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SCADA Application Development Using LABVIEW

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Abstract— ***Simple low cost automation control with rugged reliability and flexibility is the real need in today's industrial world. Frequent failure of costly & complex proprietary OEM Hardware for Human Machine Interface (HMI) results in raise of Mean Time To Repair (MTTR) and there by affects productivity and quality in any manufacturing unit. Proprietary OEM hardware's for Human Machine Interface (HMI) cannot be serviced by maintenance personals in the field and many times even by OEM's service team. This leads to having costly spares and huge inventory in any typical industry. This paper discusses a novel idea to develop a SCADA application (Supervisory Control and Data Acquisition) using user friendly software like LABVIEW and low cost field serviceable Human Machine Interface that is a Personal Computer. The complete conceptual information about the Communication with a Remote Terminal Unit (SIEMENS CPU 315) using MPI protocol, data transfer using a (IBH) OPC server and SCADA application development using LABVIEW installed in personal computer which can realize more than the intended result is explained in this paper. The idea discussed in this paper can result in development of a low cost alternative for proprietary OEM hardware's and software's thereby will result in low investment, less inventory, reduced MTTR, ease of operation etc.,***

Index Terms—**SCADA, LABVIEW, HMI, RTU, SIEMENS PLC, MTTR, OPC SERVER.**

I. INTRODUCTION

SCADA (supervisory control and data acquisition) is a type of Industrial Control System (ICS). Industrial control systems are computer controlled systems that monitor and control industrial processes that exist in the physical world. SCADA systems historically distinguish themselves from other ICS systems by being large scale processes that can include multiple sites, and large distances. These processes include industrial, infrastructure, and facility-based process. In this paper we present an idea of using a graphical Programming language (LABVIEW) as a front end and OPC server (IBH OPC server) as the interface between the HMI Personal computer with XP OS) and the RTU (Siemens S7 315 PLC).Equipment reliability is measured in terms of MTTR and MTBF in any industry. Usage of OEM proprietary hardware's like SIEMENS OP 277 whose cost is more than 1 lakh INR becomes unjustified when the same was not serviceable even by the OEM in case of failures or glitches like frequent freezing of operation.

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II. PROBLEM DESCRIPTION

The case study we have taken is a fully automated process to produce a special Gas using a catalyst reactor whose temperature and flow of input gas to be precisely maintained for optimal productivity and quality of the output special gas . The human machine interface for the process is implemented with a SIEMENS Operator Panel 277 and a SIEMENS PLC CPU 315 as Remote Terminal Unit through Multi Port Interface communication. Productivity and Quality of the process got effected 3 to 4 times due to a failure in the SIEMENS Operator Panel 277 and once it had taken 54 hours to restore at a cost of 1.3 Lakh INR for a new Hardware. The problem become complicated when the original WIN CC project file got corrupted and the maintenance team don't have a backup of PROSAVE backup file. Even during the failure the OEM was not able to help for restoring the plant. The root cause of the frequent failure of the Operator Panel is not identified and eliminated.

III. PROPOSED SOLUTION

The main cause of the problem is the failure of the HMI hardware ie., SIEMENS OP277. It was proposed to go for Personal computer (PC) based HMI hardware for better reliability and serviceability. The SIEMENS proprietary SCADA software WINCC run time plus development environment and LABVIEW plus IBH OPC server we taken for study. Both proposals can be installed in a Personal Computer and can communicate with SIEMENS RTU CPU 315 through a PCI Communication Processor card or a USB adapter card

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IV. SCADA HARDWARE

A SCADA system consists of a number of remote terminal units (RTUs) collecting field data and sending that data back to a master station, via a communication system. The master station displays the acquired data and allows the operator to perform remote control tasks. The accurate and timely data allows for optimization of the plant operation and process. Other benefits include more efficient, reliable and most importantly, safer operations. This result in a lower cost of operation compared to earlier non-automated systems. On a more complex SCADA system there are essentially five levels or hierarchies:

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- Field level instrumentation and control devices
- Marshaling terminals and RTUs
- Communications system
- The master station(s)
- The data processing system

Background to SCADA 5

The RTU provides an interface to the field analog and digital sensors situated at each remote site. The communications system provides the pathway for communication between the master station and the remote sites. This communication system can be wire, fiber optic, radio, telephone line, microwave and possibly even satellite. Specific protocols and error detection philosophies are used for efficient and optimum transfer of data. The master station (or sub-masters) gather data from the various RTUs and generally provide an operator interface for display of information and control of the remote sites. In large telemetry systems, sub-master sites gather information from remote sites and act as a relay back to the control master station. Figure 1 shows the typical configuration of any SCADA system and figure 2 depicts the configuration of problem area. Figure 3 shows represent the various components of the hardware configuration.

