SOME STUDIES ON A LOW COST VSAT SATELLITE MESH NETWORK

by

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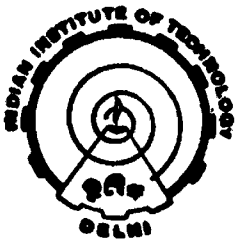

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CERTIFICATE

This is to certify that the dissertation entitled, **"Some Studies on a Low Cost VSAT Satellite Mesh Network"** which is being submitted by Mr. Mahesh Kumar Goel to the Indian Institute Of Technology, Delhi, is a record of the bonafide research work carried out by him under my guidance and supervision.

In my opinion, this dissertation has reached the standard fulfilling the requirements of all the regulations relating to the degree. The results contained in it have not been submitted in part or in full to any other university or institute for the award of any degree or diploma.

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to Madam Shanta Kohli Chandra

SYNOPSIS

This thesis presents simulation studies and network design of a low cost satellite messaging network using Small Messaging Terminals (SMTs). The messaging network has been configured as a Mesh network operating in C-band. The network design is based upon the results obtained by a simulation of a satellite mesh network using **Spread ALOHA** transmission protocol. It also proposes a scheme for acquisition and synchronisation of **Spread ALOHA** signal. A Transputer realisation of some of the baseband hardware for the SMT is also suggested.

Multiaccess protocols for satellite communications facilitate orderly sharing of the common satellite resources amongst many users. They are classified according to their approach to the allocation of transmission resources. Fixed assignment and random access protocols are the two extremes of channel allocation processes whereas the reservation protocols fall somewhere in between. Fixed assignment protocols distribute the resources equally amongst all the users whereas random access protocols do not perform any allocation at all. FDMA, TDMA and CDMA are fixed assignment techniques sharing frequency, time and a mix of the two respectively. These techniques are typically used in the case of small number of large and steady traffic terminals like in Computer-to-Computer file transfer, Video and Voice traffic transmission. Random access techniques are particularly suited to a large user population with irregular user activity. A representative case of such a user group is of

interactive terminal operators like that in an enquiry-response kind of system or a messaging system. These operations result in bursty data traffic. The user requirement of communication resources is rather infrequent, but whenever there is a requirement, a rapid response is desired. In such cases there is an inherently large peak-to-average ratio in the required data transmission rate. For a large number of such users the demand on the channel resources at any instant tends to be equal to the sum of the average demands of that population. ALOHA and its variants, ARRA, SSMA and RMA are the prominent random access schemes. Reservation protocols keep some resources reserved for some of the users and the rest are shared on a random basis. Polling and Reservation ALOHA are the major access schemes in this category. Some features of the above access schemes have been presented in Chapter 1.

The second chapter introduces **MESCOMNET**, a **MES**sage **COM**municating **NET**work to serve the communication needs of the rural population of developing countries. Communication needs of **MESCOMNET** can most appropriately be met by a satellite based network. Satellite networks have characteristics more suited to data communication applications rather than telephone or voice applications. It is all the more suitable if user-premises Earth Stations are used to provide total bypass of telephone circuits. The suitability of satellite circuits for messaging applications arise out of the facts of distance or location independence of the cost of the circuits; full connectivity in point-to-multipoint or point-to-point mode of communication and the

ability to handle the asymmetric data rates. The qualifications of an access scheme for such a network have been defined and **Spread ALOHA** identified as a likely choice. **Spread ALOHA** has been suggested as a technique to reduce VSAT power requirements. In **Spread ALOHA**, the energy of the bits of the data packet to be transmitted on the channel, is enhanced by time-spreading. This results in improved Eb/No which can be harnessed either to operate the digital communication link at a better BER or to reduce the size of the transmitting and receiving antennas. The improved Eb/No also makes it rugged against channel noise and interference. The properties of the **Spread ALOHA** transmission protocol have been verified by a simulation. It has also been identified as a suitable access scheme for **MESCOMENT**.

The third chapter underlines the characteristics of **MESCOMET**. It discusses the traffic and population requirement and explains the packet transmission protocol. The electrical and traffic specifications of **MESCOMNET** have been laid down. Since **Spread ALOHA** is an untried access scheme, a simulation program has been developed to confirm its potential in configuring a large network like **MESCOMNET**. **NARA**, **N**etwork using **A**LOHA **R**andom **A**ccess is a simulation program developed for studying the behaviour of large networks. The program is general and allows for the study of either the Mesh or the Star connected networks. Certain variations of the classical ALOHA schemes like Slotted ALOHA (with user selectable slot length) and **Spread ALOHA** can be studied for network operation. In the case of **Spread ALOHA** access, the program can be run with Barker, Pseudorandom,

Ping Fai Li or any other spreading sequence. The simulation also allows one to vary the packet length although only fixed length packets are permitted. The results of the simulation have confirmed the utility of **Spread ALOHA** as an access protocol for **MESCOMNET**. It has identified 10% channel throughput as an operating point on the throughput-traffic curve at which **Spread Advantage** is available for power reduction of SMTs. The link calculations for **MESCOMNET** show that the network operation requires a total peak EIRP of 17 dBW which amounts to about 1/25th of a full transponder power.

