Design and Implementation of a Web Based Supervisory Control and Data Acquistion System (Scada) Software Module for Remote Access Laboratory

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Abstract: *The SCADA system is an integrated system which provides process monitoring and process control of test facility from the control centre. It enables generation of manual commands and display of processed parameters with process mimic diagram. In this implementation, the proposed system receives input parameters from two systems: Control System and Data Acquisition System (DAS) and send the command output to the test stand through Control System. The OPC connectivity is used for interfacing the SCADA software with the control system if it is complaint with the OPC standard. The SCADA software system is developed using Web technology with MySQL database. The DAS, Control System, SCADA server and Operator stations connected using Ethernet protocol. Web Based SCADA (WBS) software is developed to generate manual command to operate EP/Control valves, pumps etc along with analog and digital parameter display with process mimic diagram. The Web Based Software developed with access control for providing the required functionalities for the users at different levels (Administrator, Operator and Viewer). The redundancy of the SCADA system in each level is also provided in hardware and software. The system can be extended very easily by interfacing the SCADA with different Control systems and DAS available in various test facilities with minor changes in the interface software.*

Index Terms: *Web Based SCADA Software, DAS, Ethernet protocol, mimic diagram.*

I. Introduction

Cryogenic and Earth storable Liquid engines and stages testing are carried out in development or acceptance or qualification phase at various test facilities. Instrumentation System support is provided for the test facilities for conducting the test in safe mode. Instrumentation system consists of Control System and Data Acquisition System. Controlling the field elements from control room necessitates SCADA software for providing the control and parameter display with process mimic diagram. The commands are generated by the operator using Web Based SCADA (WBS) software to control the field elements through control system.

II. Block Diagram

SCADA refers to a system that collects data from various sensors in remote locations and then sends this data to a central computer which then manages and controls the data to the right person within the right amount of time. The Web Based SCADA software is a standard program independent of test facilities.
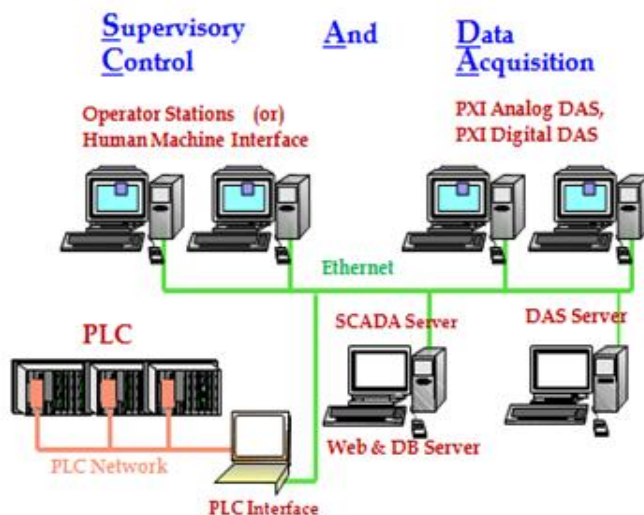

Fig.1.SCADASystem Configuration

The software is developed with the latest trend in SCADA such as

i. Standard Networking technologies Ethernet and TCP/IP protocols.
ii. Thin client SCADA systems using web based programs.

The software interfaces with the PLC and DAS may change according to the availability of PLC and DAS existing in the Test Facilities. The operator can access the control system through the functionalities of Web Based SCADA. The SCADA consists of two major parts: an underlying hardware and supporting software.

III.   Existing Scadasystems And Its Restrictions

At present various SCADA software procured along with the control system hardware from different vendors are used.