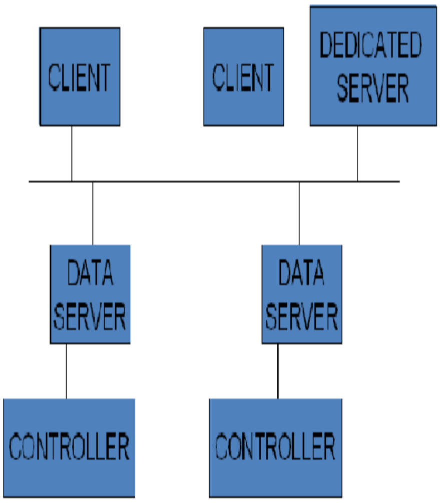

Fig 1. Typical configuration of a SCADA system

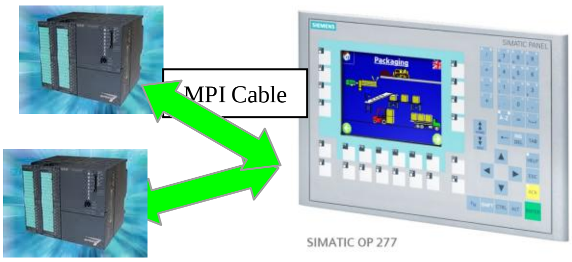

Fig 2. Hardware configuration of the case study

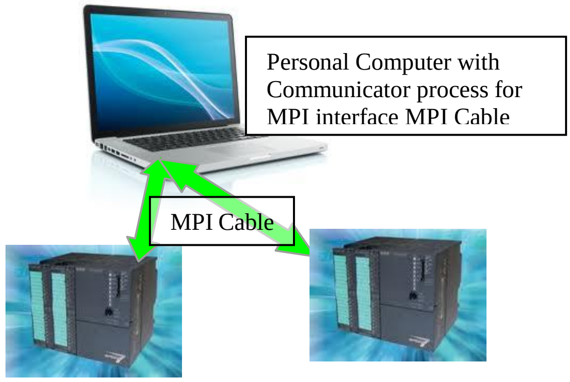

Fig 3. Proposed hardware configuration

V. SCADA SOFTWARE

SCADA software can be divided into two types, proprietary or open. Companies develop proprietary software to communicate to their hardware. These systems are sold as 'turnkey' solutions. The main problem with this system is the overwhelming reliance on the supplier of the system. Open software systems have gained popularity because of the interoperability they bring to the system. Interoperability is the ability to mix different manufacturers' equipment on the same system. Cytec and Wonder Ware are just two of the open software packages available in the market for SCADA systems. Some packages are now including asset management Integrated within the SCADA system. The key features of a typical SCADA system are:

- User interface
- Graphics displays
- Alarms
- Trends
- RTU (and PLC) interfaces
- Scalability
- Access to data
- Database
- Networking
- Fault tolerance and redundancy
- Client/server distributed processing

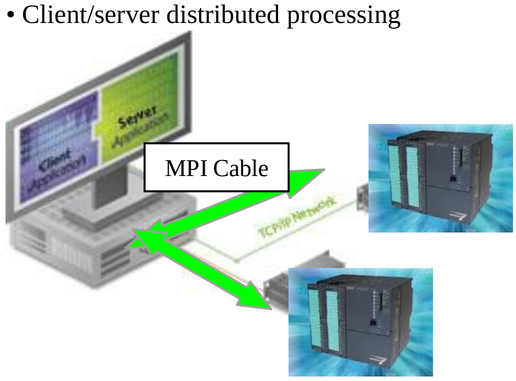

Fig 4. Proposed software and hardware integration

Figure 4 shows how both hardware and software integration is implemented to solve our problem in the case study. The Personal computer with XP OS and LABVIEW linked to IBH OPC server will be connected through MPI

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cable to the two PLC's which are controlling the plant and the process.

