Design Issues in Network Layer

Network Layer:is majorly focused on getting packets from the source to the destination, routing error handling and congestion control.

Before learning about design issues in the network layer, let's learn about it's various functions.

- Addressing**:**
  Maintains the address at the frame header of both source and destination and performs addressing to detect various devices in network.
- Packeting:
  This is performed by Internet Protocol. The network layer converts the packets from its upper layer.
- Routing**:**
  It is the most important functionality. The network layer chooses the most relevant and best path for the data transmission from source to destination.
- Inter-networking:
  It works to deliver a logical connection across multiple devices.

Network layer design issues:

The network layer comes with some design issues they are described as follows:

1. Store and Forward packet switching:

The host sends the packet to the nearest router. This packet is stored there until it has fully arrived once the link is fully processed by verifying the checksum then it is forwarded to the next router till it reaches the destination. This mechanism is called "Store and Forward packet switching."

2. Services provided to Transport Layer:

Through the network/transport layer interface, the network layer transfers it's services to the transport layer. These services are described below. But before providing these services to the transport layer following goals must be kept in mind :-

- Offering services must not depend on router technology.
- The transport layer needs to be protected from the type, number and topology of the available router.

- The network addresses for the transport layer should use uniform numbering pattern also at LAN and WAN connections.

Based on the connections there are 2 types of services provided :

- **Connectionless –** The routing and insertion of packets into subnet is done individually. No added setup is required.
- **Connection-Oriented –** Subnet must offer reliable service and all the packets must be transmitted over a single route.

3. Implementation of Connectionless Service:

Packet are termed as “datagrams” and corresponding subnet as “datagram subnets”. When the message size that has to be transmitted is 4 times the size of the packet, then the network layer divides into 4 packets and transmits each packet to router via. a few protocol.Each data packet has destination address and is routed independently irrespective of the packets.

4. Implementation of Connection Oriented service:

To use a connection-oriented service, first we establishes a connection, use it and then release it. In connection-oriented services, the data packets are delivered to the receiver in the same order in which they have been sent by the sender.

It can be done in either two ways :

- **Circuit Switched Connection –** A dedicated physical path or a circuit is established between the communicating nodes and then data stream is transferred.
- **Virtual Circuit Switched Connection –** The data stream is transferred over a packet switched network, in such a way that it seems to the user that there is a dedicated path from the sender to the receiver. A virtual path is established here. While, other connections may also be using the same path.

Routing Algorithms

when new connections are established, certain properties are desirable in a routing algorithm:

- Correctness and simplicity
- Robustness
- Stability
- Fairness and optimality

Routing Algorithms

- The Optimality Principle
- Shortest Path Routing
- Flooding
- Distance Vector Routing
- Link State Routing
- Hierarchical Routing
- Broadcast Routing
- Multicast Routing
- Routing for Mobile Hosts
- Routing in Ad Hoc Networks

The Optimality Principle

•One can make a general statement about optimal routes without regard to network topology or traffic.

•This statement is known as the optimality principle.

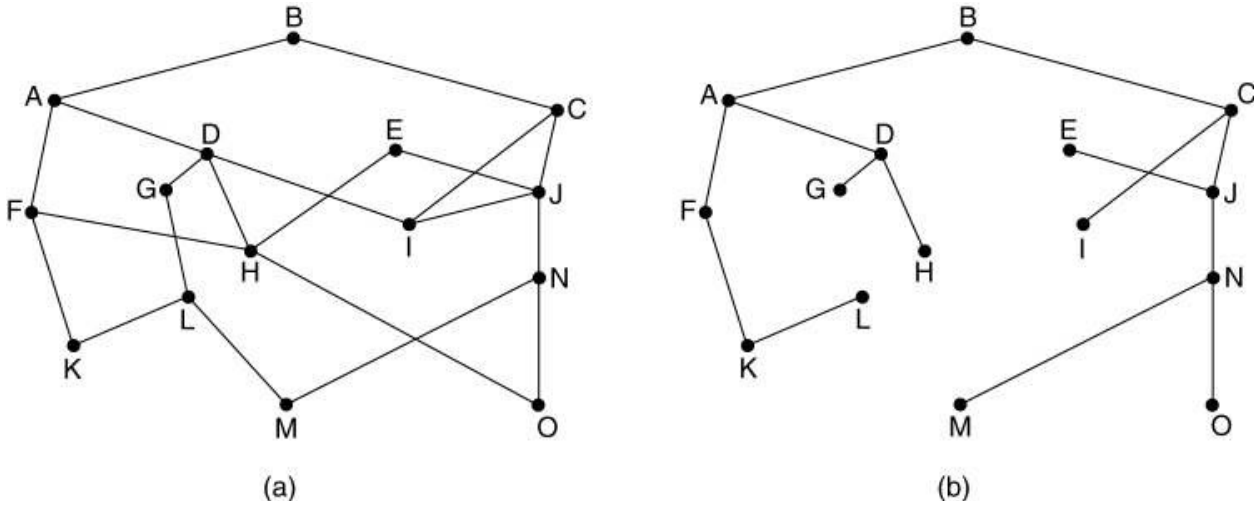
•It states that if router J is on the optimal path from router I to router K, then the optimal path from J to K also falls along the same route.

