

LB/DCN/103/07

DEVELOPMENT OF OPTIMUM UTILIZATION OF COMMUNICATION INFRASTRUCTURE. IN THE CEYLON ELECTRICITY BOARD

A dissertation submitted to the
Department of Computer Science, University of Moratuwa
In partial fulfillment of the requirements for the
Degree of Master of Business Administration
In
Information Technology

By

LIBRARY
UNIVERSITY OF MORATUWA, SRI LANKA
Univ MORATUWA wa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

PARAKRAMA BANDARAGE MAHINDA WIJAYSANTHA

Supervised by: **Dr. Lanka Udawatta, University of Moratuwa**
Dr. R. Abeysekara, Ceylon Electricity Board

Department of Computer Science & Engineering
University of Moratuwa, Sri Lanka

December 2006

University of Moratuwa



89437

89437

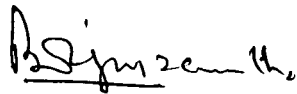
004 06
004 :65(043)

89437

DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.



P.B. Mahinda Wijayasantha

We endorse the declaration by the candidate.



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Signed by each supervisor

UOM Verified Signature

^r
Dr. Lanka Udawatta

UOM Verified Signature

Dr. R. Abeysekara

CONTENTS

DECLARATION.....	I
ABSTRACT.....	IV
DEDICATION.....	VI
ACKNOWLEDGEMENT.....	VII
ABBREVIATION.....	VIII
LIST OF FIGURES.....	XI
1. INTRODUCTION.....	1
1.1 BACKGROUND.....	1
1.2 POWER SYSTEM.....	2
1.3 SYSTEM LOAD AND DEMAND.....	2
1.4 COST OF NOT SERVED ENERGY.....	2
1.5 TRANSMISSION AND DISTRIBUTION SYSTEM.....	2
1.6 SYSTEM CONTROL CENTRE (SCC).....	3
1.7 SUPPORTING BRANCHES.....	4
1.8 CEB COMMUNICATION NETWORK.....	4
1.9 NEED OF A OWN COMMUNICATION SYSTEM.....	6
1.10 THE OPTICAL FIBERS.....	8
1.11 THE BROADBAND POWER LINE [2].....	9
1.12 TECHNICAL DESCRIPTION OF UTILITY COMMUNICATION SYSTEM.....	10
1.13 ACCESS BPL.....	11
1.14 IN – HOUSE BPL.....	12
1.15 POTENTIAL FUTURE SYSTEMS.....	13
1.16 ADVANTAGES OF BPL[2].....	13
2 PROBLEM STATEMENT.....	15
2.2 PROPOSAL FOR TELECOMMUNICATION NETWORK DEVELOPMENT.....	16
3 RESEARCH EXPECTATION.....	18
3.1 OBJECTIVES OF THE STUDY.....	18
4. LITERATURE REVIEW.....	20
5. IMPORTANCE & BENEFITS OF THE STUDY.....	22
5.1 OPPORTUNITIES AND STRENGTHS.....	22
6. RESEARCH DESIGN.....	25
6.1 ASSESSMENT: -.....	25
6.2 LIMITATIONS.....	26
6.3 DATA COLLECTION & METHODOLOGIES.....	27
6.4 NATURE AND FORM OF RESULTS.....	28
6.5 ANALYSIS.....	29
6.6 OPTICAL NETWORK DESIGN CONSIDERATIONS.....	29
6.7 TECHNOLOGY.....	35
6.8 BACKBONE DESIGN.....	36
6.9 INVESTMENT ON OPGW INSTALLATION.....	38
6.10 WORST-CASE DESIGN.....	39
6.11 COST/REVENUE CALCULATION.....	40
6.12 ASSUMPTION FOR CALCULATION OF PAY BACK PERIOD.....	42
6.13 OTHER INDIRECT BENEFITS.....	48
6.14 OPTIMISTIC SAVING PATTERN.....	49
7 SURVEY RESULTS.....	55
7.1 INTRODUCTION.....	55
7.2 HYPOTHESIS.....	56
7.3 PRIMARY RESULTS.....	57

7.4	SECONDARY RESULTS.....	57
7.5	SURVEY SUMMARY	58
7.5	BPL PILOT PROJECT – IDENTIFICATION	58
7.6	FINDINGS FROM CASE STUDIES	64
7.7	SELECTION OF A PILOT PROJECT BY CEB	65
7.8	BASIC MODEL FOR COLOMBO CITY – BPL PILOT PROJECT IMPLEMENTATION.....	68
8.	DISCUSSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH	70
8.1	DEVELOP A MECHANISM TO IDENTIFY CHALLENGES-COMPETITION.....	73
8.2	TRUNKING MOBILE VHF/UHF	73
8.3	MARKETING	73
8.3	TRAINING	74
8.4	SPARE PARTS- TOOLS.....	74
8.5	REDUNDANCY	74
9.	REFERENCE:.....	75
10.	ANNEX	A
10.1	VPN PAYMENTS /MONTHS.....	A
10.2	ANNEX-SAMPLE QUESTIONNAIRE	C
10.3	ISP PACKAGES.....	F
10.4	FIBER RINGS BY YEAR -2010	J
10.5	EXISTING TELEPHONE SYSTEM.....	K



ABSTRACT

Telecommunication plays a vital role in any business activity and is also so in the case of an electric power utility. The availability and reliability of a telecommunication system is most essential in carrying out the coordination of the Generation, Transmission and Distribution of electrical energy in the country.

