Design and Implementation of Web Based Remote Supervisory Control and Information System

R. Kirubashankar, K. Krishnamurthy, J. Indra, B.Vignesh

Abstract*— *There is a great deal of benefits for process plants in adopting the Internet to control systems. Over the years, there has been constant increase in the development of industrial automation through remote monitoring and diagnosis virtually. By surveying down the existing remote monitoring system used for process plant equipment, this system tends to focus on the recent trends and developments in the control of equipments and devices in the industries by remote monitoring through Internet. The Internet based automation is made possible by the use of Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA), Virtual Private Network (VPN) and other network elements. The objectives of remote monitoring and diagnosis are prevention of unplanned downtime, making optimal control operation and maximizing the operational life of plant assets. An online integrated web based remote supervisory control and information system takes real-time data on process control unit's performance and helps the remote expert for further analysis and thereby supports the plant engineer. The design, Internet security and user interface challenges are focused in this paper.

Index Terms*— *Web based remote monitoring system, Remote Terminal Unit, Web based supervisory control, Real-time control about four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provides human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Automation plays an increasingly important role in the world economy and in daily experience. Some of the widely used automation tools are Artificial Neural Network, Distributed Control System, Human Machine Interface, Supervisory Control and Data Acquisition, Programmable Logic Controller and Programmable Automation Controller. Industrial monitoring involves monitoring and controlling of different plant's factory or manufacturing conditions while logging data to enterprise systems. There has been an ever-increasing emphasis on machine and automation efficiency, as well as performance and quality control. Wireless technology improves the process by adding new measurements to the system that were previously impractical with a cabled solution. A Programmable Logic Controller is programmed to control the operation of the plant and a SCADA system is implemented to monitor and control the process [1]. The proposed system offers an economical solution for multiple users in the Laboratory Environment. In the fault diagnosis of the power electronic equipment in the industries [2], the technical requirements are greatly reduced but the provision for backup in case of a communication failure has not been considered.

The collection of complete real-time data from different source systems such as SCADA, databases and Internet which is pushed into an online transaction process and its immediate acquisition into online analytical process are addressed in [3]. The real time data is compared with forecasted data and historical data for effective online energy management information reporting system and the end-to-end energy information for better decision making is analyzed. The condition monitoring and fault diagnosis for growing figures of power generation systems which use components embodying intelligent computing models, structure with local and central information system is discussed in [4].

The research based on real-time web based machine tool and machining process monitoring system and steps for implementing e-manufacturing system are explained in [5].

The system architecture of a multi layered distributed SCADA system used for monitoring and controlling on establishing the link with icons on graphics panels that integrates all three levels of process control from operator panel with the distributed PLC system is explained in [6].

The online controlling of industrial process via GPRS enabled mobile phone is demonstrated using a prototype in [7]. It provides selection of process values, alarms with graphical user interface and remote controlling in user defined time. The online report diagnosation and GPRS network latency issues are not considered.The concept of E-automation, in which computer networking and distributed intelligence agent technologies are applied to industrial automation systems and the hardware, software architectures are proposed in [8]. E-automation architecture permits greater configurability than a traditional system.

Manuscript received May 30, 2011.

R. Kirubashankar, Department of Mechatronics Engineering, Kongu Engineering College , Perundurai, Erode 638052, Tamilnadu, India, Phone/ Mobile No +91-9443574434 (e-mail: rkskec@gmail.com).

Dr.K. Krishnamurthy, Department of Mechatronics Engineering, Kongu Engineering College , Perundurai, Erode 638052, Tamilnadu, India, (e-mail: dean_sbms@kongu.ac.in).

J. Indra, Department of Electronics & Instrumentation Engineering, Kongu Engineering College , Perundurai, Tamilnadu ,Erode 638052, India,(e-mail: indrajaganathan@gmail.com).

B. Vignesh, Department of Mechatronics Engineering, Kongu Engineering College, Perundurai, Erode 638052, Tamilnadu, India. (e-mail:bvigneshbtech@gmail.com)

The growing need for better monitoring of process plants, improved operations, safety and detailed knowledge of critical supervisory control and monitoring is becoming increasingly important. This makes the implementation of web based remote supervisory control and information system as the best solution.

The design challenges, network security issues, user interfaces and possible solutions are focused in this research. The further sections present experimental approach that was carried out and the results are being presented.

II. CASE STUDY

Web based automation is a recent development in the industrial sector. The implementation of industrial process control is made possible by the use of Internet, PLC controlled by PC and SCADA. Due to the advances in the Internet, the ability to acquire information and even to control devices at fingertips over the Internet is becoming desirable to the general public as well as professionals. This has actually lead to the concept called " Web Based Supervision and Control System " .The Internet is now providing a new and increasingly important medium for distributing information world wide without time constraints, permitting information to be displayed numerically and graphically on any client platform. It allows end users to access the real-time data and to control the instruments via a web browser.

In this research, in order to show the applicability and effectiveness of the design and implementation, real-time experiments have been carried out on a real process control unit in the Interface and Automation Laboratory at Department of Mechatronics Engineering, Kongu Engineering College. Fig 1.0 & Fig 1.1 show the layout of the experimental system and real time experimental setup's photographic view, which includes the process control unit and a PC with SCADA. The process control unit includes a heating tank and two water tanks: one at the bottom acting as a reservoir and another as an overhead tank. PLC functions as a local control system.

The reservoir tank contains a pump to circulate water to the overhead tank. From the overhead tank, water flows to the heater tank. Based on the liquid level of tank1, water is pumped to tank2. The sequence of these operations is controlled by the PLC. The objective is to control the liquid level in the three tanks by regulating the flow rate of the pump. Temperature monitoring and control plays an important role in industries and it is one of the major industrial control parameters. Hence temperature is taken as the parameter to be controlled using this experimental setup.