•As a direct consequence of the optimality principle, we can see that the set of optimal routes from all sources to a given destination form a tree rooted at the destination.

•Such a tree is called a sink tree.

•The goal of all routing algorithms is to discover and use the sink trees for all routers

The optimality principle in computer networks is stated as **follows**



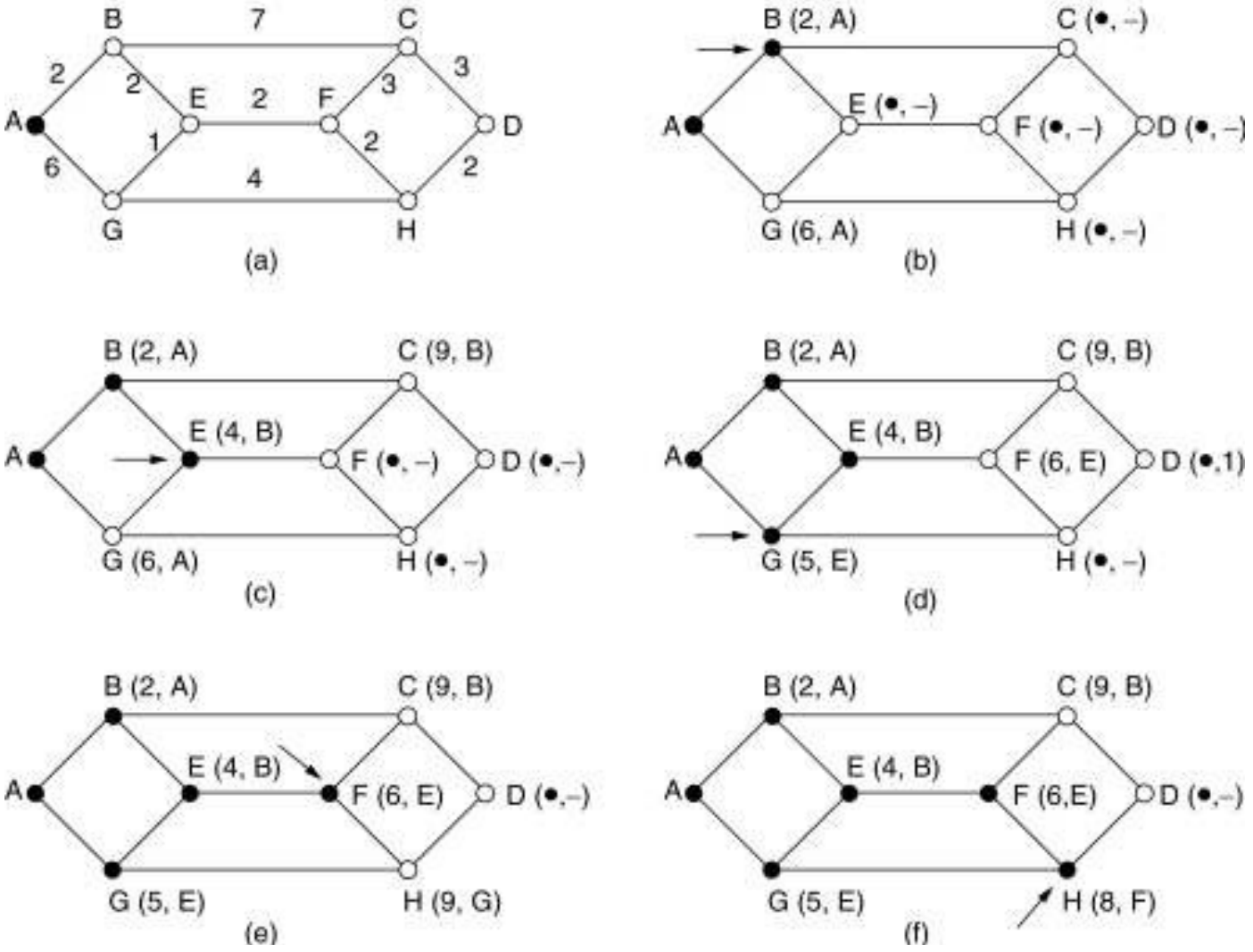
(a) A subnet. (b) A sink tree for router B.

The optimal path from a particular router to another may be the least cost path, the least distance path, the least time path, the least hops path or a combination of any of the above.

Shortest Path Routing

•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.

•To choose a route between a given pair of routers, the algorithm just finds the shortest path between them on the graph.



The first 5 steps used in computing the shortest path from A to D.

The arrows indicate the working node. In the general case, the labels on the arcscould be computed as a function of the distance, bandwidth, average traffic,communication cost, mean queue length,measured delay, and other factors.

Dijkstra's algorithm to compute the shortest path through a graph.

Flooding

• Another static algorithm is flooding, in which every incoming packet is sent out on every outgoing line except the one it arrived on
.

• Flooding obviously generates vast numbers of duplicate packets, in fact, an infinite number unless some measures are taken to damp the process. One such measure is to have a hop counter contained in the header of each packet, which is decremented at each hop,
with the packet being discarded when the counter reaches zero.

• Ideally, the hop counter should be initialized to the length of the path from source to destination .A variation of flooding that is slightly more practical is selective flooding.

• In this algorithm the routers do not send every incoming packet out on every line, only on those lines that are going approximately in the right direction.

• Flooding is not practical in most Applications.