Design and Implementation of SCADA System Based Power Distribution for Primary Substation (Monitoring System)

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Abstract- This research describes monitoring system and networking in SCADA based electrical distribution technology for primary substation. The objective of the study is to transform the manual control system to automated switch control system in Myanmar. There are four main portions in SCADA based electrical distribution system. They are automated control system, interfacing units, monitoring system and network architecture. The monitoring system and networking are emphasized in this research. The monitoring system can be accomplished with the use of GUI. This system monitors status of field devices and data transfer between RTU and MTU so that the system can be easily controlled by the operator via server and clients. The simulations based approach automated system are demonstrated. According to the simulation results, the user can easily control based on this GUI software environment. This system is efficient and reliable for conventional electrical distribution system in Myanmar by using SCADA based technology.

Keywords – SCADA, monitoring system, electrical distribution of primary substation

I. INTRODUCTION

Power distribution SCADA system is a computer-based production process control and scheduling automation system. It uses the data acquisition module to monitor and control the operation of field devices so as to achieve data acquisition, device control, measurement, parameter adjustment, and various signal alarms. The power distribution SCADA system has many advantages, such as information integrity, efficiency, correct grasp of system running status, speeding up decision-making, and can help quickly diagnose the failure state of the system. It has become an indispensable tool for power dispatching.

The SCADA system can monitor and control equipments operated on the site so as to achieve functions, such as data acquisition, measurement, parameter adjustment, and various signal alarms. The power distribution monitoring system uses two monitoring hosts (one main host, and one standby host) to call and monitor the load status, load distribution curve, important alarm, accident statistics, working status, and other electricity monitoring data of various substations.

SCADA is an acronym for Supervisory Control and Data Acquisition. SCADA systems are used to monitor and control a plant or equipment in industries. These systems encompass the transfer of data between a SCADA central host computer and a number of Remote Terminal Units (RTUs) .A SCADA system gathers information (such as where the fault in transmission line has occurred), transfers the information back to a central site, then alerts the home station that a fault has occurred, carrying out necessary analysis and control, such as determining if the fault is critical, and displaying the information in a logical and organized fashion. SCADA systems have made use of the infrastructure of the corporate Local Area Network (LAN)/Wide Area Network (WAN), Wireless technologies for monitoring purposes.

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II. INTERFACING BETWEEN SCADA AND SUBSTATION CONTROL SYSTEM

A. Introduction of SCADA system

SCADA (supervisory control and data acquisition system) refers to the combination of telemetry and data acquisition. SCADA encompasses the collecting of the information via a RTU (remote terminal unit), transferring it back to the central site, carrying out any necessary analysis and control and then displaying that information on a number of operator screens or displays. The required control actions are then conveyed back to the process. SCADA is a common process automation system. It is also called Energy Management System(EMS). A SCADA system gathers data from sensors and instruments located to remote sides. Then, it transmits data at a central site for controller monitoring process. SCADA system consists of one or more field data interface devices (RTUs or PLCs).A communication system such as radio, telephone, cable, satellite, etc. A central host computer sever or severs (also called a SCADA center, or Master Terminal Unit (MTU)). A collection of standard and/or custom software (Human Machine Interface(HMI)).

Critical infrastructure systems include critical physical processes. These processes are controlled by automation systems which combine humans, computers, communications, and procedures. Automation systems are used to increase the efficiency of process control by trading off high personnel costs for low computer system costs. They also contribute to improve performance by taking advantage of faster computer control instead of human reaction times. These automation system are often referred to as process control system (PCS) or supervisory control and data acquisition (SCADA) systems, and the widespread use of such systems makes them critical to the safe, reliable, and efficient operation of many physical processes.

Specific terminology is associated with the components of SCADA systems. These SCADA elements are define as follows:

- **Operator:** Human operator who monitors the SCADA system and performs supervisory control functions for the remote plant operations.
- **Human machine interface (HMI):** Presents data to the operator and provides for control inputs in a variety of formats, including graphics, schematics, windows, pull down menus, touch-screens, and so on.
- **Master terminal unit (MTU):** Equivalent to a master unit in a master/ slave architecture. The MTU presents data to the operator through the HMI, gathers data from the distant site, and transmits control signals to the remote site. The transmission rate of data between the MTU and the remote site is relatively low and the control method is usually open loop because of possible time delays or data flow interruptions.
- **Communications means:** Communication method between the MTU and remote controllers. Communication can be through the Internet, wireless or wired networks, or the switched public telephone network.
- **Remote terminal unit (RTU):** Functions as a slave in the master/slave architecture. Sends control signals to the device un.der control, acquires data from these devices, and transmits the data to the MTU. An RTU may be a PLC. The data rate between the RTU and controlled device is relatively high and the control method is usually closed loop.