The Level sensor monitors the water level in the tank2 and thereby the pump controls water flow to the tank. Water from the tank 2 reaches tank 3 where it is heated above the boiling point. The temperature of the liquid in the tank3 is measured by using a temperature sensor. The outputs from all the sensors are fed to the PLC. The set temperature is controlled through the ladder logic program with the PID function incorporated in it.

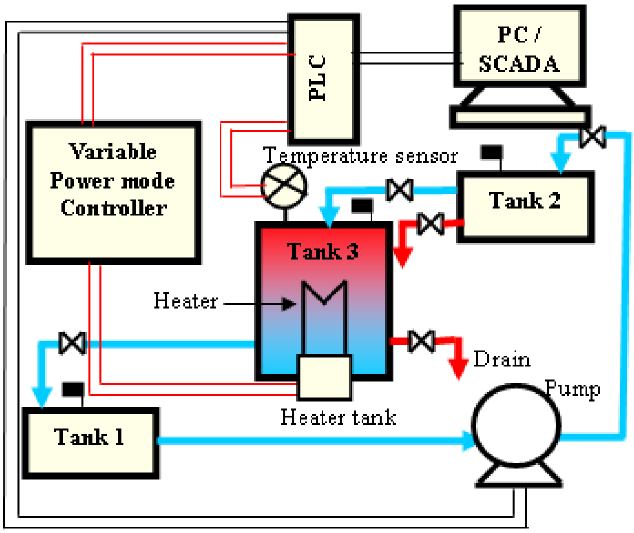

Fig 1.0 Block Diagram of Pilot Plant Experimental setup

Fig 1.1 Photographic view of real-time experimental pilot plant with LCU and GPRS Gateway device

The PID controllers are used for controlling almost all process variables like temperature, flow, level and pressure etc., in a continuous or batch process.

The output of a PID controller is given by

$$OP = b+100/PB\ [e+1/T_i \int e.dt+Td.de/dt]$$

Where OP is the output, b is the bias, PB is the proportional band in %, e is the error signal, T_i is the integral time and T_d is derivative time. Selection of proportional band, integral time and derivative time to achieve desired process response to changes in load is called tuning of the controller.

The desired set point values are achieved by proper tuning of PID parameters through process reaction. The tuned output from PLC is fed to the variable power mode controller which in turn controls the operation of the electric heater. Thus the desired temperature is achieved by using the tuned output from PLC.

III. POSSIBLE IMPLEMENTATION OF THE PROPOSED ARCHITECTURE

The design and development process for the web based remote supervisory control and information system includes requirement specifications, architectural design, control algorithm design, user interface design and security issues. The Fig 2.0 shows various levels of system monitoring and control requirements in the automation hierarchy architecture. Considering the architecture, a possible implementation of a web based remote monitoring system is essential to meet all the requirements.

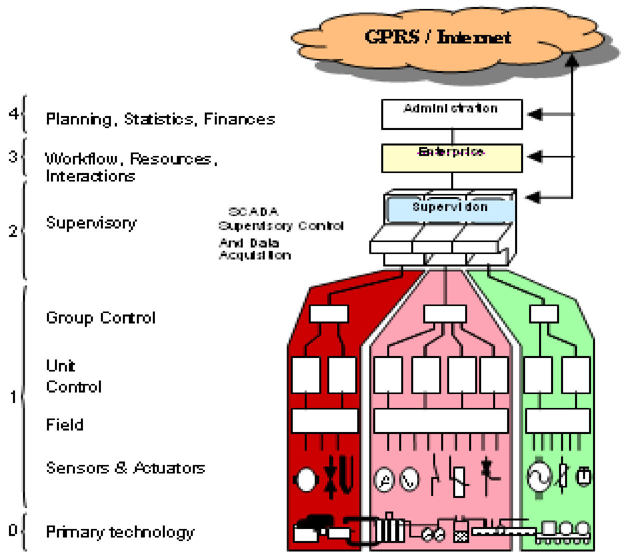

Fig 2.0 Integrated web based automation architecture

(Courtesy: Rockwell automation)

A. Requirement Specifications

In general, a system comprises of a set of components working together to achieve web based remote supervisory control. The experimental pilot plant is an example here to describe the procedure for specifying requirements for a web based remote supervisory control.

In this system, the goal is to maintain a particular relationship between input to the system and output from the system when the process is critically disturbed. As shown in the Fig 3.0, the web based supervisory control and information system is based on a web client / server configuration. Information exchange between experimental pilot plant and Internet-based clients allows the client to remotely monitor, control and thereby modify the parameters of the process plant. Web based supervisory control and information system strategy must be employed towards solving the problems associated with communication latency, security and user interface issues. The design of web-based remote supervisory control and information system, implementing the effective point-to-point network communication architecture and ideal control strategy, aids in decreasing the Internet latency and maintains system stability.

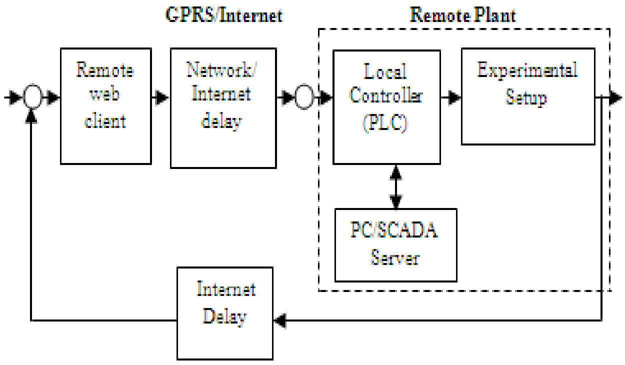

Fig 3.0 Web-based supervisory control over the Internet

IV. SYSTEM ARCHITECTURE

The proposed architecture of the web based remote supervisory control and information system is shown in Fig 4.0. It consists of pilot experimental plant, local control unit, work station and Ethernet based Gateway device for Internet connectivity with other network elements. The pilot plant is controlled by Programmable Logic Controller. The Programmable Logic Controller is connected with the Gateway device to establish wireless Internet connectivity.

