UNIVERSITI PUTRA MALAYSIA

INTERNET - BASED SECURITY AND MONITORING SYSTEM

ISAMELDIN MOHAMMED SULIMAN

INTERNET-BASED SECURITY AND MONITORING SYSTEM

By

ISAMELDIN MOHAMMED SULIMAN

Thesis Submitted in Fulfillment of the Requirements for the Degree of Master of Science in the Faculty of Engineering Universiti Putra Malaysia

November 1998

To my parents and sisters

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to my supervisor Dr. Abd Rahman Ramli. This thesis would not have been done without his support, encouragement, comments. Thanks and appreciation is extended to the members of the supervisory committee Dr. Mahmud Hassan and Mrs. Roslizah Ali.

I would also like to express my thanks to the staff at the Graduate School Office for their help and cooperation. My appreciation and gratitude to all of the individuals at the Department of Computer and Communication System Engineering, cooperative.

I gratefully acknowledge the support of Ir. Dr. Norman Bin Mariun the general manager of Control and Automation System Center (CASC). My thanks and appreciation to my colleagues at the CASC for their help and suggestions during the research work.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AC	Alternating Current
AWT	Abstract Windowing Toolkit
CCTV	Closed-circuit TV
CGI	Common Gateway Interface
CPU	Central Processing Unit
DAA	Data Access Arrangement
DC	Direct Current
DCE	Data Communication Equipment
DLAB	Divisor Latch Access Bit
DTMF	Dual Tone Multi-frequency
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EOI	End of Interrupt
FIFO	First In First Out
GUI	Graphical User Interface
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IER	Interrupt Enable Register
IRQ	Interrupt Request
ISR	Interrupt Service Routine

JVM	Java Virtual Machine
LAN	Local Area Network
LED	Light Emitted Diode
MSR	Modem Status Register
OOP	Object Oriented Programming
PC	Personal Computer
PIC	Programmable Interrupt Controller
PSTN	Public Switched Telephone Network
PWS	Personal Web Server
RI	Ring Indicator
RISC	Reduced Instruction Set Computing
ROM	Read Only Memory
RTS	Request To Send
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition
TCP/IP	Transmission Control Protocol/Internet Protocol
UART	Universal Asynchronous Receiver/Transmitter
URL	Uniform Resource Locator
WWW	World Wide Web

Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science.

INTERNET-BASED SECURITY AND MONITORING SYSTEM

By

ISAMELDIN MOHAMMED SULIMAN

NOVEMBER, 1998

Chairman: Abd Rahman Ramli, Ph.D.
Faculty: Engineering

This study describes a remote monitoring and security system based on the Internet. It is intended to investigate the possibilities of using the integration of the Internet and telephone lines in providing solution to security problems by conveying alarm signals from remote monitored locations.
developed to allow selected users to get monitoring and security information. A special purpose web server was designed to handle the system. This web server which is acting as a central monitoring station will supply the system's users with information reporting any intrusion at remote monitored locations

The system utilised the existing telephone network,
and user friendly in alarm transmission from remote monitored location.
modem was used to maintain interface between the telephone line and the web server.

data capturing from the modem through the serial port

web server. Java language was used for developing a server program that is running in the background to enable data provided by the communication program to be put on the Internet for access. A graphical user interface (Java applets) implemented to allow users to access the system.

The results of applying this approach showed the possibilities of using the integration of the Internet and telephone lines in conveying alarm signals and control command. It also emphasised the import

developing software programs for Internet-based systems. Furthermore,

is still required to fill the low-level interface gap that was not supported by Java language. Finally,

Internet can be used not only for information exchange and retrieval,

as a communication medium for monitoring and controlling of remote physical environments.

Abstrak tesis yang dikemukan kepada Senat Universiti Putra Malaysia
untuk ijazah Master Sains

SISTEM KESELAMATAN DAN PEMANTAUAN BERASASKAN INTERNET

Oleh:

ISAMELDIN MOHAMED SULIMAN

NOVEMBER, 1998

Pengerusi: Abd Rahman Ramli, P.hD.

Fakulti: Kejuruteraan

Kajian ini menerangkan satu sistem pemantauan dan keselamatan jarak jauh menggunakan internet. Tujuan kajian adalah untuk menyiasat kemungkinan menggunakan integrasi talian telefon dan Internet untuk menyelesaikan masalah keselamatan dengan menghantar isyarat penggera dari lokasi jauh. Halaman web dibangunkan untuk membenarkan pengguna mendapatkan maklumat bagi pemantauan dan keselamatan. Komputer perumah (pelayan WWW) bertindak sebagai stesen pemantauan pusat yang menyediakan kawalan keselamatan dan laporan maklumat keadaan sistem pengguna di lokasi pemantauan pada jarak jauh. Satu pelayan web dibina khusus untuk mengawal sistem ini.