Chapter 4 proposes a scheme for implementing the synchronisation and acquisition circuit for the SMTs of **MESCOMNET**. It also gives a scheme for Transputer realisation of some portion of the total acquisition circuit.

Chapter 5 contains the conclusions and the scope for future work.

This thesis is based upon the following publications:

Refreed Papers

M.K. Goel and Vinod Chandra, "A Low Cost VSAT Satellite Mesh Network and Proposed Transputer Realisation of Synchronisation Circuits", to appear in the special issue on Satellite Communications of the Journal of the Institution of Electronics and Telecommunication Engineers, India.

Papers Presented at Conferences

M.K. Goel and Vinod Chandra, "Some Simulation Results on the Error Rate Performance of Spread ALOHA", Proc. IEEE Southeastcon'88, Knoxville, Tennessee, April 10-13, 1988.

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Communicated Papers

M. K. Goel and Vinod Chandra, "Design of a VSAT Mesh Network for Messaging Applications", Journal of Selected Areas in Communications, IEEE.

CONTENTS

Certificate (i)

Acknowledgements (ii)

Synopsis (iv)

List of Figures (ix)

List of Tables (xi)

CHAPTER 1 MULTIACCESS SCHEMES FOR SATELLITE COMMUNICATIONS: A REVIEW

1.0 Introduction 1

1.1 Multiaccess Protocols 1

1.2 Fixed Assignment Techniques 3

1.2.1 FDMA and TDMA 3

1.2.2 Code Division Multiple Access 4

1.3 Random Access Techniques 6

1.3.1 ALOHA 7

1.3.2 Announced Retransmission Random Access 13

1.3.3 Spread ALOHA 14

1.3.4 Spread Spectrum Multiple Access (SSMA) 14

1.3.5 Random Multiple Access (RMA) 16

1.4 Demand Assignment 17

1.4.1 Centrally Controlled Demand Assignment 18

1.4.1.1 Circuit Oriented Schemes 18

1.4.1.2 Polling Systems 18

1.4.2 Demand Assignment With Distributed Control 19

1.4.2.1 Reservation ALOHA 20

1.5 Adaptive Strategies and Mixed Modes 22

1.5.1 Priority-Oriented Demand Assignment (PODA) 22

1.6 Conclusion 24

References 25

CHAPTER 2 A RURAL MESSAGING NETWORK USING SPREAD ALOHA ACCESS

2.1 Introduction 30

2.2 Network Using Very Small Aperture Terminals (VSATs) 31

2.3 Spread ALOHA 36

2.3.1 The Spreading Sequence 39

2.3.2 Bit-Spread ALOHA 41

2.3.3 Simulation of Spread ALOHA Protocol 46

2.4 Conclusion 50

References 51

CHAPTER 3 DESIGN OF MESCOMNET - A MESH CONNECTED NETWORK IN C-BAND

3.1 Introduction 53

3.2 Characteristics of MESCOMNET 54

3.3 NARA 59

3.3.1 Access Mechanism Model 63

3.3.2 Population Model 65

3.3.3 Time Model 66

3.3.4 Master Schedule 70

3.3.5 Channel Model 73

3.3.6 Calculation Module 76

3.4 Results 79

3.4.1 Throughput vs Traffic Curve 79

3.4.2 Throughput vs Delay Curve 81
3.4.3 Channel Occupancy vs. Throughput 82
3.4.4 Average Number of Retransmissions vs. Fresh Traffic 85
3.5 General 86
3.6 MESCOMNET Link Calculations 86
3.6.1 Required C/No Calculations 87
3.6.2 Intermodulation C/No Calculations 87
3.6.3 Uplink C/No Calculations 88
3.6.4 Downlink C/No Required 88
3.6.5 Transponder Power Requirement 89
3.6.6 Transponder Availability 90
3.6.7 Link Budget 91
3.7 Conclusion 92
References 94

CHAPTER 4 TRANSPUTER IMPLEMENTATION OF A SOFTWARE LOCKED LOOP FOR USE IN MESCOMNET TERMINALS

4.0 Introduction 95
4.1 Synchronisation Requirement of Digital Satellite Communication 95
4.2 An Acquisition and Tracking Scheme for MESCOMNET Terminals 97
4.3 Transputers and Occam 101
4.4 Implementation of SLL Using Transputer 103
4.5 Conclusion 113
References 114

CHAPTER 5 CONCLUSION AND SCOPE FOR FUTURE WORK

5.1 Conclusions 116

5.2 Scope for Future Work 118

VITAE 120

Abstract 121