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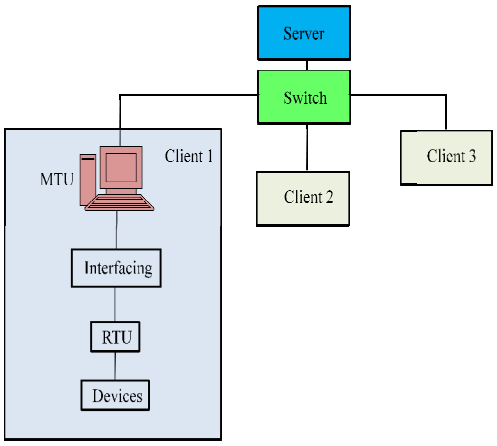

Figure 1: Block diagram of SCADA system

B. Primary substation

It can be performed as a transmission substation and also as a distribution substation. As a distribution substation, the sub-transmission voltage is reduced for general distribution throughout the area. A substation needs devices such as the following intelligent electronic devices:

- Potential transformers (PT)
- Current transformers (CT)
- Main transformers
- Disconnecting switches (DS)
- Circuit breakers (CB)

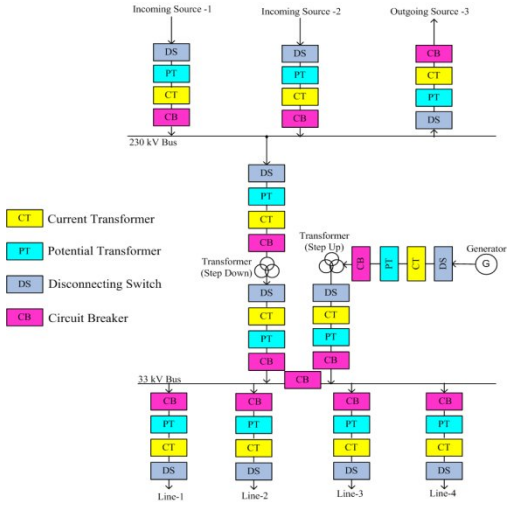

Figure 2: Block diagram of a primary substation

C. Interfacing between SCADA and substation control

Distribution system is concerned with hardware components such as generator, transformers, transmission lines and circuit breakers etc. SCADA system has participated with software packages and main target is for supervisory control and data acquisition. For this reasons, distribution system components must connect to the various sensing devices (such as CTs, PTs) for collecting data from the power lines.

There are interfaces to substation intelligent electronic devices (IEDs) to acquire data, determine the operation status of each IED and interface to the energy management system (EMS) to receive data from the substation integration and automation system at different periodicities. The system must interface with all of the IEDs in the substation. This includes polling the IEDs for readings and event notifications. The data from all the IEDs must be sent to the utility enterprise to populate the data warehouse or be sent to an appropriate location for storage of the substation data. The system must know the status of all connected IEDs at all times.

Basic information describing the operation state of the power network is passed to the SCADA system. This information is collected automatically by the equipment in various substation and devices and can be categorized as status indication, measured values and energy values. The status of switching devices and alarm signals are represented by status indications and these indications are already closings connected to digital input boards of the RTUs.

Measured values reflect different time varying quantities, such as voltage, current, temperature and tap changer positions, which are collected from the power system. They fall into two basic types, analog and digital. All analog signals are transformed via an A/D converter to binary format because treated as momentary-value that they have to be normalized before storing in the SCADA database. The SCADA system is configured around the following standard functions such as data acquisition, monitoring and event supervising, control, data storage archiving and analysis, and then reporting. However, this paper illustrates monitoring and event supervising of substation distribution system.

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III. MONITORING SYSTEM OF A PRIMARY SUBSTATION

The monitoring system is a real time supervision system of the field devices real time status (currents, voltages, pressures, temperatures, contacts, etc.). This supervision is made through digital equipments and special sensors that are installed in the field devices of the substation. The data are collected and processed in a data acquisition and control unit (UAC), to thereafter through a communication network, using desirably a protocol standardized internationally, be sent to a central computer located at the control building of the substation and later to the operation centers and so allowing a remote supervision.

A. Implementation of monitoring system of a primary substation

The monitoring system of a primary substation is, as shown in fig3, composed of main window and three sub-windows where the operator can easily work out.