Sistem ini menggunakan rangkaian telefon yang sedia ada, yang mana ia lebih kos efektif dan senang dipakai dalam penghantaran isyarat penggera dari lokasi jauh. Satu modem dalaman digunakan untuk mengantaramukakan talian telefon dengan pelayan web. Program komunikasi yang dibangunkan dalam bahasa C bertanggungjawab untuk

mendapatkan data dari modem melalui pangkalan bersiri dan menghantar data itu kepada pelayan web. Bahasa Java digunakan untuk membangunkan satu program pelayan yang lari pada latar belakang supaya data yang diberi oleh program komunikasi boleh dipaparkan pada internet untuk dicapai. Satu pengantara bergrafik (Java Applet) dibangunkan supaya pengguna boleh mencapai sistem tersebut.

Keputusan daripada perlaksanaan kaedah ini menunjukkan kemungkinan untuk mengguna integrasi internet dan talian telefon dalam menghantar isyarat penggera dan arahan kawalan. Ia juga menitikberatkan kepentingan bahasa Java dalam pembangunan perisian untuk sistem berasaskan internet. Selanjutnya, bahasa C masih diperlukan untuk memenuhi ruang aras rendah yang tidak dapat dilakukan oleh bahasa Java. Secara kesimpulan, kajian yang diterangkan ini telah membuktikan bahawa internet boleh digunakan bukan hanya kepada pertukaran maklumat dan capaian, tetapi ianya boleh digunakan sebagai perantara komunikasi untuk pemantauan dan kawalan persekitaran fizikal pada jarak yang jauh.

CHAPTER I

INTRODUCTION

Computer networks and data communications are of great importance in today's information society. Data communications is used to extend the power of computers and allow computer facilities to be accessed at remote sites. The emergence of advanced networking capabilities and the availability of software and information components makes it easier to implement networked data acquisition systems that is used to support a wide range of applications like telemedicine (Koblas and Stienbakk, teleconferencing (Kirstein,
applications.

Within the Internet,
integrative platform to access Internet services.
distributing and sharing information. WWW offers a suitable infrastructure that integrate computer-based services from multiple platforms and provides flexible and effective tools for examining and monitoring remote physical environments. The adoption of new Web-based systems will allow for higher level of interaction between users at remote clients and servers.

The design and installation of security systems employs a wide variety of techniques,

specific applications (Traister,

systems to become highly efficient and flexible. Alarm signal transmission is the most import

communication systems have been used for alarm signalling. Telephone lines over the years have proved extremely reliable which provides a practical solution consistent with both security and costing. Moreover,

the security considerably.

The work described in this study is an attempt that has been made to use the integration of the Internet and telephone lines in security systems. The intense interest in propert

Monitoring services are needed for several reasons;

location, away

The thesis outlines an approach used to build reasonably interactive security system,

presents the benefits brought and limitations imposed by using the WWW and Java language in developing real-time applications.

of how modern technology can be used to provide security services.

Benefits of a Web-Based Environment

Within the past few years,

network connecting modest number of research institutions to a backbone connecting individuals,

infrastructure (Lamm and Reed,

convenient way to access information in the Internet. Moreover,

language as an effective tool for extending functionality and improving performance of the Web will facilitate utilising the Internet in building real-time applications.

The protection of property against attacks is the aim of any security procedure. Many types of security systems are used to support protection of human property,

range from private protection (homes)

continuously scanning the area under monitoring,

whenever intrusion is detected.

the ability to provide many services (communication,

enhance security system in several ways.

Internet could be used to supply visual and audio information to a security guard at a central monitoring station as well as security system users around the world.

Objectives

The objectives of the Internet-based security and monitoring system are as follows:

1. To investigate the possibilities of using the integration of the Internet and telephone lines in providing solution to security problems by conveying alarm signals from remote monitored locations.
2. To establish a web server that acts as a central monitoring station to receive alarm signals and to enable information to be put on the Internet for access.
3. To implement a graphical user interface (Java applets)

   web server.

Thesis Organisation

The thesis consists of six chapters.

objectives of the project. In Chapter II a literature review on security systems and alarm signalling is provided. Chapter III gives theoretical background of the tools that are used in building the system. Chapter IV gives a general description of the system.

provides methods used for the software development. The system's performance and results are discussed in chapter V.

summarises the conclusions and directions of future efforts.

CHAPTER II

REVIEW ON SECURITY SYSTEMS AND ALARM SIGNALLING

Introduction

The need for security systems in all types of buildings becomes a necessity with the increase in crime rate. Alarm and monitoring systems can be used to prevent crime. By protecting places such as homes,
guards and patrol officers can spend more time in areas with high crime rates and with fewer premises protected by alarm systems. This chapter will review the components of security and monitoring systems,
have been used in designing and building of security systems.