This thesis describes the current status of the telecommunication facilities available in the Sri Lankan power system, its usage in day-to-day operation, its limitation in monitoring of the power system and other inherent problems.

The latest technology adopted in most parts of the world for utility communications is the OPGW. The golden opportunity of readily available right of way to the last mile can be used very effectively using this telecommunication practice at competitive prices. Hence the CEB also embarked on this technology and has installed a few OPGW on some High Voltage lines. As the communication capacity is almost unlimited in this type of technology, it is essential to maximize the usage more economically and effectively to solve the communication requirements of CEB.



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

This reports further analyzes the Communication requirements of CEB (Objective 2)

Furthermore, this thesis also describes various areas where one could utilize the technology to resolve System Operations, SCADA, customer related issues, billing & metering etc in a most cost effective manner. The finding has justified the ways and means of utilizing these assets to venture into non-core business activities in the field of telecommunications. (Objective 3)

A commercial licence is required for entering into a telecommunication business. Partnering with the market leader in the telecommunication industry would create a good image among the public.

Investing on fiber optic based telecommunication is the best option for today and even tomorrow. In this study Optical Ground Wire (OPGW), single mode with 1550nm window is selected. It is proposed to have four STM fiber optic rings together with some radial links for the use in the CEB. The extra capacities can be used for doing telecommunication business. Marketing E-1 links has been considered in this study and 10% of the available capacity is the threshold point of project viability. But it is seen that even with low capacity demands for bandwidth (<10%) the indirect benefits are higher than the project cost. Hence the implementation of OPGW project is in any case viable and profitable.

Developing a OPGW network would benefit the CEB in many ways while giving quality service to the public. It is expected that 50% of present telecommunication costs paid to other operators can be drastically reduced together with reduction in Total Energy requirement to the country which would save millions of rupees to the CEB and to the country using sophisticated software. The broadband over power line (BPL) technology has been selected to access the last mile to provide VoiP, video and data, together with other utility requirements in this study. Although the BPL Standard is yet to be published by the authorities, since the basic costs are identified, it is suggested that a pilot project be implemented to see if it is viable. From the available CEB database, the total potential of customers has been identified. The questionnaire results have justified the hypothesis that BPL is the low cost solution to provide Internet to the rural sector. Good marketing strategy and early adaptation of OPGW & BPL can perform better than competitors and at a competitive price. The public sector, Government ministries like Health, Education, Defense and the Agriculture sector etc. can grab the services offered through this technology for the betterment of the country.



DEDICATION

This thesis is dedicated to my beloved parents, wife **Manomanie**, and two daughters **Amanda & Chelsea**, who have always been with me in every hurdle I cleared.

Mahinda Wijayasantha

December- 2006.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

ACKNOWLEDGEMENT

I am most grateful and privileged to have Dr. R.Abeysekara (Chief Engineer (IT), C.E.B) and Dr Lanka Udawatta, University of Moratuwa) as the supervisors for my MBA thesis. Their kind and encouraging assistance with regard to the problem formulation, constructing and comments on the results is greatly appreciated.

I am deeply indebted to all the lecturers of University of Moratuwa who assisted me in various ways; colleagues and friends too numerous to mention here, who have contributed so generously in various stages of this project over a few months. Special mention should make to the engineers in the CEB , Mrs S. Pathirana, Mr H.Atapattu, Mrs A.M.S.R.H Attanayake – Communication branch, Mr.J. Nanadakumar -System Control, Mr A.R.K.Gamage- Distribution Planning branch and colleagues from other departments in CEB.

Many thanks are owed especially to the Head and the Staff of the Department of Computer Science and Engineering, Department of Electronics & Communication, University of Moratuwa, colleagues of the MBA (IT) 2004 batch and the non executive staff of the Communication Branch, CEB for assistance in reviewing, compiling and editing this report.

Not forgetting, I would like to express my sincere gratitude to all concerned, who have filled my questionnaire and helped me in numerous way to make this a success..


P.B.Mahinda. Wijayasantha

December 2006.