The Ethernet based Gateway device can be expanded over high speed wireless networks and integrated as a part of internal network. At the remote location both the Ethernet and serial devices can be connected with Gateway device unit to the central site of the global systems which is possible with the most common wireless networks. The remote monitoring station consists of a local work station and Machine to Machine (M2M). The importance of M2M offers secured two-way communication (static IP address) between machines without human intervention. M2M can also mean the family of sensors, actuators, middleware, software and applications that help to improve efficiency and quality by tying together a myriad of sensors and actuators with business processes. Development and deployment of M2M system is necessary for creating a pervasive and intelligent environment. M2M is a combination of various heterogeneous electronic communication and software technologies**.**

The key features for the proposed architecture are:

- No distance limitations, Global systems are possible if GSM/GPRS-2G/3G networks are available.
- Secured two-way communication (static IP and public IP).
- Expands Ethernet over GPRS network.
- Offers mobile operator independent static IP addressing for connecting remote gateway devices.
- Firewall and VPN for secured communication.

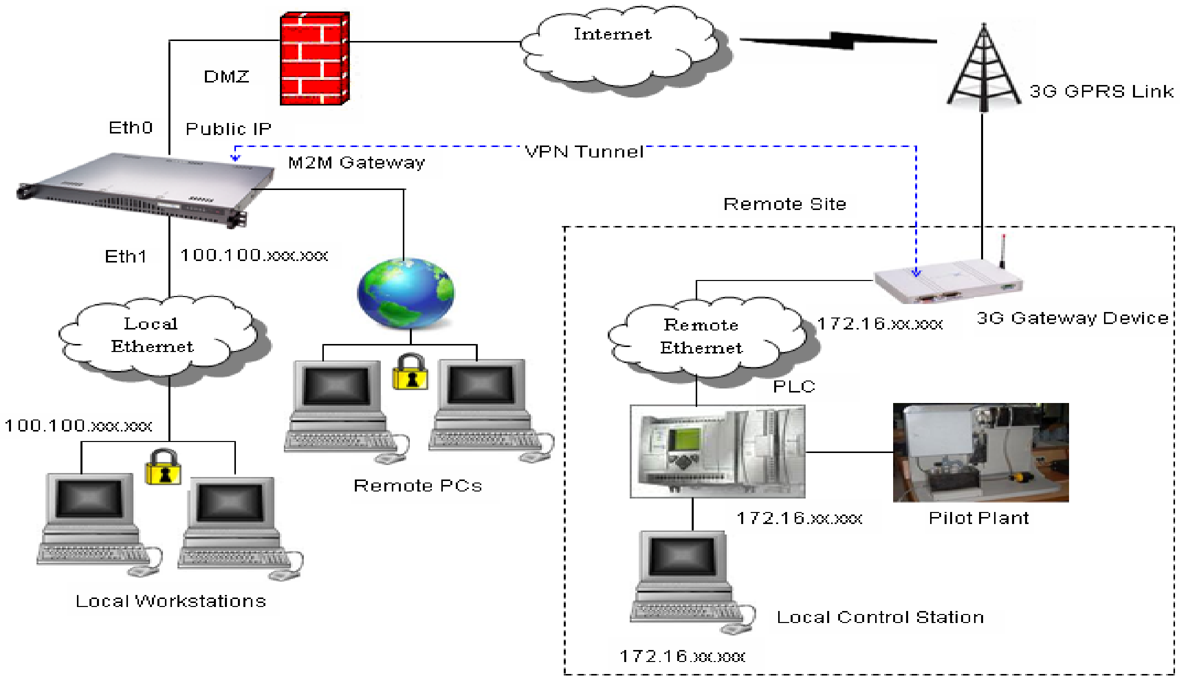

Fig 4.0 Architecture of web based remote supervisory control and information system

A. Supervisory Control And Data Acquisition Control

SCADA generally refers to an industrial control system: a computer system monitoring and controlling a process. It usually refers to a system that coordinates, but does not control processes in real time.

It usually consists of the following subsystems:

- A Human-Machine Interface or HMI is the device which presents process data to a human operator through which the human operator monitors and controls the process.
- A supervisory (computer) system, gathering (acquiring) data on the process and sending commands (control) to the process.
- Remote Terminal Units (RTUs) connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.
- Programmable Logic Controller (PLCs) used as field devices because they are more economical, versatile, flexible and configurable than special-purpose RTUs.
- Communication infrastructure connecting the supervisory system to the Remote Terminal Units.

A SCADA system allows users to monitor an entire plant or individual pieces of equipment and processes by collecting real-time data from various sensors through a network. It is very important for organizations to monitor these network activities, as doing so informs them of problems with their mission-critical processes. By monitoring these processes, organizations can quickly respond when there are problems within their network. Effective monitoring saves significant expenditures on repairs and lost revenue due to network downtime.

An effective combination of SCADA with wireless remote monitoring makes the proposed system efficient in monitoring the real-time critical processes.