✓ Existing SCADA Systems:
1) Intellimax SCADA (Windows) used with Sigmatek PLC in TCT facility.
2) DCS 2000 SCADA used for B&R PLC in MET facility.
3) SCADA using Lasel Screen software with Sigmatek PLC in SET facility.
4) In house developed VB based mimic used with B&R PLC and NEFF DAS in LAM_HAT facility.
5) WINCC SCADA with SIEMAN's PLC in PTS.
6) Wonderware SCADA with PXI based PLC in CST.
✓ SCADA Restrictions:
1) Upgradation of SCADA and additional operator station requires   new license.
2) Parameter EU display with first order conversion is used in most of the SCADA.
3) Parameter Updation Rate is slow (>1 Sec.) and slow valve operation response.
4) Fault fixing of proprietary SCADA is difficult due to non availability of source code.
5) Complexity of SCADA operations with more unused options.
6) Cost is high.
7)

IV.   The Key Aspects Of Web Based Scada

Web Based SCADA development based on the current trends in SCADA and modern techniques to achieve

• Performance improvement
• Reliability
• Economical benefits
• Maintainability
• Extensibility

It is developed with web based technology such as AJAX technology for getting the dynamic updation and for better user interaction.

It also reduces the network traffic and web server loading. The performance improvement is also achieved by providing the actual requirement of SCADA usage. The communication between PLC and WBS is provided using OPC which is an open standard.Data communication between DAS and WBS uses multicast UDP communication.

V.   The Scada Hardware Architechture

The SCADA system presents an integrated system for process monitoring and process control, optimized for large and complex control systems. The overall diagram of SCADA usage is given below.
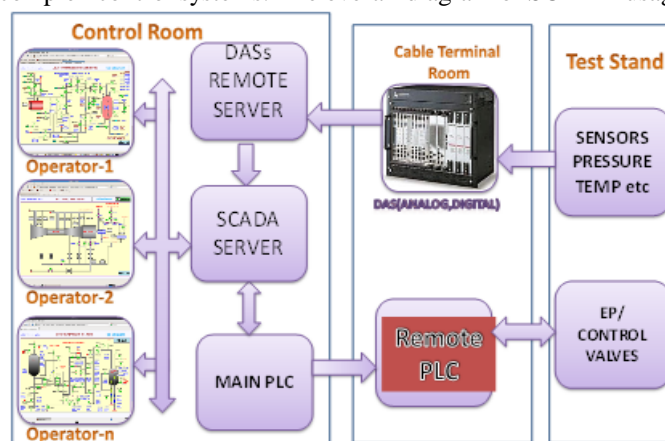

Fig.2.SCADA system usages in test facility

A. SCADA System
1) Web Based SCADA Server:
The Web Based SCADA Server may be a single / multiple hardware system and it is installed with following Web/ MySQL /DNS software servers. The Red Hat Linux Server version 5.5 or later versions can be used as the Server Operating System.

a) Web Server
- Apache web server package is used, that works under Linux as well as under other OSs.
- The primary advantage of Apache is that it is generally free or available at modest costs.
- It is mostly used web server.

b) MySOL Server
- MySQL is an open source relational database management system
- It includes the SQL server and client programs accessing the server.
- Widely used by web application development together with PHP and APACHE.

c) DNS Server
DNS Server is used for   providing the Web Server redundancy.
- The mechanism by which Internet software translates names to attributes such as addresses.
- Data from master is copied to multiple slaves.
- DNS is a very lightweight protocol.

d) HMI/Operator stations
- Apparatus which presents process data to a human operator.
- Human operator monitors and controls the process.

B. Control System
1) B&R/Sigmatek/PCBased Control System
Control system consists of Programmable Logical Controller with remote stations for controlling the field devices. Control system is having Input cards for acquiring the control parameters and output cards for field devices control.

2) OPC System / Protocol convertor
OPC servers are used to communicate data between PLC and systems. It is a open standard using OLE technology, communicate real-time information exchange between software applications and process hardware. OLE for Process Control (OPC) software interface technology facilitates the transfer of data between industrial control systems, Human Machine Interfaces (HMI), supervisory systems.

C.Data Acquisition System
PXI based Data Acquisition Systems are used to acquire the field parameters data for storage or monitoring. The measurement parameters are acquired by single or multiple systems. The acquired parameter may be analog or digital.

