Implementation of Substation SCADA System for 3X500 MW Power Plant

OVERVIEW

Substation monitoring and control functions are moving out of age due to recent development in communication system. IEC61850 standard is one of the established and proven standards which is now widely accepted due to its increased openness and interoperability between devices. This case study presents real situation and implementation of IEC61850 based substation automation system.

Implementation details

Country : *India*

Year of Execution : *2009-2010*

Business Situation

Providing SCADA based automated solution for 1500 MW power plant

Key Platform

Wonderware SCADA, SEL Numerical relays, IEC 61850

Key Benefits

- *IEC61850 based Automation*
- *Lesser manual interventions*
- *All critical data in a centralized system*
- *Report generation*
- Remote Relay settings

INTRODUCTION

The client is the one of the biggest thermal power producer in the country with overall production of 30644MW, which is approximately 42% of India's overall power production. This plant network consists of power plant with total capacity of 1500 MW (3X500), electrical system consists of voltage levels HT (33KV 11KV, 3.3KV) and LT (415V) and around 35 different substations with 600 numerical relays

SYSTEM REQUIREMENTS

The plant consists of 600 feeders. The manual monitoring of these feeder parameters is not possible. So the primary requirement is the SCADA system which will allow the operator to monitor and control all the relays and devices remotely. All the relays in the plant support IEC61850 based standards. So the proposed system will make use of all the features that are possible with IEC61850. All the relays are connected to the common LAN so that any relay in the network can be accessed by the computer in the control room.

Major requirement of the system are as follows:

- Integrated SCADA with all HT and LT substation
- Remote Relay Settings
- Event and Alarm list with time stamp
- Time synchronization of all the equipments
- Measurement with data quality
- Monitoring of network equipments
- Audible alarm with filtering
- Detailed reporting of feeder data
- Two LAN subnet for substation and control room
- Three levels of Security
- Event and report data storage up to five years

The customer has a requirement of remote relay parameterization facility through centralized SCADA system without affecting communication performance. The main objective in this project was to control the communication traffic and achieve the 2sec updating time of events with the exact origin timestamps. All the data must be tagged with quality status like over range or under range or last know value, etc. The customer also required a network device which monitors switches and routers to find the network cable status, link status of all the Ethernet links used in the project and also to distinguish alarm dependency on the type (Protection/Communication/Trip).

Figure 1: System Architecture

SOLUTION

System Overview

The 600 relays are grouped into six based on its geographical location of where they are mounted. Each group of relays is connected into one data concentrator, which is connected to the Wonderware server. The data concentrator is acting as the data access server (tag server) and data storage server for the corresponding group of relays. There are three SCADA clients that are fetching the plant data from the six Data concentrator to view, control, and parameterize the numerical Relays. Figure-1 shows the system architecture
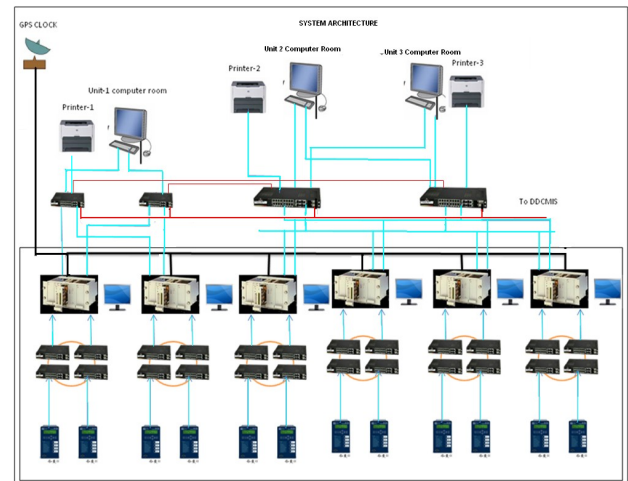
Two levels of ring network are used, which gives the redundancy in field network and enterprise network. The Garretcom and Hrishman industrial switches are used to established the ring network by making use of the RSTP technology. All the switches used support IEC61850. Figure- 2 shows a SCADA screen with the single line diagram of the plant.
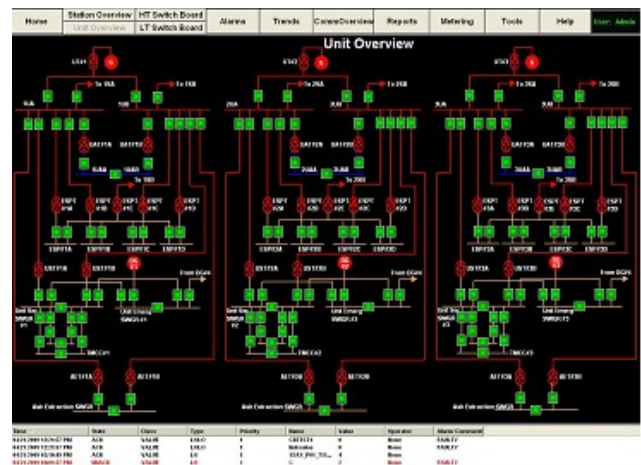

