Network Layer

Functions of Network Layer

- The network layer is concerned with getting packets from the source all the way to the destination.
- The network layer must know about the topology of the network (i.e., the set of all routers and links) and choose appropriate paths through it, even for large networks.
- It must also take care when choosing routes to avoid overloading some of the communication lines and routers while leaving others idle.
- Finally, when the source and destination are in different networks, new problems occur. It is up to the network layer to deal with them.

Provided Services

- On sending side encapsulates segments into datagrams
- On receiving side, delivers segments to transport layer
- Network layer protocols in *every* host, router
- Router examines header fields in all IP datagrams passing through it

Routing Algorithm

- The routing algorithm is the part of the network layer software responsible for deciding which output line an incoming packet should be transmitted on.
- Decision must be made anew for every arriving data packet since the best route may have changed since last time.

Properties of Routing Algorithm

- **Correctness**: The routing should be done properly and correctly so that the packets may reach their proper destination.
- **Simplicity**: The routing should be done in a simple manner so that the overhead is as low as possible. With increasing complexity of the routing algorithms, the overhead also increases.
- **Robustness**: Once a major network becomes operative, it may be expected to run continuously for years without any failures. The algorithms designed for routing should be robust enough to handle hardware and software failures and should be able to cope with changes in the topology and traffic.
- **Stability**: The routing algorithms should be stable under all possible circumstances.
- **Fairness:** Every node connected to the network should get a fair chance of transmitting their packets. This is generally done on a first come first serve basis.
- **Optimality**: The routing algorithms should be optimal in terms of throughput and minimizing mean packet delays. Here there is a trade-off and one has to choose depending on suitability.

Classification of Routing Algorithms

- **Static Routing** *In static routing the paths are preconfigured. The predetermined paths are loaded to the routing table. Such is suitable for small networks. The disadvantage of static routing is its inability to respond quickly to network failure.*
- **Dynamic Routing** *Dynamic routing algorithms change their decisions if there is change in network. Each router continuously checks the network status by communicating with neighbors. The disadvantage of dynamic routing is its complexity in the router.*

The Optimality Principle

General statement about optimal routes without regard to topology or traffic: "If router *J is on the optimal path from router I to router K, then the* optimal path from *J to K also falls along the same route"*

Different Routing Approaches

- Shortest Path Routing
- Flooding
- Distance Vector Routing
- Link State Routing
- Hierarchical Routing
- Broadcast Routing

Shortest Path Routing

- A static routing technique
- Given a network topology and a set of weights describing the cost to send data across each link in the network
- Find the shortest path from a specified source to all other destinations in the network.
- Shortest path algorithm first developed by E. W. Dijkstra

Dijkstra's Algorithm

- **Basics**
  - Dijkstra's Algorithm starts at the chosen node (the source node) and it analyzes the graph to find the shortest path between that node and all the other nodes in the graph.
  - The algorithm keeps track of the currently known shortest distance from each node to the source node and it updates these values if it finds a shorter path.
  - Once the algorithm has found the shortest path between the source node and another node, that node is marked as "visited" and added to the path.
  - The process continues until all the nodes in the graph have been added to the path. This way, a path is achieved that connects the source node to all other nodes following the shortest path possible to reach each node.