VI.   The Scada Software Implementation
The SCADA software consists of the centralized Web Based SCADA program and the interface programs. The Web based SCADA program is developed with AJAX technology. It is build with MySQL database and PHP as server side scripting language.

This Web based SCADA software can be used with any PLC or DAS with the required interface programs. It provides the following functionalities:
1) Access Control
2) Installation phase
3) DesignTime Environment
4) Run time Environment
5) Log management
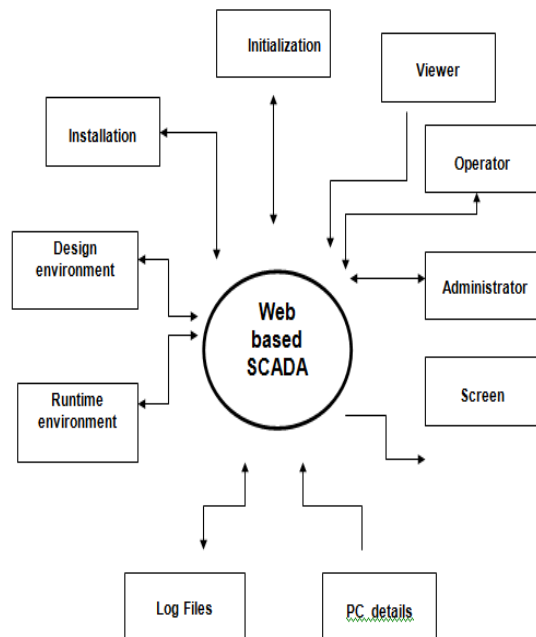
Fig.3. Web Based SCADA Software Interface

1) Access Control Module

This module implements the access control functions for authentication and authorization for different functionalities in the software. It implements the following:

- New User Creation
- Authentication
- Authorization(low level in default)

2) Installation Module

This module implements installation functionalities. It implements the following:

- MySQL Database creation
- MySQL Tables creation
- All valves Table creation
- Group creation
- User Authorization

3) Design Environment SCADA Software

This software realizes all the web based
SCADA design functions with respect to interfacing with the existing control system and data acquisition system. It implements configuration with authentication & authorization and safety requirements like generation of logs.
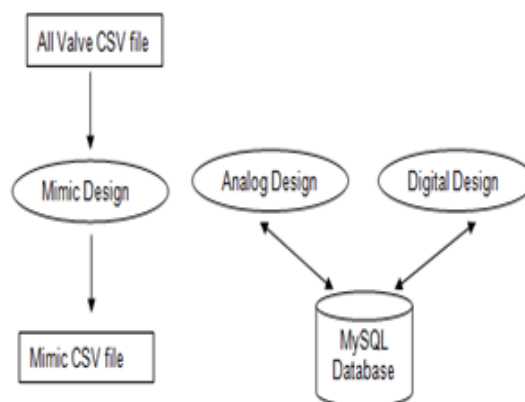
Fig.4.Design Time Software Interface

User interacts with this software for conducting different tests and monitoring the parameters / status.
The Design environment is accessible only by the user having Administrative rights.
The different functional entities that comprise this software are the following:

- Analog Random Channels Design
- Digital Random Channels Design
- Mimic Background Design
- Mimic Design