B. CHALLENGES OF WEB BASED REMOTE SUPERVISORY CONTROL SYSTEM

The challenges of successful implementation of web based supervisory control for an application is the provision of effective real-time processing and data transfer over the Internet. The real-time web based supervisory control involves data transfer and exchange of large amount of numerical data over the Internet. Additionally, large amount of data such as graphics screen, trend analysis, database information system are viewed in the Internet browser environment.

In order to obtain reliable data transmission over Internet a novel web based supervisory control is proposed to minimize the effect of Internet time delay and data loss. There are various risks including the operational difficulties such as cyber hackers, especially in the systems linked to the industrial operations which result from the application of network technologies. Therefore Internet enabled plant will never be absolutely safe and secure if a remote user is allowed to directly access and make changes to the local control system. In order to overcome these security challenges, VPN based authorized remote user access level is the best solution.

V. TYPICAL IMPLEMENTATION

In the last decade, the most successful network development is the Internet. It is widely used as a communication and data transfer mechanism. The Internet is a global platform for information retrieving and also for web based remote control. The objective of this implementation focuses on providing a flexible graphical user interface over Internet environment, enhanced security to access the remote pilot plant and reducing the Internet latency.

The main goals for applying graphical user interface over Internet in process control interface are as follows:

- To enable the remote expert and plant engineer operators to appreciate more rapidly what is the present state of the process dynamic system.
- To provide more information on the process i.e., online/offline trend analysis.

The graphical user interface and program logics are developed in the SCADA.

C. Ensuring Security Between Plant And Remote End User

The real-time implementation to ensure plant security and end user access level is focused. A typical open VPN is used to ensure security between plant and remote end user.

VPN uses relatively low-cost, widely available access to public networks like the Internet to connect remote sites together securely. This yields Virtual Private Networks that link geographically distributed sites. In a VPN, traffic from one site destined for another must traverse through an untrusted public network like the Internet. The site-to-site traffic is protected from outsiders.

D. Security Objectives Of Vpn

- Isolate a distributed network from outsiders.
- Protect the privacy and integrity of messages traversing untrusted networks
- Handle the whole range of Internet protocols currently in use.
- Public Internet access is available and cheaper.

E. OPEN VPN

To ensure the security over the Internet environment the OpenVPN client certificate based security is developed and implemented successfully in the experimental pilot plant system. A point-to-point connection is programmed in M2M and routed configurations are made which help to make remote access facilities. It uses SSL/TLS security for encryption and is capable of traversing network address translators (NATs) and firewalls.

OpenVPN allows peers to authenticate each other using certificates or username/password. It allows the server to release an authentication certificate for every client using signature and Certificate authority. It uses the OpenSSL encryption library extensively as well as the SSLv3/TLSv1 protocol.

F. ENCRYPTION

OpenVPN uses the OpenSSL library to provide encryption of both data and control channels. It lets OpenSSL to do all the encryption and authentication work, allowing OpenVPN to use all the ciphers available in the OpenSSL package. It can also use the HMAC packet authentication feature to add an additional layer of security to the connection (referred to as an "HMAC Firewall" by the creator). It uses hardware acceleration to get better encryption performance.

G. Authentication

The implementation of web based remote supervisory control information system for the experimental pilot plant is authenticated at two different levels.

- The Open VPN certificate based authentication at the end remote user terminal.
- The SCADA is programmed with multiple user access level and is password protected to ensure the authorized user to view plant status and provides further assistance to the plant / site engineers.

OpenVPN has several ways to authenticate peers to one another. During the implementation of M2M, it is programmed with OpenVPN certificate which has more features and robust. The username/password is a new feature that can be used with or without a client certificate. The source tarball includes a sample Perl script to verify the username/password with PAM and a C auth-pam plug-in.

H. Gprs / Internet Transmission Delay And Data Loss From The Network View

The possible solution for reducing GPRS/Internet data transmission delay is presented in this section. Unpredictable time delay and data loss are difficult to design at any period of time.

The pilot plant's local control unit i.e., PLC is connected to the gateway device which is 2G/3G enabled. The GPRS/Internet is a public and shared resource in which various users transmit data via the GPRS/Internet simultaneously. So the VPN is implemented between experimental pilot plant and remote end user which ensures a channel for data transmission. This prevents collision of data when two or more remote users receive the data via the same route simultaneously.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

