STUDY OF MULTIPLE ACCESS TECHNIQUES IN SATELLITE COMMUNICATION

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Abstract: In this paper we focus on Multiple Access Methods that are used in satellite communication. In telecommunications and computer networks, a channel access method or multiple access method allows several terminals connected to the same multi-point transmission medium to transmit over it and to share its capacity. Multiple Access Techniques (MAT) are used for interconnecting a large number of earth station (ES) terminals via satellite. It is based on a multiplexing method which allows several data streams or signals to share the same communication channel/physical medium. Using multiple accessing techniques, one earth station can communicate with all other stations using a same satellite. These techniques provide wide range of geographical coverage capability. Various multiplexing techniques are FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access) and CDMA (Code Division Multiple Access).

Index Terms: Bandwidth, Multiple Access, multiplexing, frame, burst, Acquisition, Synchronization

I. INTRODUCTION

Multiple access is the ability of mobile nodes to communicate and interconnect their data through a common medium. These problems are fundamental to mobile communications because of very limited amount of frequencies available for communication. It allows interconnection among various earth stations via satellite. These allow best utilization of satellite channel. These allow several users to share a medium with minimum or no interferences. Several multiple access techniques that are available today are discussed below.

II. TYPES OF MAT:

A. FDMA (Frequency Division Multiple Access)

In FDMA, satellite frequency is divided into disjoint bands, and hence small channels are made. One user is allowed to use the frequency band of infinite amount of time for wireless cellular communication into 30 channels, each can carry a voice conversation or digital service carrying digital data. This multiple access technique is termed as Frequency division multiple access (FDMA) since the accessing is done on the basis of broken disjoint frequency bands, or channels. FDMA can be divided into two ways:

1) Fixed Assignment Multiple Access (FAMA):

The sub channel assignments are fixed, that is allotment for every sub channel is same. Demand may fluctuate. Multiple stations access the satellite by using different frequency bands. This type of multiple access techniques is suitable for broadcast satellite communication.

2) Demand Assignment Multiple Access (DAMA):

The sub channel allotment depends and changes with demand, hence according to user’s demand this allotment changes. When the circuit is no longer in use, the channels are then returned to the central pool for reassignment to other users. Now the entire bandwidth is divided and given to several channel separately, and a guard band is placed so as to avoid the overlapping of data. This type of multiple Access technique is suitable for point to point communication.
B. TDMA (Time Division Multiple Access):

In TDMA, multiple earth stations transmit at the same frequency but in different time slots, i.e., entire frequency band is divided on the basis of time where one transmitter will use the complete frequency band for a given time slot and the another user will use the same frequency band for different time. Thus they are separated in time period.

Fig. 2 Principle of TDMA

Hence there are several earth stations ES as shown in the Fig. 2. These transmit traffic bursts in a period time frame known as TDMA frame structure. Hence the earth stations can access the entire bandwidth of the transponder but during their time slot. This is a time termed as guard time between transmitting times of individual bursts such that bursts may not overlap each other. TDMA can be of two ways:

\[ n = 1 - \frac{u}{T_F} \]

a. Fixed Assignment TDMA

b. Demand Assignment TDMA

- In Fixed Assignment TDMA, frame is divided into time slots of fixed duration.
- In Demand Assignment TDMA frame, the transmission time is demand based.

Number of voice channels \( n \) in a TDMA system is given by the expression:

\[ n = \frac{1}{r} \times \left( \frac{R - NP}{T} \right) \]

r: Voice channel bit rate
T: Frame period
P: Number of digits in the preamble
R: Satellite channel bit rate (power or band limited)
N: Number of bursts in a frame.

1) TDMA frame structure:

Fig. 3. frame structure

2) TDMA burst structure:

Fig. 4. Burst structure

3) TDMA frame efficiency:
\[ \sum t = \text{sum of all guard times and preamble} \]

\[ T_F = \text{Frame duration} \]

4) **TDMA Frame Acquisition and Synchronisation:**

It is very important that the traffic stations while transmitting must transmit in the given time slot and similar goes with the receiver end. The aim is the burst should not overlap with each other. This accuracy is achieved by using Frame Acquisition and Frame Synchronisation.

Various timings in TDMA are Transmit Frame timing, Transmit burst timing, Receive frame timing and Receiving burst timing. The processes of acquisition and synchronisation are receive frame acquisition, transmit frame acquisition, transmit frame synchronisation and receive frame synchronisation.

Doppler shift is used in various timings on the basis of techniques for determining \( D_N \), there are two kinds of synchronisation processes:

i. **Open Loop control Method** : \( D_N \) is determined by earth station directly from monitoring its own transmission.

ii. **Closed Loop control Method** : In this bursts aren’t received directly by transmitting stations but some other methods are used.

C. **CDMA (Code Division Multiple Access):**

CDMA uses digital format technique. In this several transmissions take place simultaneously on the same frequency bandwidth. The user data at the transmitter side is combined with an orthogonal code and is then transmitted and everything gets mixed in air-radio spectrum and at the receiver’s side the same code is used. Frequency reuse factor is used in CDMA technique. Thus they are separated in code.

**Fig. 5. Principle of CDMA**

**Fig. 6**

**Comparison of FDMA, TDMA, CDMA**

**III. Conclusion:**

Since, we have limited bandwidth and infinite number of users then multiple accessing techniques are very essential. So we have studied FDMA, TDMA and CDMA which are the widely used multiple accessing techniques in satellite, mobile and wireless communication. Hence by using these techniques satellite channels are best utilised and allows to cover geographical area widely.

**References:**

[1]. Satellite Communications by Dr. D.C. Agarwal

[2]. Wireless Communications by Theodore S.Rappaport


[4]. http://electronicdesign.com