4) Runtime Environment SCADA Software

This software realizes all the Web Based SCADA runtime functions.
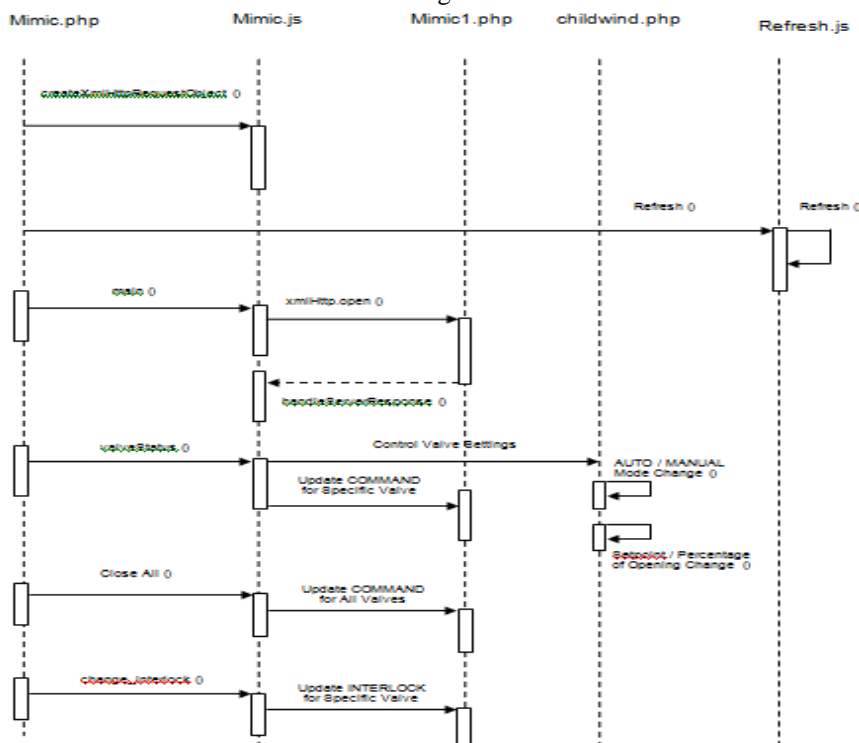User provides the runtime environment for the following.

Fig.5.Sequence Diagram for Runtime Environment SCADA Software

The different functional entities that comprise this software are the following. The runtime functionalities require the dynamic updation of webpage. The AJAX technology is implemented for providing the dynamic updation in the web page displays.
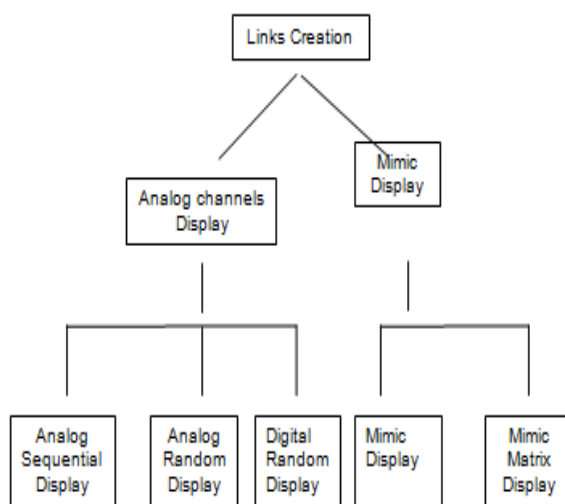
Fig.6.Runtime Interface

- Analog Random Channels Design

This provides display   sequential for 100 numbers of parameters in a page. By using 'Move Next' and 'Move previous' buttons page transitions is provided for monitoring all available analog parameters.