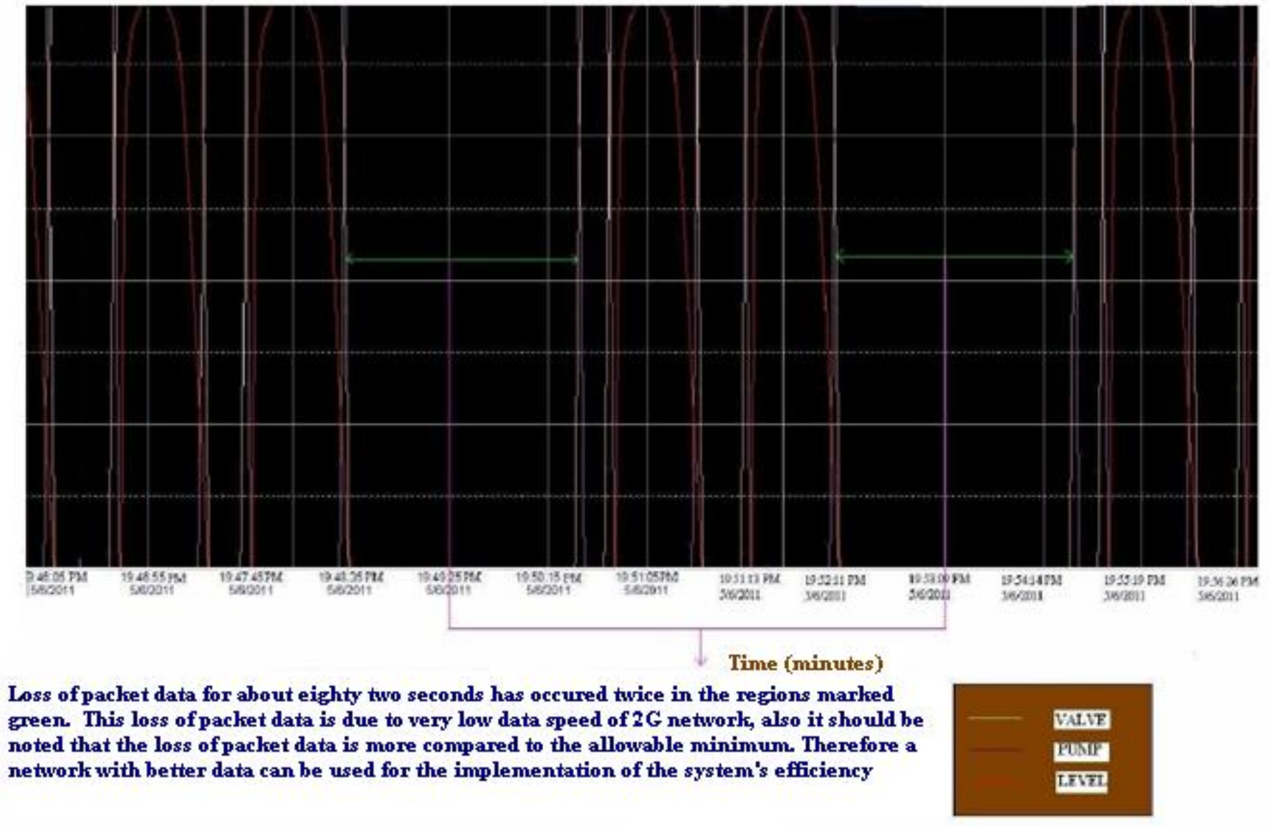

Fig 5.0 Process trend of Pilot plant operation viewed through web browser in 2G environment

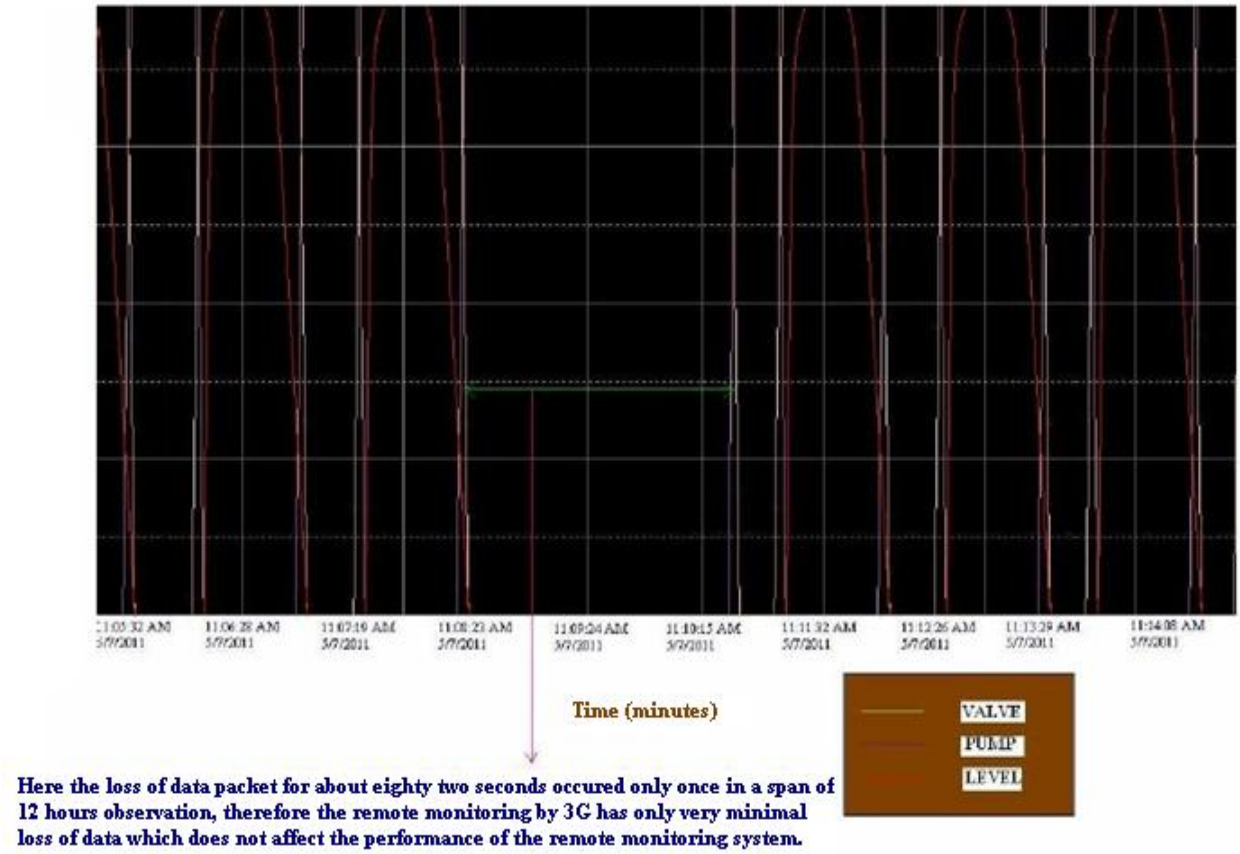

Fig 6.0 Process trend of Pilot plant operation viewed through web browser in 3G environment

The real-time implementation of web based remote supervisory control and information system is carried out initially with 2G GPRS environment. The Fig 5.0 shows the remote expert user interface process trend (web client trend) for online analysis of the pilot plant operation. The live trend interface shows the data loss over the process control operation during different time intervals. A maximum of 120 seconds interval is observed during 8 hours of continuous remote monitoring. The real-time on-line examination is also carried out with 3G –EDGE in the remote pilot plant gateway device. In 3G environment, the data transfer rate is above 356Kbps compared to 56-110kbps in 2G. The Fig 6.0 shows the process parameters on–line trend of the pilot experimental plant in the 3G environment. The pilot plant was monitored and controlled online continuously for more than one day by the end user remotely.

