MULTISERVICE TRAFFIC ALLOCATION IN LEO SATELLITE COMMUNICATIONS

by

Reza Septiawan

Submitted to the Faculty of Information Technology
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

BOND UNIVERSITY

July 2004

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Abstract

Satellite communication promises potential methods for providing global communication. In particular, by the development of a Low Earth Orbital (LEO) satellite constellation, both global coverage and broadband communication will be accessible. Problems arise in situations where various traffic types in broadband communication require different levels of quality of service (QoS). Traffic control is required to make sure that each traffic demand may receive the expected QoS. Another problem is that the dynamic topology of a LEO satellite network requires a traffic allocation control, which is able to allocate traffic demand into the Inter Satellite Links (ISLs) between LEO satellites.

In this thesis, traffic allocation strategy in a dynamic LEO satellite communication network is studied and analyzed. The delivery of Quality of Service (QoS) is an important objective. Traffic allocation control is performed in the LEO satellite constellation to provide a near optimal utilization of these ISLs. An alternative solution is proposed in this research, in which a combination of two algorithms will be used to allocate traffic in this dynamic satellite network. The first algorithm allocates traffic during small time intervals, based on an assumption that the topology is unchanged during these intervals. The second algorithm allocates traffic after topology updating has been accomplished. Traffic allocation respects some constraints including QoS (due to multiservice requirements), capacity constraints, traffic distribution, and availability constraints. Both theoretical and empirical studies have been undertaken to examine the performance of the proposed algorithm, denoted GALPEDA (Genetic Algorithm Linear Programming and Extended Dijkstra Algorithm). The proposed algorithm provides privileges to a class of high priority traffic, including benefits for traffic allocation of multiclass traffic in LEO satellite communication. It provides a novel traffic allocation mechanism to cope with the dynamic topology of a LEO satellite; moreover this algorithm distributes multiservice traffic evenly over the network. Simulations results are provided.

Thesis Supervisor: Stephen Sugden
Title: Dr, Associate Professor

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Acknowledgements

Pursuing a doctoral degree is a long journey. It is not undertaken alone and consequently, there are many people who I would like to thank for their contribution.

First, I would like to thank my parents for all the love, support and encouragement they have provided me. They have made many sacrifices to provide the wonderful opportunities that I have had. I am most grateful to them.

Graham McMahon and Stephen Sugden have been fantastic supervisors. They continually impressed me with their wisdom and many helpful discussions during my study and research at Bond University. I wish to thank them for always being available when I needed their advice. Moreover, they were excellent teachers especially, when it came to casino games and tennis. During the early period of my research, the Bond Algorithm Group helped me to solve some problems in relation to understanding different aspects of algorithms.

Thanks to Les Berry from RMIT for his significant advice in teletraffic engineering, and to Zheng Da Wu for his advice on networking issues. Marcus Randall deserves thanks for sharing his experiences in Simulated Annealing, and Elliot Tonkes for helping me to solve mathematical equations. I wish to thank James Montgomery for giving me the opportunity to continue his research on 'gennet', which I have used as a starting point for my own research, and for proofreading my work at the end of my research period.

Thanks also, to Margareth DeMestre and Neville DeMestre for their advice. Thanks to Jessica Syme for editing my thesis. Clarence Tan provided advice and challenging questions regarding mobile communication, which sharpened my research. I wish to thank him also for providing the opportunity to learn about neural networking. Additionally, he gave me the opportunity to learn badminton from him and Paddy Krishnan.

I thank Ron Luken from Reach-Telstra, Sydney for giving me the opportunity to learn more about their satellite sites during my research in Sydney. Thanks must go to - Tiok Woo Teo who provided much help with all kinds of technical and non-technical problems - Cyrille Clipet for guiding me through the difficulties of setting up network simulator (ns) and using Linux. I also wish to thank my fellow research students and friends who have 'come and gone' during my long stay in the research room, room 5323 IT School. I am most grateful to all the IT School staff who helped me during my research at Bond.

