The Channel Allocation Problem

In a broadcast network, the single broadcast channel is to be allocated to one. This is called as channel allocation. There are two different schemes used for channel allocation as follows:

- **Static channel allocation**

The traditional way of allocating a single channel, such as a telephone trunk, among multiple competing users is Frequency Division Multiplexing (FDM). If there are *N* users, the bandwidth is divided into *N* equal-sized portions , each user being assigned one portion. Since each user has a private frequency band, there is no interference between users. When there is only a small and constant number of a user, each of which has a heavy (buffered) load of traffic (e.g., carriers' switching offices), FDM is a simple and efficient allocation mechanism.

- **Dynamic channel allocation**

In this method no fixed frequency or fixed time slot is allotted to the user. The user can use the single channel as per his requirement. Following assumptions are made for the implementation of this method.

I. **STATION MODEL:** The model consists of N independent stations (e.g. computers, telephones or personal communicators, each with a program or user that generates frames for transmission. Stations are sometimes called terminals.

II. **SINGLE CHANNEL ASSUMPTION:** A single channel is available for all communication. All stations can transmit on it and all can receive from it. As far as the hardware is concerned, all stations are equivalent, although protocol software may assign priorities to them.

III. **COLLISION ASSUMPTION:** If two frames are transmitted simultaneously, they overlap in time and the resulting signal is garbled. This event is called a collision. All stations can detect collisions. A collided frame must be transmitted again later. There are no errors other than these generated by collisions.

IV. (a). **CONTINUOUS TIME:** Frame transmission can begin at any instant. There is no master clock dividing time into discrete intervals.
(b). **SLOTTED TIME:** Time is divided into discrete intervals (slots). Frame transmissions always begin at the start of a slot. A slot may contain 0, 1 or more frames, corresponding to an idle slot, a successful transmission or a collision, respectively.

V. (a).**CARRIER SENSE:** Stations can tell if the channel is in use before trying to use it. If the channel is sensed as busy, no station will attempt to use it until it goes idle.

(b).**NO CARRIER SENSE:** Stations cannot sense the channel before trying to use it. They just go ahead and transmit only later can they determine whether the transmission was successful.

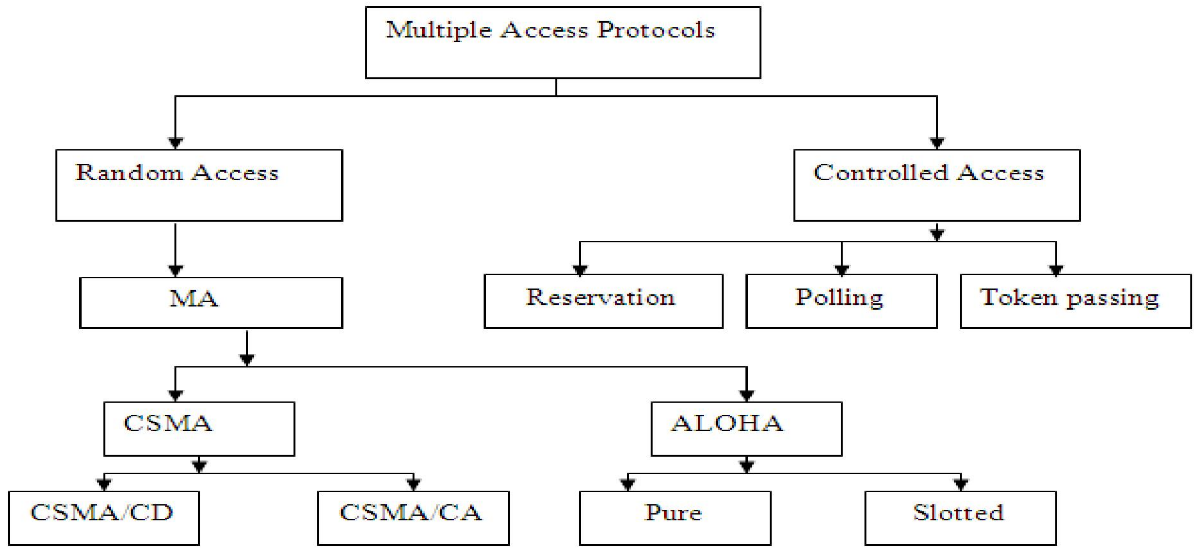

Figure 3.1 Multiple Access Protocol

Multiple Access

When a number of stations (users) use a common link of communication system we have to use a multiple access protocol in order to coordinate the access to the common link.

The two techniques used to deal with the multiple access problem are as follows:

1. Random access
2. Controlled access

Random access

In the random access there is no control station. Each station will have the right to use the common medium without any control over it. With increase in number of stations, there is an increased probability of collisions or access conflict. The collision will occur when more than one user tries to access the common medium simultaneously. As a result of such collisions some frames can be either modified or destroyed. In order to avoid collisions, we have to set up a procedure.

ALOHA: The earliest random access method was developed at the University of Hawaii, in the early 1970’s by Norman Abramson and his colleagues.