VI. GRAPHICAL AND DATA FLOW PROGRAMMING IN LAB VIEW

LABVIEW ties the creation of user interfaces (called front panels) into the development cycle. LABVIEW programs/subroutines are called virtual instruments (VIs). Each VI has three components: a block diagram, a front panel, and a connector panel. The last is used to represent the VI in the block diagrams of other, calling VIs. Controls and indicators on the front panel allow an operator to input data into or extract data from a running virtual instrument. However, the front panel can also serve as a programmatic interface. Thus a virtual instrument can either be run as a program, with the front panel serving as a user interface, or, when dropped as a node onto the block diagram, the front panel defines the inputs and outputs for the given node through the connector pane. This implies each VI can be easily tested before being embedded as a subroutine into a larger program**.** The programming language used in LABVIEW, also referred to as G, is a dataflow programming language. Execution is determined by the structure of a graphical block diagram (the LV-source code)on which the programmer connects different function-nodes by drawing wires. These wires propagate variables and any node can execute as soon as all its input data become available. Since this might be the case for multiple nodes simultaneously, G is inherently capable of parallel execution. Multi-processing and multi-threading hardware is automatically exploited by the built-in scheduler, which multiplexes multiple OS threads over the nodes ready for execution.

VII. BENEFITS AND ADVANTAGES

One benefit of LABVIEW over other development environments is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These present themselves as graphical nodes. The abstraction layers offer standard software interfaces to communicate with hardware devices. The provided driver interfaces save program development time. The sales pitch of National Instruments is, therefore, that even people with limited coding experience can write programs and deploy test solutions in a reduced time frame when compared to more conventional or competing systems. A new hardware driver topology (DAQmxBase), which consists mainly of G-coded components with only a few register calls through NI Measurement Hardware DDK (Driver Development Kit) functions, provides platform independent hardware access to numerous data acquisition and instrumentation devices. The DAQmxBase driver is available for LABVIEW on Windows, Mac OS X and Linux platforms.

The different options that need to be implemented in the proposed system are listed below.

- MENU PAGE where the operator can navigate through other pages
- MANUAL Operation of the Plant
- SEMI AUTOMATIC Operation of the plant
- DIAGNOSTICS of any problem in the plant with operator guidance
- SETTING PAGE which needs to be password protected to control access to the sensitive parameters crucial to the process.
- ALARMS, to show all active alarms in the system.

VIII. CONCLUSION AND ADVANTAGES

SCADA implementation using Lab VIEW can aid in automating an industry and save huge amount of money in all prospects. This idea can bring down the cost primarily incurred in purchasing proprietary hardware and soft wares. There are numerous advantages notwithstanding a few limitations as mentioned below:

- A limitation caused because of the understanding on the OPC compliance of the RTU's
- The cost of implementation greatly depends on the OPC server / Client software's as cost of graphical programming software's with built-in OPC server will make the cost economically not viable

Further analysis on implementing the idea with different makes of the RTU requires specialized inputs from OEMs and academic community.

IX. ACKNOWLEDGMENT

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AUTHOR’S PROFILE

B.Somasundaram is currently working as an Engineering professional in a reputed German MNC. He has rich industrial experience of more than 14 years with manufacturing giants like Saint Gobain Glass India - Chennai, Valeo – Chennai and SPIC- Tuticorin. He has commendable skills over designing, commissioning and maintaining State of the Art facilities and world class automation controls. Some of the automation systems he enjoys working with are Yokagowa Distributed control system, FoxPro Distributed control system, Industrial control products like PLC,HMI & SCADA of leading brands like SIEMENS, Allan Bradly, Mitsubishi, Schneider - TeleMechanic.,He is a certified Maintenance professional for the famous 840 D Siemens CNC systems. He is a Life Time Member in Indian Society of Technical Education.

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