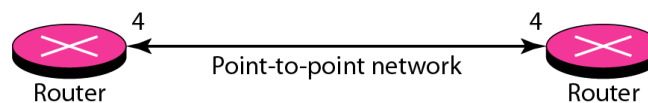
Metric

The OSPF protocol allows the administrator to assign a cost, called the metric, to each route. The metric can be based on a type of service (minimum delay, maximum throughput, and so on)

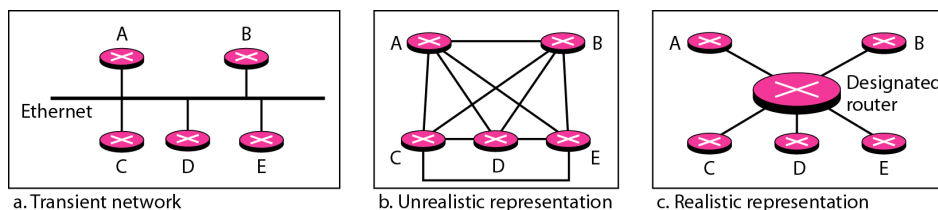
Links



A point-to-point link connects two routers without any other host or router in between. In other words, the purpose of the link (network) is just to connect the two routers.

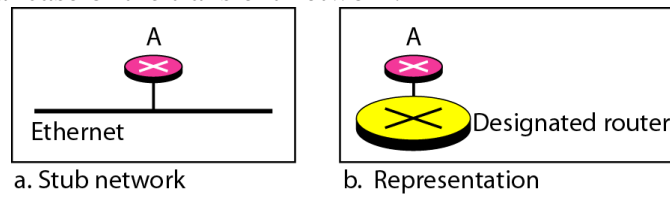


A transient link is a network with several routers attached to it. The data can enter through any of the routers and leave through any router. All LANs and some WANs with two or more routers are of this type.



A **stub link** is a network that is connected to only one router. The data packets enter the network through this single router and leave the network through this same

router. This is a special case of the transient network.



When the link between two routers is broken, the administration may create a **virtual link** between them, using a longer path that probably goes through several routers.