CHAPTER I

INTRODUCTION

This research presents an Internet-based solution for the implementation of SCADA systems. Based on Internet and web-based environment, the solution makes the idea of utilizing Internet in industrial processes more obvious in both upgrading the existing systems and in building the new ones.

The introduction chapter talks about the motivation of the idea, the objectives that the author wished to achieve and the scope of the research as well as the methodology to fulfill the stated objectives.

1.1 Motivation

The motivation part describes in deep details what lies behind the term "SCADA" and the reason why Internet is chosen to be the communication network after a careful consideration on other choices.

Nowadays, Internet is becoming one of the most common terms for all people in the world. The development of Internet has been placing itself not only in the position of sharing information as its very first aim, but also in various applications such as entertainment, and files and information storage as well as in industrial processes.
Focusing on the industrial purpose of Internet-based applications, we see that Internet is most widely deployed in SCADA systems. SCADA is the most common type of telemetry systems in various sectors. SCADA systems provide the users the ability to access, monitor information and data of their equipment and processes, and to issue control commands on large, complex and mission critical installations like power stations, oil/gas pipelines (for measurement and control of outward flow power/energy and oil, gas respectively), irrigation systems.

SCADA is no longer a new concept in the recent years. However, the ways to implement the SCADA systems have been still being developed with the technology's advance in both hardware and software. Of all the problems concerning the implementation, the **communicating medium** and the **data transfer speed** are the most concerns.

In order to solve these problems, there are several communication options which have been proposed so far. The pros and cons of each of the options will be discussed, a conclusion is withdrawn afterwards.

1. Leased Lines.

Leased lines have been used in SCADA systems for many years. These lines were used to connect many Remote Terminal Units (RTUs) in the field together, and then they were pulled back to the master station which was normally many miles away from the field. With this kind of systems, it is neither easy nor economical to place the communication processing close to the RTUs in the field.

Additionally, the number of RTUs is limited due to the very complex wiring job. Once the wiring job has been done, it will be hard and not flexible to be replaced with any new kind of communications without having to remove and re-wiring everything.

2. Radio Systems.

Radio communication is used to reduce the cost of connecting the RTUs to the master station or even among the RTUs. In most cases, it depends on a Line of Sight environment to operate, and it is better if there is a clear path between two antennas in a radio system. However, it brings the complexity to the RTUs and it requires a lot of multiple repeaters. Besides, in recent years, a big number of unlicensed radio systems have been introduced and it causes the big interference to the existing licensed systems operating at the same frequencies.

3. GPRS.

GPRS, which stands for General Packet Radio Service, is a technology to get many working stations connected without wiring. GPRS requires no Line of Sight environment to operate, but with the nature of radio communication, it inherits the disadvantages, which have been discussed above, of radio systems. In addition, there are some more issues we have to consider such as:

- Data are sent in packets and then a big amount of data have to be broken into several smaller parts, this causes the high probability for the data to be lost.
- No confirmation of data delivery. We need to develop an appropriate protocol to solve this problem.
- The data transfer speed is quite low due to the reason that many procedures must be established before the actual data is sent. This is not suitable for industrial processes where real-time issue is the biggest concern.
- The cost of GPRS service is currently high.

- GPRS depends much on the hardware.
- For the stations which are far away from the Global System for Mobile Communications (GSM) base station, the connection may be dropped down at any time.

4. Satellite.

Satellite communication allows a very wide communication range. However, it does bring some obstacles as follows:

- It is necessary to have a clear view of the sky.
- Very high cost and complex installation.

Satellite is normally used for special purposes such as earth observation, military jobs or astronomy researches.

5. Internet.

Internet originates from the term *Internetworking. Internetworking* is used to describe a scheme that provides the universal services among heterogeneous networks, despite of their incompatibilities in network topologies. This scheme uses both software and hardware. Additional hardware are used to interconnect a set of physical networks. Software on all the attached computers provide the needed services. An internet is not limited in size and in the number of attached computers.

Nowadays, internet is almost provided in every corner of the world. For the industrial systems and processes, most are SCADA systems; Internet also plays an important role with its many great features.

SCADA systems, which were previously difficult or costly to implement, now are much easier, faster and with lower cost by means of Internet with most outstanding points as stated below:

- Internet creates a standard-based system which leverages the existing computers and communication technologies to achieve optimum system functionalities. It provides the openness for a multi-vendor environment, allowing the interoperability among various system components regardless of the vendors.
- Internet makes it easy to run a SCADA system because the internet browsers are known to anyone who has ever worked with Internet. This translates to less training and faster learning.
- The use of standard, vendor-independent hardwares and softwares requires lower training cost both for operator and maintenance staffs; therefore reducing the total operating cost of the system.

Besides, Internet may bring problems about system performance, security, network's traffic and reliability. Nevertheless, the recent advances in internet technology are promising to prevent all of these limitations. How they make it will be stated in details with the given solution in the later part of this proposal.