VI. RESULTS AND DISCUSSION

The web based remote supervisory control and information implemented with leading edge technology enables remote end user to easily obtain secured data, information and knowledge to support decision-making at all the levels of the process plant. A number of positive and successful initiatives are investigated to improve the operations and utilization of process control system, information system and infrastructures used by the plant engineers and remote expert support team. In this section experimental result is presented and further suggestions are discussed.

To ensure the security over the Internet environment, VPN is implemented. Further password control is also programmed in the SCADA to stop unauthorized access to the local control system over Internet. The Fig 7.0 shows that only a registered user can view the remote control user interface and have access to web based remote supervisory control and information system.

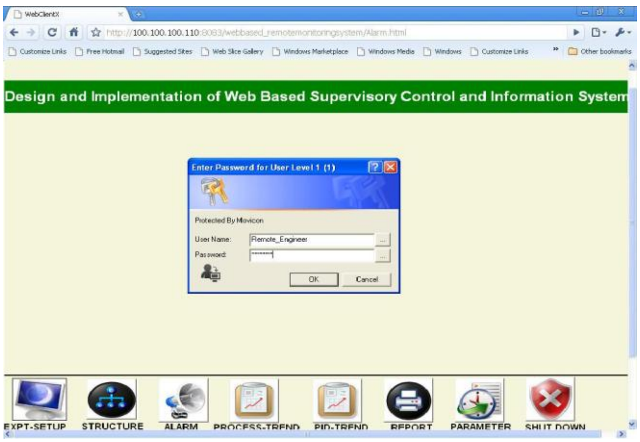

Fig 7.0 Remote user access login request over web browser environment – security check

- The actual SCADA Screen for experimental setup over the Internet looks as shown below in Fig 8.0.
- This graphical screen helps us to easily understand the overall process.
- The set point temperature and actual process variable are shown in the display.
- Also the controller output is displayed in the screen.

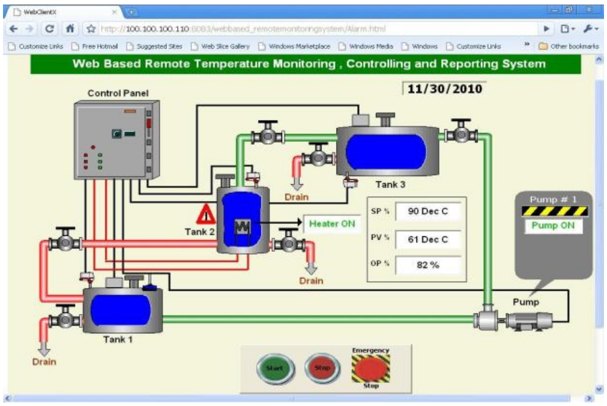

Fig 8.0 SCADA screen for experimental setup viewed through Internet

The process or PID parameters can be tuned and controlled over the Internet remotely. The parameters tuning window appears as below in the Fig 9.0

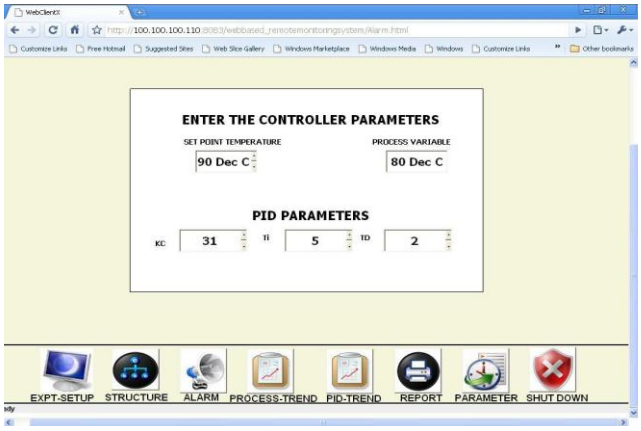

Fig 9.0 SCADA screen for controller tuning viewed through Internet

The simple experimental setup over the Internet looks as in the Fig 10.0 shown below. Here the remote SCADA acts as a client.

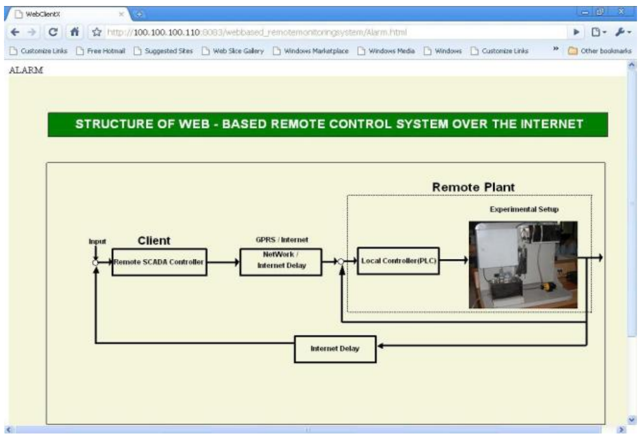

Fig 10.0 Structure of the experimental setup viewed through the web browser

Various critical alarms and their status can be monitored over the Internet. The sample alarm window screen is shown below in the Fig 11.0

