IMPLEMENTATION OF INTEGRATED SYSTEMS MONITORING TOOL FOR POWER AND NETWORK APPLICATIONS IN EXPRESSWAYS

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Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science

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DECLARATION

"I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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N. R. E. Jayasuriya Date

The above candidate has carried out research for the Masters under my supervision.

…… …….

Dr. D. P. Chandima Date

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Prof. N.K. Wickramarachchi Date

Abstract

With the rapid development of information and communication technology, use of electronic and telecommunication based systems is increasing day by day. It improves the efficiency and quality of most of the traditional work flows by replacing fully manual operation procedures with fully automated systems or with partially automated operation with significantly reduced number of staff.

Operation of all modern expressways uses such systems significantly in large geographically distributed area for efficient management of expressways with enhanced comfortability and safety. But it will add an additional workload on expressway maintenance team to manage all critical systems in operation with minimum or theoretically with zero downtime.

System monitoring is one of the key elements in systems operation to verify its operation. It helps system maintenance team to identify the status of the system remotely. But, the system monitoring has not been implemented completely in Sri Lankan expressways, causing difficulties to identify system problems as soon as they occur. It was understood that this factor has major impact on the reliability of the systems operation by studying past operation experience. Hence the objective of the proposed design is to improve availability and reliability by minimizing down times of IT and Electronic systems in the expressway.

During the first part of this research, operation of two similar scenarios was selected for background study. Initial study is from Japan, which is a country of having more than fifty year experience of operation of the expressways and related facilities. Second study is performed with Sri Lanka Telecom, the pioneer of the telecommunication industry in Sri Lanka. Reliability analysis was performed based on the log book entries of the systems maintenance team of Southern and Outer Circular expressways in Sri Lanka, to identify possible scenarios of faults occurred and how its effect on the reliability of critical systems and challenges faced on identification of faults during corrective maintenance sessions.

As the second part, theoretical design of an integrated systems monitoring application was carried out by following modular design approach. The design is covered all critical functional blocks of a monitoring system with a model for performance analysis. The new design consists of several improvements over conventional monitoring systems to enhance the functionality. Several methods were designed for alarm optimization to reduce number of repetitive alarms. Heuristic knowledge base was linked with the designed monitoring system, hence it ensures that the maintenance personal is updated with its all history records before attending to the repair.

Implementation of designed monitoring system was completed in all critical components. It included both software and hardware module implementation and deployment. All modules use open protocols and open source software components.

Several functional tests were carried out with their performance values both in a test bed and in the production environment. The results indicated that the system is working as expected and help to improve the availability of systems through proposed methodologies.

Index Terms— Alarm optimization, Failure modes, Fault detection, Integrated monitoring, Protocols, Redundant systems, System reliability and availability

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TABLE OF CONTENTS

Declaration of the candidate & supervisor i
Abstract ii
Acknowledgement iii
Table of Content iv
List of Figures vii
List of Tables ix
List of Abbreviations x
List of Appendices xi
1. Introduction 1
1.1 Use of electronic and telecommunication based systems in modern expressway operation 1
1.1.1 Toll collection system 1
1.1.2 Closed Circuit Television system 3
1.1.3 Voice communication system 3
1.1.4 Intelligent transport systems 4
1.1.5 Data communication systems 5
1.1.6 Management systems 5
1.2 Operation, maintenance and management requirements of systems 5
1.2.1 Corrective and preventive systems maintenance 5
1.2.2 Requirement of systems monitoring and management 6
1.3 Problem statement 8
1.4 Aim and objectives 12
1.5 Approach and methodology in brief 13
1.6 Structure of this document 14
2. Literature Review 16
2.1 System operation study in Japanese roads and expressways 16
2.1.1 System operation and maintenance 16
2.1.2 Fault detection mechanism example in Japanese systems – Traffic light system 17
2.2 Systems operation study at Sri Lanka Telecom 21
2.3 Commercially available systems for fault detection & monitoring 22
2.4 Observations on systems operation and management 24

