Chapter 2

Routing in Traditional Networks

2.1 Routing Algorithms

The primary function of a network is to accept packets from a source node and deliver them at the destination node. Routing in computer networks is determining the path that a packet originating at source node of a network takes in order to reach the destination. Routing algorithms are a part of network layer software. The algorithms and data structures used in routing are major design issues in network layer. The desirable attributes (Ref: 5) of a routing algorithm are correctness, computational simplicity, adaptive to changing traffic and topologies, robustness, stability, fairness and optimality.

Routing algorithms are classified based on many properties.

1. Packet switching scheme (Data gram, Virtual Circuits).
2. Method of information dissemination (central, distributed, isolated).
3. Route selection mechanism (shortest path, gradient based).
4. Based on taxonomies they are classified as (Static, Dynamic).

2.2 Static and Adaptive Routing

Static Routing

It has fixed routes. The advantage of fixed routing is simplicity. It works well in a reliable network with steady load. It lacks flexibility and does
not react to network congestion or failure. It is not suitable for Ad-hoc networks.

**Adaptive Routing**

Changes the routing decision to reflect changes in the topology, and usually traffic as well. Adaptive algorithm differs in where they get their information (i.e. locally, from adjacent routes, or from all routers), when they change the routes (every ΔT sec. when load changes, or when topology changes), and what metric is used for optimization (distance, number of hops, or estimated time transit) (Ref: 15).

Adaptive routing increases processing burden, and creates traffic overhead. Adaptive routing strategies are most prevalent as they improve the performance and aid traffic control (Ref: 6).

They can be classified as three types

1. Centralized
2. Isolated
3. Distributive

**2.3 Route Computation - distributed and centralized**

Centralized routing is impossible in dynamic networks even for fairly small networks. Route computation should not involve maintenance of global state. The data traffic overhead needed to distribute the routing information is large.

So distributed routing is used in Adhoc networks.
In the isolated routing (Ref: 8) algorithms the nodes make routing decisions based upon the information they themselves have gathered.

2.4 Various routing algorithms

2.4 (a) Shortest Path Routing:

Dijkstra's (Ref: 7) shortest path routing selects the route with minimum distance from the source to destination. The metric for shortest path can be distance, or number of hops, or mean queuing and transmission delay.

Network is modeled as a graph, with the nodes as vertices and the communication lines as edges. The labels of arcs can be functions of the distance, bandwidth, average traffic, communication cost, mean queue length, delay and other factors. By changing the weighting function the algorithm would then compute the "Shortest Path" measure according to one of the criteria or a combination of criteria.

This algorithm forms the basis of many algorithms.

2.4 (b) Distance Vector Routing or The Bellman-Ford Routing Algorithm

It is based on the principle, if a node C is in the shortest path between A and B, then the path from the node C to A, and from B to C must also be the shortest paths (Optimality Principle).
It was used in original ARPANET and is also used in Internet under the name RIP (Ref: 9). CISCO routers also use the improved version of RIP. It has count to infinity problem. It lends itself readily to distributed implementation. The process involves having each node independently compute its minimum cost to each destination and periodically broadcast the vector of minimum costs to the neighbors.

Distance Vector Tables consists of (Ref: 15, Page No: 177) a series of destinations (vectors) and costs (distances) to reach them and define the lowest cost to the destinations at the time of transmission. The main advantage of distance vector is that it is very easy to implement. It has the following advantages. Instability by old persisting routes, long convergence time and limit (max hop counts) imposed on network size.

2.4 (e) Flooding

It is a static routing algorithm, in which every incoming packet is sent out on every out going line except the line it arrived on. Damming of flooding can be done by hop counters, or by keeping track of packets that have been flooded and avoid sending them out a second time, or use time to live field.

Flooding is not practical for many applications due to the large communication overhead that it generates (Ref: 16). However flooding is useful in military applications and for broadcasting packets to all the hosts connected in the network.
2.4 (d) Source Routing

It is a routing approach which does not require an intermediate node to maintain a routing table but rather puts the entire burden on the source nodes. Source routing can work on Virtual Circuit or datagram form of packet switching (Ref: 10 & 17).

![Diagram of Source Routing](image)

**Figure: 2-1 Example of Source Routing**

The Internet protocols IPV4 and IPV6 (Ref: 19 & 20) provide an option for source routing of IP packets. Before a source host sends a packet it has to know the complete route to the destination host in order to include the route information in the header of the packet. Dynamic Source Routing (DSR) is described for wireless networks in the next chapter.

2.4 (e) Link State Routing

In the link state routing (Ref: 10) each node maintains the complete topology with a cost per each node. To keep these costs consistent each node periodically broadcast the link cost of its out-going links to all other nodes using flooding. When the other nodes receive this information, they update their view of the network and apply a shortest path algorithm to choose the next hop for each destination.
Some link costs in a node view can be incorrect because of long propagation delays. Such inconsistent topological views can lead to formation of temporary routing loops and they disappear in a time (time taken by a message to traverse the diameter of the network).

Link state routing is widely used in actual networks (Ref: 22). The OSPF Protocol that is being increasingly used in the Internet, uses link state algorithm. Another important link state protocol is Intermediate System – Intermediate System (IS – IS). The link state routing converges more quickly than Distance Vector Routing (Ref: 21). It was adapted for ARPANET from 1979.

Link state routing is not feasible for Adhoc networks due to enormous state propagation overload it generates when the network topology changes.

2.4 (f) Hierarchical Routing

In hierarchical routing, the routes are divided into regions or zones. A node knows the details of all the destinations within its region, but for other regions it will just forward it to that zones region. As the network becomes large it is impossible to keep the complete routing information for network at each node. So this hierarchical routing reduces table space needed at each node.

Unfortunately the gains in space are not free. The penalty is in the form of increased path length (but is acceptable). Kamon and Kleinvocle (1979) have discovered that the optimal number of levels for N router subnet is ln N.
2.4 (g) Broadcast routing

Sending a packet to all the destinations simultaneously is called broadcasting. For broadcasting different techniques like flooding, propagating using spanning tree and multi destination routing are used.

Reverse path forwarding is also used. The principal advantage of reverse path forwarding is that it is reasonably efficient and easy to implement. It does not require routers to know about spanning trees, nor does it have the overhead of a destination list or a bit map in each broadcast packet as does multidestination routing.

2.4(h) Multicast Routing

Sending a message to a group is called as multicasting and the routing algorithm is called multicast routing. To do multicasting each router computes a spanning tree covering all other routers in the subnet.

Alternate designs use core base trees. Multicasting is used to send messages to well-defined groups that are numerically large in size but small compared to the network as a whole.

The principles of these routing protocols form the basis for the adhoc routing protocols.