Fig.7.Analog Parameter display

- Digital Random Channels Design

This provides display of randomly selected digital parameters as per requirement with the maximum of 12/32/50 analog channels. Page selection is available for providing transition between different pages. For digital display positive/negative logic can be used. In positive logic 0 corresponds to green and 1 is red in color. In negative logic it is reverse.
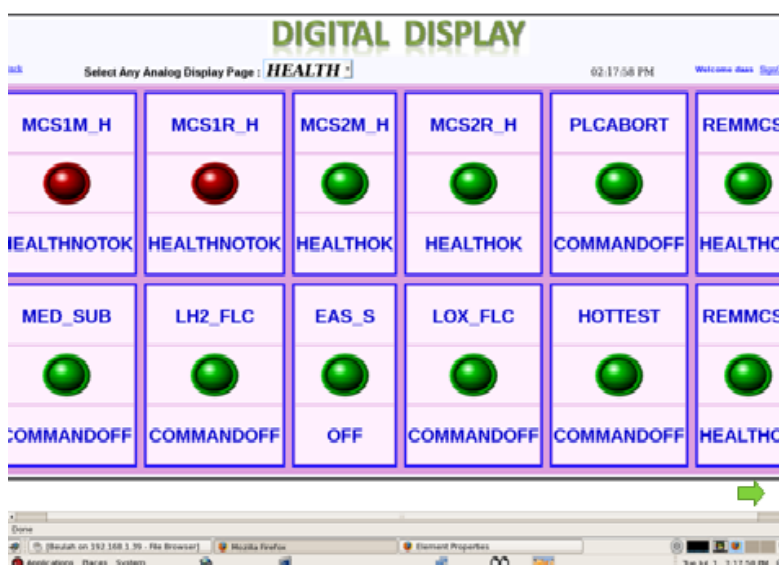

Fig.8.Digital Display of   Selected channels

Mimic Display shows/ displays valves for operation in two formats:
1. Valves positioned in the mimic diagram with analog / digital display. In mimic display the valves will be positioned with respect to the mimic background.
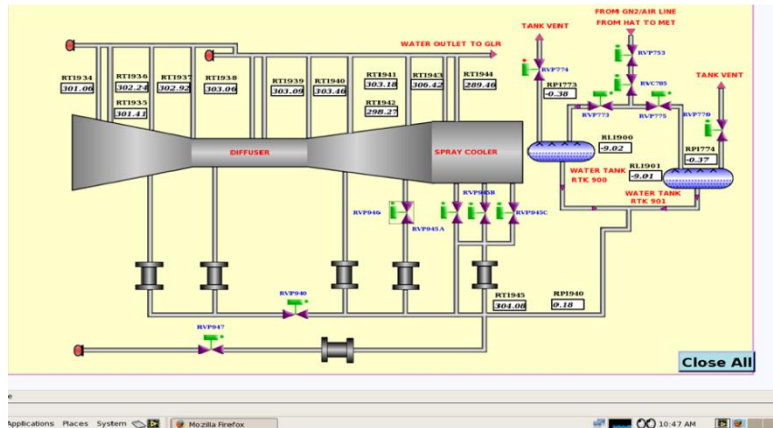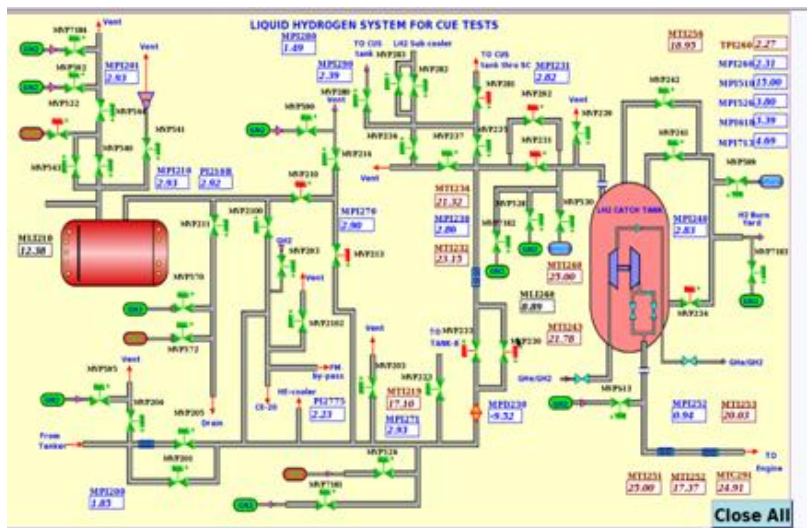
Fig.9.Runtime Mimic Display