Figure 2: Plant Overview

System architecture

The total system consists of six Wonderware SCADA servers that are located in six different locations. Each data concentrator is fetching data from around 100 relays that are connected to the substation LAN. In the Substation LAN, the topology is RING topology with each

node in the RING is a network switch with each switch connected to 8 to 14 relays in STAR topology. The six data concentrators are connected in a control room LAN in another RING network. All the data concentrators, HMIs, Relay programming laptops etc, are connected in the switches that are acting as the nodes in the control room LAN. Different subnet for the control room LAN and substation LAN is used to control unwanted traffic in the network. To make the ring effective and to avoid signal retransmission the usage of RSTP enabled switches in the network is used.

The Wonderware client system consists of whole substation SLD, Individual substation SLDs, Measurements, Trends, Alarms and Events. The individual substation SLD gives the picture of each substation. For each feeder in a substation there are many links attached. By using the links one can easily view the Alarm/Event list, trends (Real time/Historical) and Relay details of a particular feeder. The relay details shows/displays the input /output status of the relay, Measurements and LED status.

In the measurements data quality also displayed using the quality bits received from the relay through IEC61850. The color of the measurement display is changed in order to understand the different quality of the data received. The Quality information is used in Trend, where the pen color will change as per the Quality change.

The MSSQL2008 is used for the centralized data storage. There are two servers that continuously store the field data. The SQL mirroring mechanism for missing data retrieval from one server to another is used. Using the SQL data the detailed reports of the plant is given and also the reporting tool has the ability to handle feeder wise data for the last five years.

The remote relay parameterization is a main feature of this SCADA application. The control room computer can easily access any relay in the substation. So using this feature relay engineer can change or program the relay settings from the control room.

The total network is monitored by the SCADA for any link failure and switch healthiness etc. This is achieved by using the SNMP protocol. The SNMP server located in the SCADA data concentrator receives the SNMP trap messages from the switches. SCADA monitors the trap message and displays the link failure, port failure and even the location of the failure.

There are around 40000 tags (field points) in this application. So in order to reduce the traffic IEC61850 reporting function is used. Here the SCADA will not poll all the relays for the signal updation. The relay will send the signal only when there is a change in the signal status. So this event reporting technique has considerably reduced the traffic in the network.

ACHIEVEMENTS

The main challenge in this project was the network traffic control. Around 40000 tags (field points) were present in this application which was controlled and monitored by SCADA. However Kalkitech has overcome this by making use of latest IEC61850 protocol features and thereby making it one of the biggest IEC61850 based substation automation system implemented in India at the time.

The Remote Relay parameterization is a main feature of this SCADA application. Though this feature is not new to substation automation, it is implemented in a way that any computer can access any relay in the network. This feature helps the substation engineer to change the relay settings, read the disturbance recordings, and change the protection parameters. Kalkitech, thus successfully met all key requirements set out by the client initially.