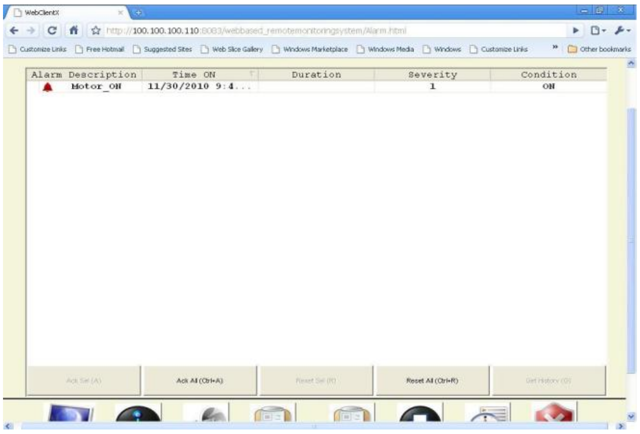

Fig 11.0 SCADA screen for alarm window viewed through Web browser.

The actual trend window over the Internet is pictured as below in Fig 12.0. Description of various parameters over a time period can be monitored.

Fig 12.0 SCADA screen for trend window viewed through Internet.

The report on different process information can be viewed periodically. This option is made available by using a SCADA screen and it can be viewed over the Internet from any place. Fig 13.0 below shows such a screen over the Internet.

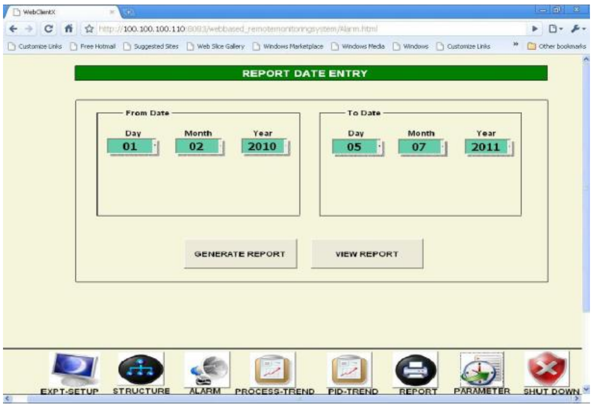

Fig 13.0 Information system window viewed through the Internet web browser.

The web based online report of process station appears as in the screen shown below in Fig 14.0. The web based information system that uses the stored data to determine the performance of the pilot plant which makes intelligent discussion regarding the periodical monitoring of the entire process variables is possible. Online monitoring of set point value is done and it is noted that when the process variable reaches the set point value, the controller output reaches zero. Any process parameter can be verified successfully and monitored through Internet using the same.

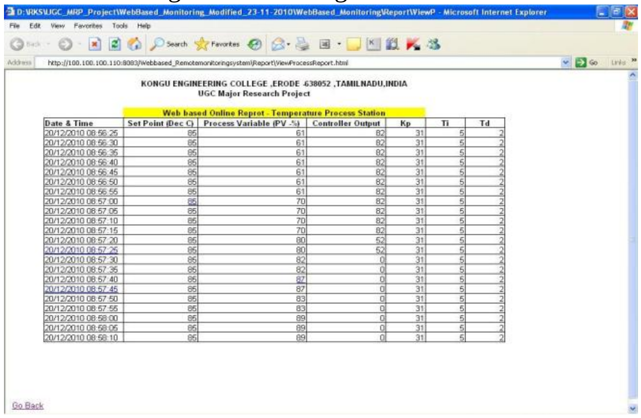

Fig 14.0 Web based online process Information report viewed in web browser environment

VII. CONCLUSION

In this paper, Design and Real Time Implementation of Web based Remote Supervisory Control and Information system is presented. This novel architecture is secured and decreases the Internet latency. This system prevents the unplanned downtime making optimal control operation and maximizes the operational life of plant assets. The operational cost of the proposed system using GPRS is cheaper compared to the conventional remote monitoring methods which use Internet. Also this system is beneficial over the traditional system in terms of remote monitoring, control and maintenance. The proposed system further reduces the technical requirement for monitoring and diagnosing in enterprises and communicates information among the administration department, running field and the experts to acquire broad information, integrated experience and knowledge from different aspects. The system is successfully tested at the pilot plant in Kongu Engineering College.

ACKNOWLEDGMENT

This research is supported by the University Grants Commission (UGC), New Delhi, India under Major Research Project Scheme and Kongu Engineering College, Erode, Tamilnadu, India.

REFERENCES

1. Zafer Aydogmus, Omur Aydogmus, "A Web-Based Remote Access Laboratory Using SCADA", IEEE Transactions on education, Vol. 52, No. 1, February 2009, pp. 126-132.
2. Xin Zhao , Wei Liang , "Research on the Remote Monitoring and Intelligent Fault Diagnosis System ", Sch. of Computer & Electronic Eng., Hunan University of Commerce, Changsha , Wireless Communications, Networking and Mobile Computing(WiCOM'08), 2008 , pp.1-4.