Fig.10.Mimic Display

2. Valves arranged in a matrix format for the valve operations. Here the valves positioning and background are not needed.
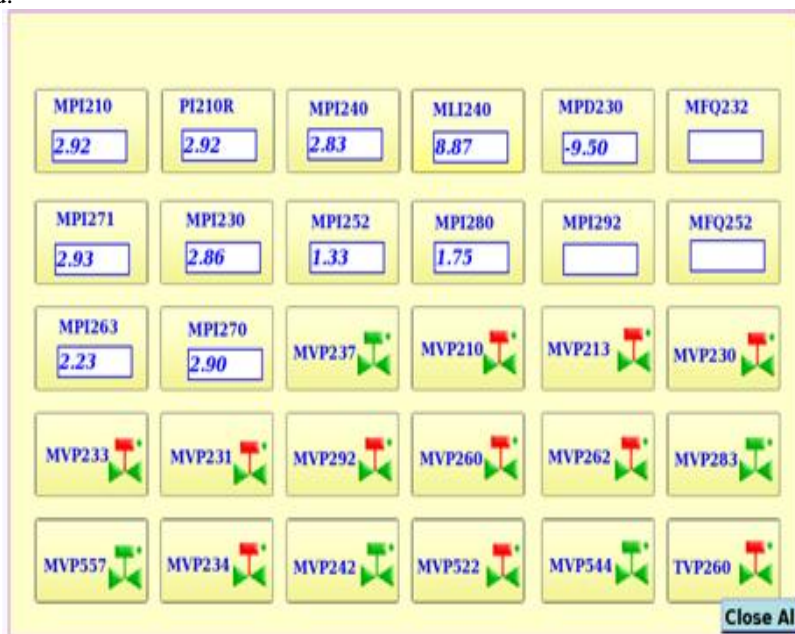

Fig.11.Mimic Display in Valve Matrix Format

B. Interface Programs

1. SCADA Interface Program

The SCADA interface software is developed in Labview. This interface program does the interfacing of DAS and PLC. This program receives the data acquisition systems and sends the command data to the PLC interface program. The analog data, digital data and valve related data are stored in separate tables. This interface receives the data from DAS Server and sends the data to the OPC server in the form of UDP multicast packets.

C. PLC interface program

PLC interface will be used between the PLC and SCADA interface for receiving the data from the PLC or sending the commands to the field through PLC. This interface program is the OPC interface or protocol convertor program. The PLC interface program is running in the OPC server if the PLC is having the OPC connectivity. The PLC interface program will be protocol convertor program if it is arc net based PLC. This interface is used with respect to the PLC availability in the test facilities.
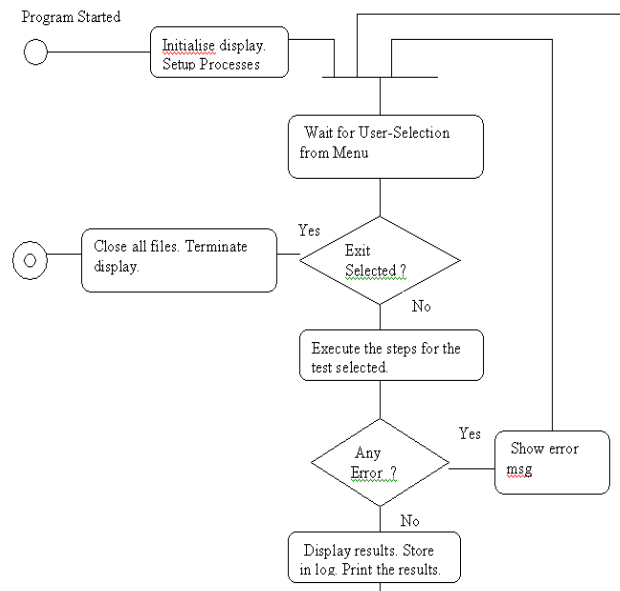

Fig.12.Activity Diagram for SCADA Interface

VII.   Conclusion

Web Based SCADA System is implemented in the test facilities to reduce the unplanned downtime, and maximizing the operational life of plant assets.

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