Bridges in Local Area Networks

- The previous discussions have been on the topologies and the different kinds of transmission media. Different topologies and the media are discussed.

- Then the addressing and frame format of MAC has been discussed.

- Almost in all cases, there is a need to expand beyond the confines of a single LAN, to provide interconnection to other LANs and Wide Area Networks.

- Two general approaches have been used for this purpose
  - Bridges
  - Routers

- The reason for not having a very large single LAN can be listed as follows
  - Reliability
  - Performance
  - Security
  - Geography

- The bridge is designed for use between local area networks that use identical protocols for the physical and link layers.

- *Functions of a bridge*:- As shown in the diagram below a bridge connecting two LANs A and B using the same MAC (Medium Access Control). The total function is performed using two “half-bridges” one on each LAN.

  - ✓ Read all frames transmitted on A and accept those addressed to any on station B.
  - ✓ Using the medium access control protocol for B, retransmit each frame on B.
  - ✓ Do the same for B-to-A traffic.

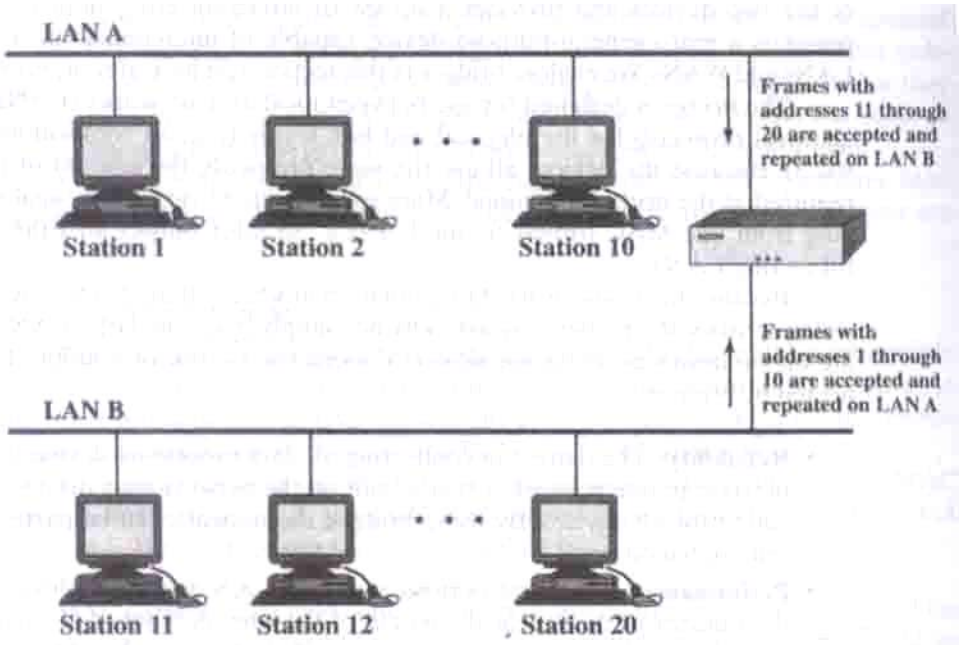

Figure 15.8 Bridge Operation

Bridge Operation

- Introduction to Routing Algorithms:- As the number of LANs grows it becomes important to provide alternate paths between LANs via bridges for load balancing and reconfiguration in response to failure and soon we find that fixed routing is sometimes inadequate.

- Consider the diagram below which will be used to illustrate fixed routing. Basically in a complex network of LANs connected through bridges we need the frame to be transmitted to reach the required destination in the network and for that routing decisions need to be taken.

- There are two general approaches to routing in interconnected LAN networks:-
    - FIXED ROUTING
    - SPANNING TREE APPROACH

