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

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Degree of Master of Science

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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.

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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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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

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