Security and Monitoring Technology

Security and monitoring systems were originally introduced as a means to protect people and property by drawing attention to a problem in its beginning stages so that the problem can be controlled through quick action. The use
the fight against crime is not new. When electricity was put to practical use around the

later part of the last century, methods were devised to use door bells, entrance detectors, and manually operated fire alarms for signalling devices (Traister, 1990). In 1858, Edwin began the first central office burglar alarm system (Cunningham, 1988).

The two basic signal circuits that were used for security and fire alarm systems are open and closed circuit. The advantage of the open circuit technique was the reduced cost in providing alarm protection. However it has certain drawback as a wire to one of the sensors could be cut and there would no means of detecting it. To avoid difficulties of the open circuit (Capel, 1989), the closed circuit technique came into general use. In the early 1960s, closed circuit TV (CCTV) was introduced (Fennelly, 1997) to provide a useful supplement to an intruder alarm system, particularly in large building complexes. In an effort to improve security systems, multiplexing circuits were used to transmit multiple alarm signals using a common carrier. Another major improvement in security systems was the change from analogue to digital data transmission which made it possible to apply the capabilities of digital computers for security systems (Hopf, 1979).

Security alarms consists of several functional parts. Sensors to detect the action or penetration of an intruder, control unit that is used to receive, process and transmit alarm signal to a central station, communication medium, and a central monitoring station that operates for 24 hours a day to supervise, record, and maintain alarms (Fennelly, 1997). When an alarm or monitoring information is to be transmitted, the medium of communication can be in the form of:

1. Power line. The power mains are used to transfer alarm signal from the monitored locations to the central station. The use of power lines as the transmission medium in a facility could significantly reduce cabling costs (Halbig, *et al.,* 1994).
2. Cabling. A dedicated cabling system is run from the protected location to the central monitoring station. The disadvantage of the direct cabling system is the high cost of the dedicated line.
3. Telephone. The most common cost-effective form of alarm monitoring has been via telephone lines. If an alarm device wishes to communicate with the central station, it will instruct the dialler to dial the monitoring station reporting the alarm information.
4. Radio signal transmission. This method takes the alarm signal from the protected locations and sends it via radio frequency to a central monitoring station.

Supervisory Control And Data Acquisition (SCADA) is an industrial measurement and control system consisting of a central host usually called a master station, one or more remote terminal units (RTU), communication medium and a collection of software used to monitor and control remote located data field elements. SCADA applications includes monitoring and control services for fire, security, building management as well as meter reading and control for utilities such as gas, water and electricity. The overall performance of SCADA system depends on satisfactory performance of the integral data communication links (Bruce and Lee, 1994). SCADA covers large geographic areas and rely on variety of communication interfaces between RTU's and the master station. Transmission of data could take place over the power

line, radio frequency link, twisted pair network in addition to a normal telephone line. The data acquisition is accomplished by RTU's scanning the field input connected to the RTU to detect alarm conditions, and if an alarm is detected it will be sent to the master station. SCADA carry out all necessary analysis and control, and then display this data on a number of operator screens.

Intrusion Detection and Monitoring Systems

In the past, security systems that implemented CCTV were forced to use expensive television equipment. However, Christoffersen (1990) showed that the PC-based CCTV system is a highly functional alternative to conventional video system equipment as it could offer reduced cost and reduced amount of software and hardware maintenance besides the equipment is of compact size. According to Barry (1993), improved capacity links have enabled the development of high data sensors such as remotely controlled camera and imaging units. Laura (1994) showed that a storage area can be monitored by collecting a basis image representing the monitored area and then continuously monitoring the area to detect changes in the monitored area.

In many video surveillance applications used for intrusion detection, a variety of factors lead to some errors like varying illumination conditions, small camera motion, rain, etc. Michael, *et al*. (1996) solved these problems by applying compression techniques to transmit video images to a surveillance centre using digital network. Although sending video images to the central monitoring station eliminates false alarms

by allowing central station operators to see what is happening inside the protected area, the video images and detection results have to be transmitted to the surveillance centre. Therefore an individual transmission channel is required for each sensor connected to the monitoring centre. In addition, as the video signal is transmitted, the connection needs high bandwidth, as a result the costs increase with the distance and number of connections.

Centralised monitoring and security systems have been in use for many years but increasing demands for expansion, flexibility and system integrity along with the cost have exceeded the capabilities of the traditional systems. Key to the establishment of security systems is a robust and well designed communications network. However. a separate communication networks for security only is expensive and not necessary (William, 1989). A new concept has been developed which allows for sharing resources to provide security measures in a cost-effective manner. The most important resource which may be shared is the data network. Johnson, *et al.* (1994) developed a remote monitoring system by utilising network cable to collect data from sensors and store them in storage medium. These data are remotely monitored via telephone. They concluded that number of technologies could be combined to introduce new approaches to provide unattended remote monitoring of facilities.

Another technique of alarm signalling is the utilisation of optical fibres which are used to communicate restricted data, transmit CCTV pictures and detect intruders moving across restricted areas. Hawkes (1995) described a study on a fibre optic