Special thanks to the ARC (Australian Research Council) large and small grant, which supported our research, and gave me the opportunity to purchase a very useful computer. Thanks also, to BPPT (the Agency for Assessment and Application Technology of Indonesia) which provided the opportunity for me to study overseas, and jointly with the IT School at the end of my study period, provided my allowance and scholarship permitting the continuation of my work.

Finally, I would like to thank my wife and her family, who supported me and accompanied me throughout this long journey of pursuing my doctorate. Her patience and support are highly valued.

Abbreviations and Acronyms

ABR	Available Bit Rate
AMPS	Advanced Mobile Phone System
ARMA	Auto Regressive Moving Average
ATDMA	Asynchronous TDMA
ATM	Asynchronous Transfer Mode
BER	Bit Error Rate
Bpsat	Bent Pipe Satellite
CBR	Constant Bit Rate
CDMA	Code Division Multiple Access
DAMA	Demand Assignment Multiple Access
D-AMPS	Digital AMPS

DCR	Dynamic Control Routing
DCS	Digital Communication System
DDS	Digital Data Service
DNHR	Dynamic Non Hierarchical Routing
DSCP	Differentiated Services Codepoint
EDA	Extended Dijkstra shortest path Algorithm
EDGE	Enhanced Data Rate for GSM Evolution
EIR	Equipment Identity Register
ERP	Effective Radiated Power
ES	Earth Station
ETSI	European Telecommunication Standards Institute
EURESCOM	European Institute for Research and Strategic Studies in
FDMA	Frequency Division Multiple Access
FHRP	Footprint Handover Rerouting Protocol
FIFO	First In First Out

FITCE	Federation of Telecommunication Engineers of the European
GA	Genetic Algorithm
GALPEDA	Genetic Algorithm Linear Programming Extended Dijkstra
GEO	Geostationary Earth Orbit
GPRS	General Packet Radio Service
GSM	Groupe Speciale Mobile, Global System for Mobile communication
GSO	Geosynchronous Orbit
GW	Gateway
HEO	Highly Elliptical Orbit
HLR	Home Location Register
HSCSD	High Speed Circuit Switched Data
HVS	Human Visual System
IETF	Internet Engineering Task Force
ILP	Integer Linear Programming
IP	Internet Protocol

IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISL	Inter Satellite Link
ISO	International Standards Organization
ITU	International Telecommunication Union
IWF	Inter Working Function
JDC	Japanese Digital Cellular
LAN	Local Area Network
LEO	Low Earth Orbit
LHS	Left Hand Side
LLC	Logical Link Control
LOS	Line of Sight
LP	Linear Programming
LUI	Last Useful Instant
MAC	Medium Access Control

MCNSP	Minimum Cost Network Synthesis Problem
MCR	Minimum Cell Rate
MEO	Medium Earth Orbit
MFA	Mean Field Annealing
MMPP	Markov Modulated Poisson Process
MSC	Mobile Switching Centre
MT	Mobile Terminal
ND	Neighbours Discovery
NOCC	Network Operations and Control Centre
NORAD	North American Aerospace Defence Command
OD	Origin Destination
OSI	Open System Interconnection
PASTA	Poisson Arrivals See Time Average
PDC	Personal Digital Cellular
PCN	Personal Communications Network

PLMN	Public Land Mobile Network
PSK	Phase Shift Keying
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RAAN	Right Ascension of Ascending Node
RF	Radio Frequency
RHS	Right Hand Side
RLP	Radio Link Protocol
RRAA	Random Reservation Adaptive Assignment
RSVP	Resource Reservation Protocol
SDMA	Space Division Multiple Access
SGP	Simplified General Perturbation
SGP	Simplified General Perturbation
SIU	Satellite network Interface Unit
Swsat	Intelligent Switching Satellite

TACS	Total Access Communication System
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TDMA	Time Division Multiple Access
TINA-C	Telecommunication Information Networking Architecture Consortium
ToS	Type of Service
TSP	Traveling Salesman Problem
UBR	Unspecified Bit Rate
UDP	User Datagram Protocol
UMTS	Universal Mobile Telecommunication System
VBR	Variable Bit Rate
VBR-NRT	VBR Non Real Time
VBR-RT	VBR Real Time
VLR	Visitor Location Register
Xcsat	Cross Connect Satellit