ABBREVIATION

ADSS	All Dielectric Self Support
AGM-R4	Additional General Manager –Region 4
AMR	Automated Meter Reading
BPL	Broadband Power Line
CDMA	Code division multiplexing
CEB	Ceylon Electricity Board.
DCN	Data communication system
DGEU	Department of Government Electrical Undertakings.
DGM	Deputy General Manager
DSL	Digital subscriber Loop
DWDM	Dense wavelength division multiplexing
FTTH	Fiber to the home
GIS	Global Information System
GSS	Grid Substation
GWh	Giga Watt hours
HV	High Voltage
ICCP	Inter Control Center Protocol
IEEE	Institution of Electrical & Electronics Engineering
IP	Internet Protocol
ISP	Internet Service Provider
ITU	International Telecommunication Union

KHz	Kilo Hertz
kV	Kilo Volts
KWh	Kilo Watt hours
LAN	Local Area Network
LECO	Lanka Electricity Company
LKR	Lanka Rupees
Mbps	Mega byte per seconds
MHz	Mega Hertz
MIS	Management Information System
MTTR	Mean time to repair
MV/LV	Medium Voltage/Low Voltage
MVA	Mega Volt Ampere
MW	Mega Watt
NCP	North Central Province
NWP	North Western Province
OH	Over Head
OPGW	Optical Ground Wire
PABX	Public Auto Branch Exchange
PLC	Power line Carrier
PLTS	Party line Telephone System
PLTS	Party Line Telephone System
POS	Point of Sale
PUCSL	Public Utilities Commission of Sri Lanka

RF	Radio Frequency
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition Network
SCC	System Control Centre
SDH	Synchronous Digital Hierarchy
SEMA	Strategic Enterprises Management Agency
SLT	Sri Lanka Telecomm
SMF	Single Mode Fiber
STM	Synchronous Transport Module
TDM	Time Division Multiplexing
TELCO	Telecom Operators
TRC	 University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations Telecommunication Regulatory Commission
UG	Underground
UHF	Ultra High Frequency
VHF	Very High Frequency
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
WAN	Wide Area Network
WDM	Wavelength Division Multiplexing
WPN	Western province North

LIST OF FIGURES

Figure 1-GeO ₂ Doped Silica Optical Fiber	9
Figure 2 In house BPL applications (By courtesy of http://www.archnetco.com/images0/network.jpg)	12
Figure 3-Existing Telephone System	15
Figure 4 Fiber arrangement in OPGW	30
Figure 5-South East Asia-Middle East- Western Europe-3 Fiber Connection	32
Figure 6-SEA-ME-WE 4 Fiber Connection -(Courtesy- - <i>About SEA-ME-WE 4.htm</i>)	32
Figure 7- Fiber Ring Arrangement	33
Figure 8-OPGW Stringing -	35
Figure 9 Ring no –1 Traffic 2Mb arrangement	37
Figure 10 - Traffic arrangement and OPGW backbone	37
Figure 11 - Behaviour of IRR	46
Figure 12-OPGW Network	54
Figure 13- Basic Configuration (courtesy: University of Technology, Jamaica)	55
Figure 14- Questionnaire Sent /Received	56
Figure 15- Questionnaire Results Summery	58
Figure 16- CEB Area Boundaries	59
Figure 17-Corinex BPL Summery	61
Figure 18- Colombo City 11kV Network	68
Figure 19-Backbone and BPL Integration (courtesy: www.ambientcorp.com)	70



LIST OF TABLE

Table 1.A Chronology of Great Milestones of Electricity Supply in Sri Lanka	1
Table 2- Length of transmission and distribution lines (Courtesy- CEB Statistic 2005)	3
Table 3 -Design requirements for CEB needs	30
Table 4- Comparison of Fiber Optic Cables	30
Table 5-Fiber Loss Budget Calculation	34
Table 6-Traffics in Rings	38
Table 7-Traffic arrangement at Sections of Sharing of rings	38
Table 8-The OPGW Deployment	38
Table 9-Total cost for Backbone and STM Multiplexer requirements	39
Table 10-Revenue Model from STM - 16 Rings	40
Table 11-Revenue Model from STM - 4 Rings	41
Table 12 -Initial Revenue Generation Pattern	41
Table 13-Yearly Revenue Pattern Due to increase in Demand by 8%	42
Table 14 - Payback Calculation (Table A1-A8)	45
Table 15-Summery of the business model	46
Table 16 -Telephone Expenditure Statement- Year -2005	47
Table 17-CEB Telephone/TRC Bills -2005	47
Table 18-Average Unit Costs of Various Diesel Power Plants up to July 2006	48
Table 19 - Additional Energy that could have been delivered	48
Table 20 - Saving Pattern	49
Table 21 - Optimistic Revenue Model	50
Table 22 - Revenue Model with 15% Capacity Sold	50
Table 23-Proposed Fibre optic Backbone links	53
Table 24-Number of Substation (Courtesy- CEB Statistic 2005)	54
Table 25-Survey questionnaire Results summary	56
Table 26-Primary Results	57
Table 27-Corinex Case Study	61
Table 28- Finding from BPL case studies	64
Table 29- July 2006 Ordinary Electricity Bill above 2000 Rupees in Sri Lanka	66
Table 30-Basic Data for a Pilot Project in Colombo City	67
Table 31- Potential customers, Area wise in Colombo City	67