It was designed to be used ground-based radio (wireless) broadcasting Local Area Network (LAN) with a data rate of 9600 bps. The basic idea is applicable to any system in which uncoordinated users are competing for the use of a single shared channel. The ALOHA system has two versions:

- Pure ALOHA
- Slotted ALOHA

Pure ALOHA

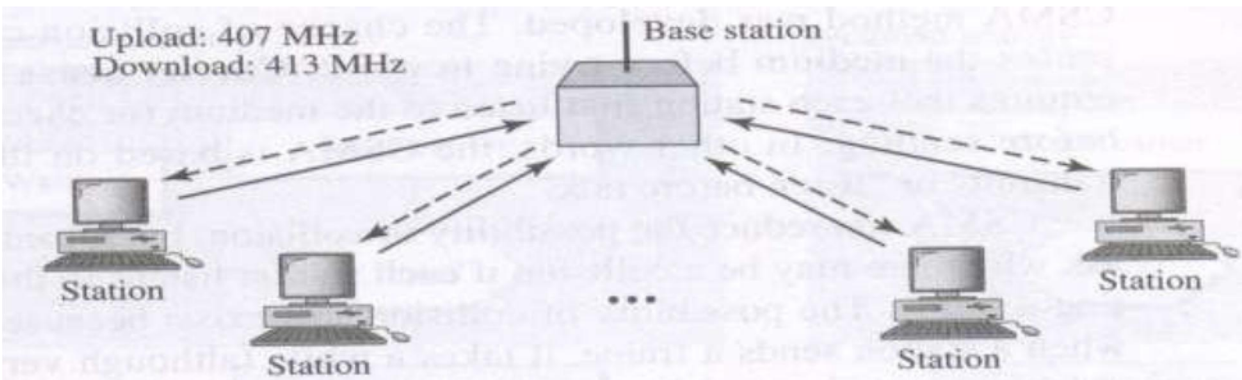

Figure 3.2 Pure ALOHA system

It works on a very simple principle. Essentially it allows for any station to broadcast at any time. If two signals collide, each station simply waits a random time and try again.

Collisions are easily detected. When the central station receives a frame it sends an acknowledgement on a different frequency.

If a user station receives an acknowledgement it assumes that the transmitted frame was successfully received and if it does get an acknowledgement it assumes that collision had occurred and is ready to retransmit.

The advantage of pure ALOHA is its simplicity in implementation but it's performance becomes worse as the data traffic on the channel increases.

Efficiency of an ALOHA Channel

Let the frame time denote the amount of time required to transmit the standard fixed length frame.

Frame time= frame length/ bit rate

We assume that ∞ number of users generate new frames with average N frames per frame time.

Let the average number of transmissions be G per frame time.

With increase in load there are many collisions G > N.

For all the loads throughput is given by

$$S=GP_0$$

Where P_0 = probability that a frame does not suffer a collision.

The probability that *k* frames are generated during a given frame time is given by

$P\, r[k] = G^k e^{-G} / k!$

If k=0 then

$P_0 = G^0 e^{-G} / 0! = e^{-G}$

If an interval is two frame time long, the mean number of frames generated is 2G.
The probability that no other frame is transmitted during the vulnerable period is,

$P_0 = e^{-2G}$

But throughput

$$S=GP_0$$

$$S=G\, e^{-2G}$$

The maximum throughput occurs at G = 0.5 , with S=1/(2*e) which is about 0.184 or 18.4%.

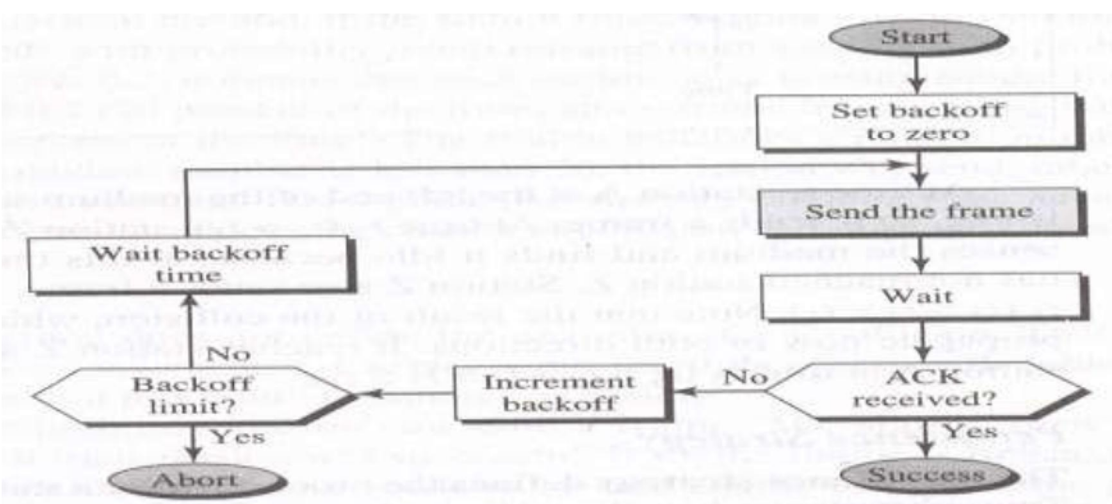

Figure 3.3 Protocol flow chart for ALOHA

Slotted ALOHA