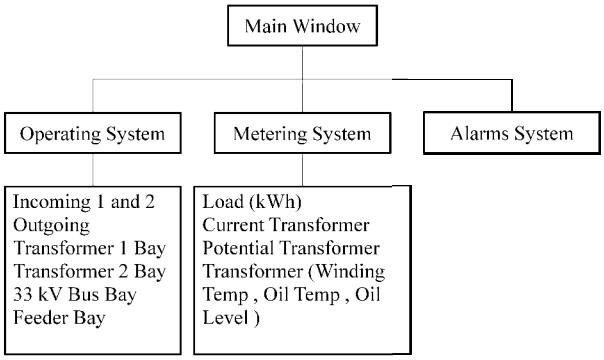

Figure 3: Flow diagram of monitoring system

The monitoring display of a substation is shown in fig.4. Supervisory condition can be seen and changed by three statuses such as no communication, closed, opened. All button and text name on control screen have already connected with the field devices or IEDs of and distribution system. Therefore, the collecting data from field devices send to their respective button and text archives, and then each button changing condition can vary the storage value of the supervision screen. If an operator wants to close or open some line, operator can directly open or close the button or text on the screen as a real time condition. Each tag properties on screen can be changed and seen by clicking on desired button.

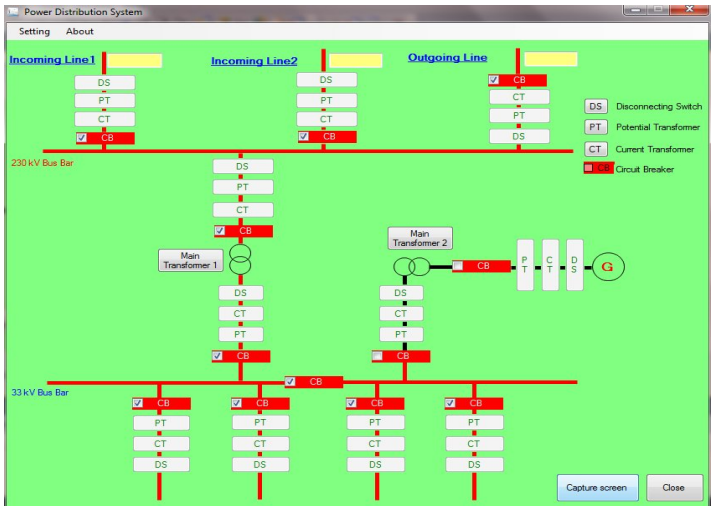

Figure 4: Supervision status of control display

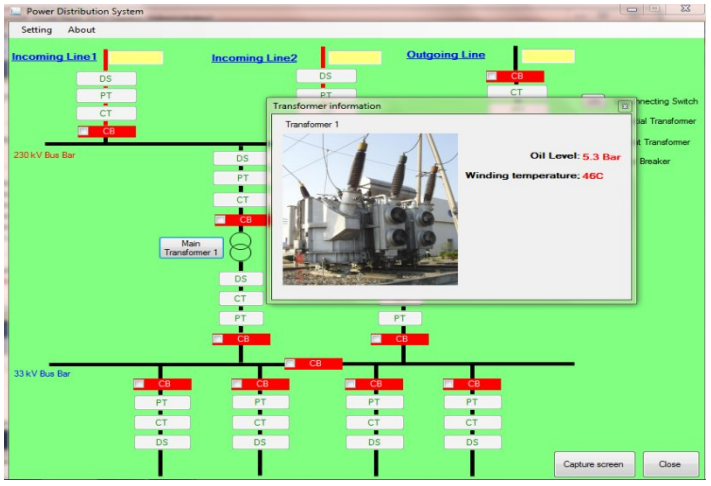

Figure 5: Showing the status of main transformer 1

IV. CONCLUSION

The main purpose of power system management (EMS) or SCADA system is to generate, transmit and distribute electric energy efficiently. SCADA main function is to supervise, control and manage power networks in an integrated manner. The whole distribution can be seen on displayed screen and periodic data changes can be acquired automatically.

The main advantage of this system is labors can be trained on computer and their skills can be improved in short time. Future plan can be

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simulated with the help of SCADA software. Then following parameter can be calculated easily.

- Load flow calculation
- Short circuit calculation
- Stability calculation
- Transient analysis
- Load forecasting
- Protective relay coordination

At the master station, the operator can know the total load, energy production per generator, frequency, overloading at the substation or transformers and losses etc. SCADA or EMS system is immediately necessary for survival of power utilities in metropolitan cities. Effective power distribution without SCADA system will be difficult.

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