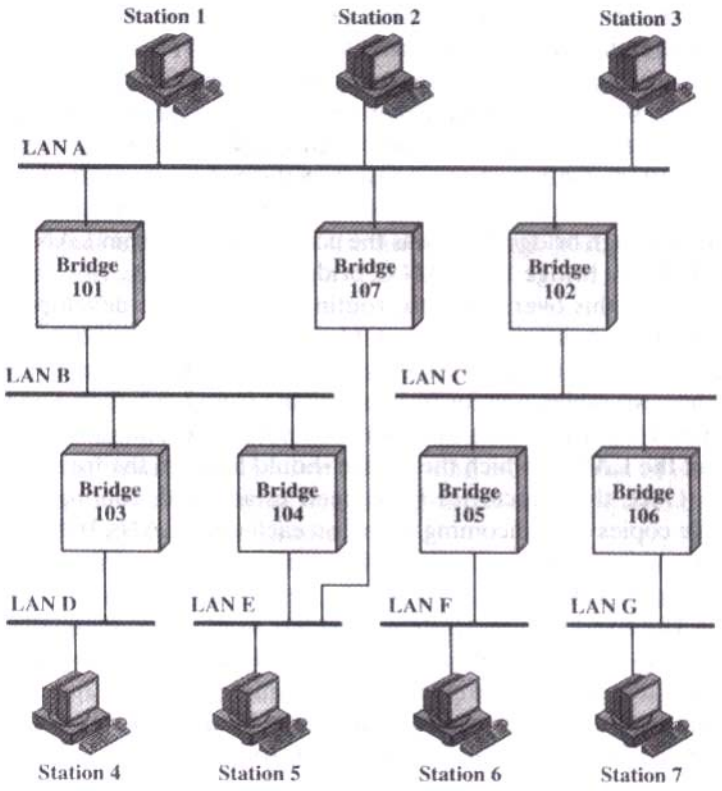

Figure 15.10 Configuration of Bridges and LANs, with Alternate Routes

Configuration of Bridges and LANs with alternate paths

- FIXED ROUTING:- As the name suggests, the routing decisions needed to be taken are pre-decided. A route is decided for each source-destination pairs of LANs in the configuration. If alternate paths are available then the one with the least number of hops is typically chosen and this path is fixed (at least until the topological conditions do not change).
  The main advantage it has is the simplicity and the minimum processing requirements. It is suitable for small internets or those internets that are most stable.
  The disadvantage being that in a complex internet, in which bridges may be dynamically added and failures must be accounted for, this strategy is most limited.

- THE SPANNING TREE APPROACH:- This approach is a mechanism in which bridges automatically develop a routing table

and update that table in response to changing topology. It consists of three basic mechanisms and they are listed as follows.

- Frame Forwading:- A bridge maintains a forwarding database for each port attached to a LAN. Suppose that a bridge receives a MAC frame on a port x, the following rules are applied.
    1. Search the forwarding database to determine if the MAC address is listed for any port except on port x.
    2. If the destination MAC address is not found, forward frame out on all ports except the one from which it was received. This is part of the learning process described subsequently.
    3. If the destination address in the forwarding database for some port y, then determine whether port y is in a blocking state. (ports can sometimes get blocked which prevents it from sending/transmitting frames).
    4. If port y is not blocked, transmit the frame through port y onto the LAN to which that port attaches.

- Address Learning:- The initial information can be loaded into the bridges as in fixed routing (which may be later modified depending on the topology). Or an effective mechanism for learning the topology may be defined. And for this the main strategy involves upon arrival of each frame the database can be updated depending on the direction of the incoming frame and then setting a timer. If the timer expires then the element is eliminated from the database. If a frame is received from an address either the database is updated and the timer reset or a new entry is created with its own timer.

- Spanning tree Algorithm:-
  The address learning mechanism is effective if the topology is a tree(i.e no closed loops exist).
  Closed loops can cause a problem as exhibited from the following figure.

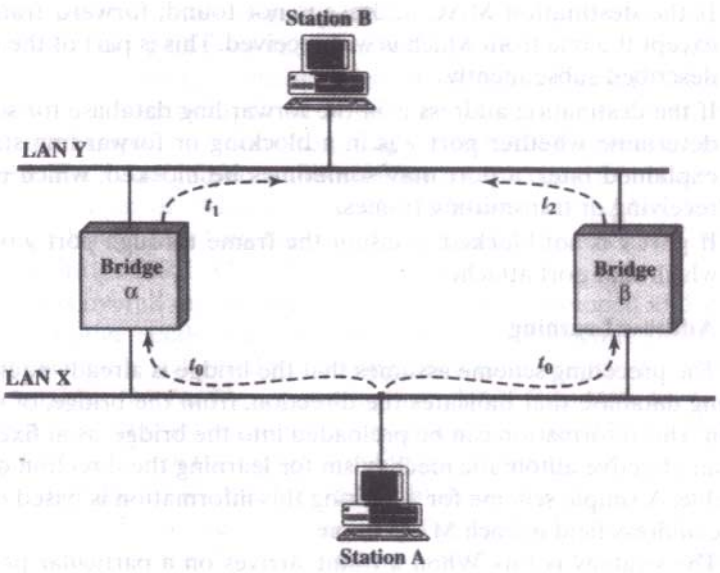

Figure 15.11 Loop of Bridges

Loop of Bridges

At time t0 the station A transmits a frame addressed to station B. The frame captured by both bridges retransmit on LAN Y after updating their databases that station A is in the direction of LAN X. If bridge ‘a’ transmits in time t1 and ‘b” transmits in t2 (a short while later) station B receives 2 copies of the frame and also each bridge receives each others copy and update their databases that the direction of LAN Y is in the direction of LAN X. Thus making both incapable of transmitting any frame to station A.

The simple solution to this problem is to find a minimum spanning tree that eliminates any closed loops. Any algorithm in place which can calculate this graph dynamically will be fine and if costs are associated with each then an effective graph may be built which can be used to route the frames.