3. D .Y. Raghavendra Nagesh, Sowjanya A and Dr S.S TulasiRam, " Real Time Decision Support for Energy Management ", Proceedings of the World Congress on Engineering 2008, Vol.1., pp. 5-9.
4. Chengen Wang , Lida Xu , Wuliang Peng , "Conceptual design of remote monitoring and fault diagnosis systems" , Science Direct (Information Systems) ,Vol.32, 2007, pp. 996-1004.
5. Shin Bong-Cheol, Kim Gun-Hee, Choi Jin-Hwa, Jeon Byung-Cheol, Lee Honghee, Cho Myeong-Woo, Han Jin-Yong, Park Dong-Sam, "A Web-based machining process monitoring system For E-manufacturing implementation", Journal of Zhejiang University Science, Vol.7 (9), 2006, pp. 1467-1473.
6. Adnan Salihbegovic, Vlatko Marinkovic, Zoran Cico, Elvedin Karadzic, Nina Delic, "Web based multilayered distributed SCADA/HMI system in refinery application", Elsevier Science, Vol.31, 2009, pp. 519-612
7. Engin Ozdemir, Mevlut Karacor,"Mobile phone based SCADA for industrial automation", ISA Transactions, Vol. 45, No. 1, 2006, pp. 67–75
8. Henry Wu, David P. Buse, Junqiu Feng, Pu Sun, "e-Automation, an Architecture for Distributed Industrial Automation Systems", International Journal of Automation and Computing, Vol. 1, 2004, pp. 17-25
9. Dr. Aditya Goel & Ravi Shankar Mishra," Remote Data Acquisition Using Wireless – SCADA System", International Journal of Engineering (IJE), Vol.3 (1), 2008, pp. 58-65
10. Albert W.L. Yao, C.H. Ku, "Developing a PC-based automated monitoring and control platform for electric power systems", Electric Power Systems Research, Vol. 64, 2003, pp. 129-136
11. Toshiaki Kimuraa, Yuichi Kandab, "Development of a remote monitoring system for a manufacturing support system for small and medium-sized enterprises ", Computers in Industry, Vol.56, 2005, pp. 3-12
12. Wei-Fu Chang , Yu-Chi Wu , Chui-Wen Chiu ,"Development of a web-based remote load supervision and control system", International Journal of Electrical Power and Energy Systems, Vol.28(6),2006 , pp. 401-407
13. Juan Jose Gonzalez de la Rosa Antonio Moreno Munoz, Aurora Gil de Castro, Victor Pallares Lopez & Jose Antonio Sanchez Castillejo," A web-based distributed measurement system for electrical power quality Assessment", Elsevier Science, Vol. 43, 2010, pp. 771-780
14. Hongbo Lana, Yucheng Dinga, Jun Honga, Hailiang Huangb, Bingheng Lua," A web-based manufacturing service system for rapid product development", Elsevier Science, Vol.54, 2004, pp. 51-67
15. Cihan Sahin & Emine Dogru Bolat, "Development of remote control and monitoring of web-based distributed OPC system", Elsevier Science, Vol.31, 2009, pp. 984-993
16. A.W.L. Yao, "Design and implementation of Web-based diagnosis and management system for an FMS", International Journal of Advanced Manufacturing Technology, Vol.26, 2005, pp.1379-1387

AUTHORS PROFILE

R. Kirubashankar, received his B.E Degree in Instrumentation Engineering and M.E. Degree in Control & Instrumentation Engineering from the Bharathidasan University and Anna University, Tamilnadu, India respectively in 2002 and 2007. He worked as a senior project engineer in a leading automation company. Presently he is working as an Assistant Professor in the Department of Mechatronics Engineering at Kongu Engineering College, Tamilnadu, India. He received research grant from University Grants Commission, New Delhi, India for his research work. Also he obtained funds from the All India Council for Technical Education for the development of robotics and automation research laboratory. He received best faculty award from Kongu Engineering College for the year 2010. He is a life member of ISTE. He has published many papers pertaining to his area of research in the International and national conferences and in the journals. His research interest covers Industrial Automation, Control & Instrumentation.
E-mail: rkskec@gmail.com

Dr. K. Krishnamurthy, received his B.E Degree in Mechanical Engineering and M.E. Degree in Production Engineering from the Bharathiar University, Tamilnadu, India in 1989 and 1991 respectively. He obtained his Doctoral Degree in Mechanical Engineering from Bharathiar University, Tamilnadu, India in 2008. From the year 1990, he is associated with Kongu Engineering College, Tamilnadu, India. Currently, he is the Dean - School of Building and Mechanical Sciences and Professor in the Department of Mechatronics Engineering, Kongu Engineering College, India. He has published about 35 papers in the reputed journals and in the national and international conferences. His research interest covers foundry, Computer aided design, Computer aided manufacturing and Mechatronics. He received research grants from University Grants Commission, New Delhi, India and All India Council for Technical Education. He is a Life Member of ISTE, C.Engg. (I), NIQR and fellow in Institution of Valuers and Institution of Engineers (India).
E-mail: dean_sbms@kongu.ac.in

J. Indra, received her B.E Degree in Electrical & Electronics Engineering Bharathiar University, Tamilnadu, India in 2003 and M.E. Degree in VLSI Design from Anna University, Chennai, Tamilnadu, in 2007. She is working as a faculty at Kongu Engineering College, Tamilnadu, India for the past 8 years. Currently she is working as an Assistant Professor (Senior Grade) in the Department of Electronics & Instrumentation Engineering at Kongu Engineering College. She is a life member of ISTE. Her research interest includes VLSI signal processing & Embedded Systems and Instrumentation.
E-mail: indrajaganathan@gmail.com

B. Vignesh, received his B.Tech Degree In Information Technology and M.B.A degree in Human Resources Management from Anna University and Bharathiar University Tamilnadu, India respectively in 2008 and 2010. Currently he is working as a Project Fellow in the department of Mechatronics Engineering at Kongu Engineering College, Tamilnadu, India.
E-mail: bvigneshbtech@gmail.com