3. System Reliability Analysis 26
3.1 Measures of systems reliability 26
3.1.1 System reliability parameters 26
3.1.2 Failure models and responses 28
3.2 Reliability analysis of expressway emergency call system 32
3.2.1 Method of data collection and analysis 32
3.2.2 Observations and conclusions from reliability analysis 38
4. Monitoring System – Conceptual Design 39
4.1 Monitoring system – Main functional blocks 39
4.2 Conceptual design of communication control application and event Observer 40
4.2.1 Interfaces available for data collection 40
4.2.2 Methods of data collection 41
4.3 Conceptual design of batch processing application and data store 42
4.3.1 Forms of collected and reference data and method of basic faults detection 43
4.3.2 Procedure for fault alarms optimization and the concept of integrated fault monitoring 44
4.3.3 Alarm processing with heuristic knowledge base 47
4.3.4 Data storage design 47
4.4 Conceptual design of monitoring control application 48
4.5 Total system architecture 49
4.6 Theoretical models for empirical performance analysis 49
4.6.1 Time to detection 50
4.6.2 Monitoring system reliability and stability 56
5. Monitoring System – Implementation 58
5.1 Method of interconnection 58
5.2 Data acquisition sensor module implementation 59
5.2.1 Detailed implementation details of main module 61
5.2.2 Detailed implementation details of sub modules 66
5.3 Monitoring system application software development 70
5.3.1 Implementation of communications control application 71
5.3.2 Implementation of batch processing application 73
5.3.3 Implementation of monitoring control application 74

5.3.4 Database system implementation 76
5.3.5 Additional security measures added to the design 77
5.4 Short message service server application development 77
6. System Testing and Results 79
6.1 System function tests and results 79
6.2 Integration setup and tests 85
6.2.1 Integration with power distribution panel in main server room 85
6.2.2 Link state monitoring through SNMP 87
6.2.3 Tests on service state monitoring through log analysis 88
6.2.4 Tests on automation scripts support 88
6.3 Summary of test results 90
7. Conclusions and Recommendations 92
7.1 Improvements added over conventional monitoring systems 92
7.2 Disadvantages in this design 93
7.3 Identified fields of improvements and recommendations 93

Annex List 94
Reference List 123
Appendices 127

LIST OF FIGURES

		Page
Figure 1.1	ETC tag and ETC reader	2
Figure 1.2	Multi-lane free flow toll station	2
Figure 1.3	ITS structure in Japan	4
Figure 1.4	Network management application	11
Figure 1.5	System generated error notifications	11
Figure 2.1	Simplified traffic light control system in Japan	18
Figure 3.1	Failures, faults and errors	27
Figure 3.2	State of the equipment at time *t* vs. time to failure	29
Figure 3.3	Distribution function *F(t)* and probability density function *f(t)*	30
Figure 3.4	Reliability function *R(t)*	30
Figure 3.5	Availability of series and parallel redundant systems	31
Figure 3.6	Actual systems availability of 1969 call system in year 2015	35
Figure 3.7	Predicted systems availability	37
Figure 4.1	Simplified architecture of monitoring system	39
Figure 4.2	Simplified architecture of data processing element	43
Figure 4.3	Alarm optimization for series systems	45
Figure 4.4	Alarm optimization method for complex systems	46
Figure 4.5	Data provision system design	48
Figure 4.6	Total system architecture	49
Figure 4.7	Detection and processing delays	50
Figure 4.8	Detection of network node outage	55
Figure 4.9	Method of redundant check points	57
Figure 5.1	Method of interconnection	59
Figure 5.2	Sensor module tropology	60
Figure 5.3	Block view of main module hardware	62
Figure 5.4	Prototype main module	62
Figure 5.5	Power supply arrangement from main module	67
Figure 5.6	Self-powered arrangement with common plane for signals	67
Figure 5.7	Block view of sub module design	68
Figure 5.8	Prototype sub module hardware	69
Figure 5.9	Monitoring system application	71

