CHAPTER 1

INTRODUCTION

Multiple Access Technique

Satellite transmission system provides a capacity resource which can be shared by a number of earth stations. Earth stations sharing of this resource can be accomplished by means of a multiple access technique. This satellite resource can be linearly subdivided and assigned to earth stations individually or a group of earth stations which, in turn, could further share their alloted capacity by a group of users. The amount of required satellite capacity depends on earth station sensitivity and power.

Multiple access techniques are classified into three seperate well-known access schemes, namely

- Frequency Division Multiple Access (FDMA)
- Time Division Multiple Access (TDMA)
- Code Division Multiple Access (CDMA)

FDMA

Transponder bandwidth is divided into a number of nonoverlapping frequency slots which constitute the access channels for a set of earth stations.

TDMA

Each earth station gains access to a common transponder within a periodic time frame.

CDMA

The most well-known form of CDMA is Spread Spectrum Multiple Access (SSMA) in which each user is assigned a particular code sequence, which is modulated on the carrier along with the digital data,to enable user to gain access through a common signalling channel. The SSMA techniques are also characterized by the use of a high-rate code (i.e.,many code symbols/data symbol) which has the effect of spreading the bandwidth of the data signals. This type of multiple access technique allows users to share the resource on a non-orthogonal basis. There are two forms of SSMA, Frequency-Hopped Spread Sprectrum (FHSS) in which each user occupies a narrow band time-varying channel, and Direct Sequence Spread Spectrum (DS-SS) in which each user uses a full wideband channel continuously.

More datails about these three multiple access techniques can be found in (Wu, 1984), (Feher, 1983), (Dixon, 1984), (Pickholtz et al.,1982), (Scholtz, 1977), and (Simon et al., 1985). Their comparison is presented in (Wu, 1984).

Other non-orthogonal access schemes called Random Multiple Access (RMA) and Frequency Comb Multiple Access (FCMA) are presented in (Wu, 1984), and (Stevenson and Yates, 1989) accordingly. Both techniques provide the basis for multiple access and information transmission. In FCMA, each user is assigned a signature which consist of quasi-orthogonal combs of frequencies. All signature combs interleave one another over the available bandwidth to provide the multiple access. In RMA, a unique signature (or code sequence) is assigned to each user in the network. Each signature assembles M numbers of time-frequency elements out of a possible total number T_d*F where T_d and F are the number of time and frequency division elements in a given frame (Wu, 1984) (Wu et al., 1985).

Requirement of System with Very Small Aperture Antennas

The development of the future satellite communication is that the satellite spacecraft is increasing in size, power and capacity while the earth terminals, in turn, reflect the inverse trend. The satellite channel is changing from a noise-limited environment to an interference-limited one because of the rapid growth in the number of earth terminals.

Most satellite networks, at present, use earth stations as shared nodes or involve a number of small terminals in a star network interacting with a central master station, such as INTELNET network (Jamshidi and Nguyen, 1986). Our proposed RMA technique will allow very small aperture terminals (VSAT) to be installed directly on end-user premises (fixed or mobile terminals) and have a mesh configuration. The reason for mesh configuration is to avoid double-hop of messages through the gateway or hub stations, thus, allowing earth terminal to earth terminal interconnectivity.

Within a satellite antenna coverage area, all terminals potentially can directly communicate with any other terminal. Therefore, the number of possible terminal-to-terminal link is given by n(n-1)/2. If the system consists of five thousand terminals or more, then the potential number of connection is over 12,497,500 different links. Under such conditions, FDMA or TDMA or any other orthogonal access system are not likely to be feasible. The DS-SS is also not shown any application for such large number of users. Therefore, it becomes apparent that the RMA is the only technique which can provide access for large number of VSATs.

New Form of Random Multiple Access Technique

In this thesis, we will propose an access technique which applies the basis of RMA but has different system model and code sequence construction from the one designed by W.Wu (Wu, 1984). The differeces in code sequence structure are listed below:

Category	Wu	New RMA
-Sequence Generation	Use only Euclidean Geometry Difference Set	Use Euclidean and Projective Geometry Difference Set
-Total Elements in the TF Matrix (M=sequence length)	M^3	M^2
-Number of Time-Division(T_d)	M	Flexible T_d and F
-Number of Frequency-Div.(F)	M^2	

The major questions associated with the design of a new RMA transmission system are:

1. What kind of code sequences are used, and how to construct them?

2. What are the properties of the sequences?

3. What is the system configuration?

4. How is the performance measured?

5. What is the performance of any user in the presence of multiple access interference?

6. How do sequence and link parameters affect the system performance?

It is the aim of this thesis to answer these questions and offer some insights into this new technique.

Chapter 2 shows the answer to the first and second question. The answers to question #3 and #4 can be found in Chapter 3 while Chapter 4 provides the answer to question #5 and #6.