Conclusions:

Of all the communication options discussed above, Internet turns out to be the best choice compared with others. Internet is becoming a big trend in designing and implementing most industrial processes. It is a good choice for both upgrading the existing SCADA systems and building the new ones because it can eliminate most of the problems which have been faced by other methods and bring many new features. Therefore, Internet is chosen in this research.

Not only the advantages of Internet, but also the hope to improve the problems we might have faced in deploying Internet into SCADA systems has motivated the research. Chapter 2, which is the literature review content, will give a clearer view on those kinds of problems and it deepens the wish to do this research in order to have a better and better performance achieved for SCADA systems.

1.2 Objectives

The thesis is setup with several objectives as follows:

1. To study and apply Internet and Internet-related technologies to SCADA systems.
2. To provide a solution to upgrade the performance in all aspects of existing or the newly-built SCADA systems by using embedded TCP/IP Protocol Stack and ADSL technology.
3. To implement the proposed solution by building a small demonstration system under a software simulation scheme.
4. To evaluate the system's performance on three criteria: operating cost, system's flexibility and real-time issue.

1.3 Scope of Thesis

This thesis presents an implementation of an Internet-based SCADA system.

1. A small demonstration system is built with the following components:

One server PC with IIS 5.1, .NET Framework 2.0 and MySQL 4.1; one client PC with Internet browser; an ADSL router + modem and one computer where the simulated device is installed; Visual C# is to be used as the programming language

2. Expected test results:

- Four security layers: By User Authentication, By User Permission, By IP Approval and By Router Configuration.
- Devices are simulated by using Visual C# and Matlab. Control commands are to be placed on these devices and feedback data will then be displayed graphically and numerically.
- Data transmission speed and time are displayed on the system's web-based interface.
- The average cost for hardware installation, software development and the system integration is also given.

1.4 Methodology

To achieve the mentioned objectives, those steps below are followed strictly:

1. **Do literature review.**

This is the content depicted in chapter 2. The literature review is a very important part in any research. Doing the literature review helps us coming out with what have been discussed on the chosen topic and what the existing problems are. This motivates the research and helps defining exactly what the researchers need to do to achieve a good and high quality study.

2. **Set up system hardware**, do small and simple experiments to make sure the solution satisfies the thesis objectives.

- All the hardwares mentioned in the scope are to be purchased.
- A router is connected to an ADSL line which is registered with the ISP. The server computer and the two Ethernet IO boards are connected to the LAN ports on the router. Once this step is done, the boards are able to be accessed over Internet and the server computer is ready to run the web-based application software.
- A Visual Basic program is written to test the connection over Internet to the boards. Once this step has been done, we have the imagination about what is going to be

included in the simulated devices in order to exactly reflect the operation of the real devices.

To finish the hardware installation work is a very important point in term of making the proposed idea obvious and doable. This step, once has been done, also gives motivation to the further works to finish the entire thesis.

3. Write and defense the proposal.

The thesis proposal, which summarizes the draft content of the thesis skeleton including the introduction, literature review, proposed solution with intended hardware and software, are written after having the second step done. The proposal step is very important since it will help determine whether what have been proposed is proper and what more should be included in the research to make it more appropriate with the master degree level.

4. Study software tools.

All of the needed software tools to complete the thesis are introduced in the chapter 3. Much time is required on this step in order to have an understanding which is deep and wide enough to build up all the system's functions.

5. Develop system software and **complete system integration.**

- After the study on all software tools have been completed, the system's software is intended to build with the most important following parts:

1. Database Design

All system's data are stored in the database. A good database is of high demand to provide a smooth and high system's functionality.

2. Web-based Interface & Device Simulation

- .Net programming promises to give an easy-to-use and friendly interface to user. The interface is accessible via conventional Internet browsers.

- Devices are simulated by both Matlab and .NET Visual C#. This reduces the design flexibility but it does require a careful study on Matlab and more time on programming.

6. Write thesis.

After getting all the system's output, all the contents which have been done throughout the research are put in the thesis in a well-organized format.

7. Take the oral defense.

The final step of the thesis is the oral defense. Here, all of the proposed contents in the proposal are proved to be achieved and fulfilled. It is also important to show that all the system's functions work and satisfy the pre-defined criteria.

1.5 Contributions

The research is expected to give some outcomes as follows:

1. The use of embedded TCP/IP Protocol Stack and ADSL method brings the new points to the recent researches in terms of allowing direct communication from computers to real devices over the Internet. This method also allows higher data transfer speed than the dial-up method and the ability to add/remove/track devices is also furnished.

2. Draw more attention on the system's security while this matter has not been taken enough care before even it is very important when using such a public network like Internet.

3. The proposed solution can be applied to various industrial telemetry systems such as Fuel Unloading/storage and Feed, Water Supply Monitoring, Irrigation, Flood Warning, Oil and Gas Tracking.