Figure 5.10	Defining parent ID with an entity	74
Figure 5.11	Screenshot of the monitoring application	76
Figure 5.12	SMS modem unit	78
Figure 6.1	System test setup 01	80
Figure 6.2	Practical test setup 01	80
Figure 6.3	System test setup 02	83
Figure 6.4	Test setup for automation script	89
Figure 6.5	Flow of simple test automation script	89
Figure 6.6	Automation test setup	90

LIST OF TABLES

		Page
Table 1.1	Preventive maintenance schedule on southern expressway CCTV system	6
Table 1.2	Present methods used for system faults detection	9
Table 2.1	Systems monitoring methodologies in Japan	17
Table 2.2	Systems monitoring methodologies used in Sri Lanka Telecom	21
Table 2.3	Commercially available systems for systems monitoring	22
Table 3.1	Key performance levels	26
Table 3.2	Reasons for systems breakdowns at year 2015	33
Table 3.3	Actual availability of equipment at year 2015	34
Table 3.4	Predicted availability of equipment with an integrated monitoring for year 2015	36
Table 4.1	Types of interfaces available for systems monitoring	40
Table 4.2	Data collection from system interfaces	42
Table 4.3	Type of references and method of detection	44
Table 4.4	Empirical time delays	51
Table 5.1	LED indications	65
Table 5.2	Method of decoding raw data	73
Table 5.3	Human machine interface – function list	75
Table 6.1	Basic tests and results – Setup 01	81
Table 6.2	Basic tests and results – Setup 02	84
Table 6.3	Monitoring tests on the server room power distribution panel	85
Table 6.4	Monitoring tests on the call system network	87
Table 6.5	Summery of basic tests and results comparison	90

LIST OF ABBREVIATIONS

Abbreviation		Description
A/D	-	Analog to Digital
AC	-	Alternating Current
BPA	-	Batch Processing Application
CCA	-	Communication Control Application
CCTV	-	Closed Circuit Television
CUCCX	-	Cisco Unified Contact Center Express
CUCM	-	Cisco Unified Communications manager
DAQ	-	Data Acquisition
DC	-	Direct Current
EEPROM	-	Electrically Erasable Programmable Read Only Memory
ETC	-	Electronic Toll Collection
HMI	-	Human Machine Interface
HTML	-	Hypertext Markup Language
HTTP	-	Hyper Text Transfer Protocol
HTTPS	-	Hyper Text Transfer Protocol - Secure
IP	-	Internet Protocol
IT	-	Information Technology
ITS	-	Intelligent Transport System
LED	-	Light Emitting Diode
MCA	-	Monitoring Control Application
MCB	-	Miniature Circuit Breaker
MCU	-	Microcontroller
MDT	-	Mean Down Time
MTBF	-	Mean Time Between Failures
MTC	-	Manual Toll Collection
MUT	-	Mean Up Time
QM	-	Quality Management
RAM	-	Random Access Memory
RCD	-	Residual Current Circuit Breaker
REST	-	Representational State Transfer
RMS	-	Root Mean Squire
SFTP	-	Secure File Transfer Protocol
SMS	-	Short Message Service
SNMP	-	Simple Network management Protocol
TCP/IP	-	Transmission Control Protocol/Internet Protocol
UDP	-	User Datagram Protocol
UPS	-	Uninterruptable Power Supply
XML	-	Extensible Markup Language

LIST OF APPENDICES

Appendix	Description	Page
Appendix 01	Gathered information from Sri Lanka Telecom	127
Appendix 02	Main module circuit diagram and module firmware	
Appendix 03	Sub module circuit diagram and module firmware	
Appendix 04	Full code base and database structure of monitoring system	
Appendix 05	SMS server code base including serial port driver	
Appendix 06	Video evidnce for integrated testing	

Note: Appendix 02 to 06 is available on the provided compact disk (CD).