SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) FOR DISTRIBUTION AUTOMATION SYSTEM (DAS)

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November 2005

I admit that I have read this report and in my point of view this report achieved the scope and quality for the purpose of graduation in Bachelor of Electrical Engineering.
(Industrial Power)

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Date : 18/11/2005

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This Report Is submitted In Partial Fulfillment of Requirements for the Degree of Bachelor in Electrical Engineering (Power Industry)

Fakulti Kejuruteraan Elektrik
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November 2005

I admit that this project is written by me and is my own effort and that no part has been plagiarized without citation.

Signature : .....

Name : SABARUDDIN BIN AKIBE

Date : 21/11/2005

Specially dedicated to

My beloved father and mother, Akibe Bin Muhamad and Dalima Binti Sappa. Also to my brothers and my sister who have encouraged me, guided me and inspired me throughout my journey of education.

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Bismillahirahmanirahim.....

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ABSTRACT

Modern Energy Management System (EMS) has high potential of future innovation and modifications. This project focuses to the distribution side, Distribution Automation System (DAS), controlling and monitoring the distribution system and the connected load. Currently, the Supervisory Control and Data Acquisitions (SCADA) system is mainly used at the generation and transmission side (high voltage side) in TNB. The SCADA system analyzes data from the electrical equipment at the substation. In TNB SCADA, it has no information about the electrical parameters directly from the distribution side. The purpose of this project is to operate, control, monitor, activate, and de-activate the system to operate with the help of Remote Terminal Unit (RTU) and Automatic By-pass Switch (ABS). The data obtained from this two devices will be useless without SCADA to handle and manage it. The final target for this project is to come up with small scale SCADA functions and operations aimed at distribution system environment.

ABSTRAK

Sistem Pengurusan Tenaga Elektrik adalah berpotensi tinggi untuk di majukan di masa hadapan secara kreatif dan inovatif. Projek ini memfokuskan pada bahagian pengagihan, sistem pengagihan automasi yang mengawal dan membuat paparan pada sistem tersebut dan bahagian beban yang bersambung. Sistem SCADA yang digunakan di TNB sekarang cuma di bahagian penjanaan dan peghantaran sahaja iaitu bahagian voltan tinggi. Sistem SCADA TNB cuma menganalisa data daripada radas-radas dan tidak ada informasi secara terus tentang parameter dari pencawang-pencawang di bahagian pengagihan. Tujuan utama projek ini adalah untuk mengawal, memaparkan, mengaktif dan mematikan system dengan bantuan *Remote Terminal Unit (RTU) dan Automatic By-pass Switch (ABS)*. Data-data yang diperolehi daripada radas tersebut akan diuruskan oleh sistem SCADA. Sasaran akhir projek ini adalah menghasilkan satu skala kecil tentang SCADA yang mampu beroperasi pada sistem pengagihan.

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CHAPTER 1

INTRODUCTION

1.1 Overview

SCADA stands for Supervisory Control and Data Acquisition. The acronym has been around for 30 years. SCADA systems in the past years were primarily industrial monitoring systems with limited data gathering and control capability. However, in the last 10 years technology has evolved so that many systems maintain huge historical data repositories and are the front end for implementing and viewing sophisticated control schemes. This project focuses to the distribution system, Distribution Automation System (DAS), controlling the distribution system and the connected load.

In this project the SCADA system will be implemented at the distribution side. The SCADA system consists of remote terminal units (RTU's), sectionalizing switches (automatic by-pass switch), data acquisition system, and communication interface and control computer. Distribution SCADA involves collecting and analyzing information to take decision, implementing the appropriate decision and then verifying whether the desired results are achieved.

1.2 Transmission and Distribution

A typical layout of a generation, transmission and distribution network of a large system which would be made up of the elements is shown in Figure 1.0.

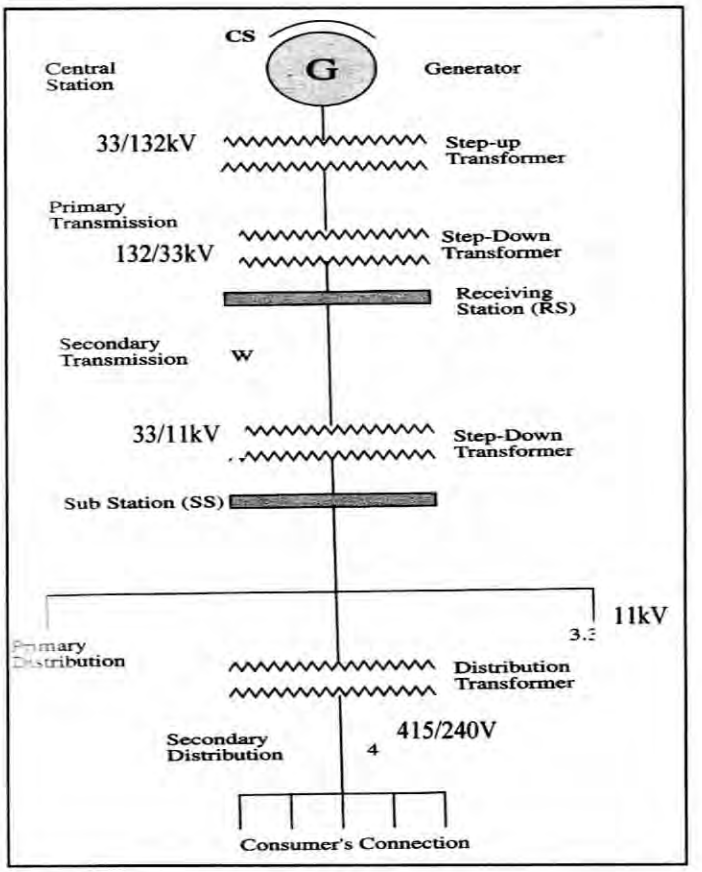

Figure 1.0 : Layout of a generation, transmission and distribution network.[1].

To explain and realize Figure 1.0 that one or more of the elements may be missing in any particular system. For example, in a certain system, there may be no secondary transmission and in another case when the generation station is nearby, there may be no transmission and distribution system. In some other cases also, the distribution part at the generation side only for 33kV and 11kV below, mostly 11kV exist.

High-voltage transmission is carried out at 500kV at PMU Ayer Tawar Perak, Yong Peng Johor, Paka Terengganu and Kapar Selangor but mostly the transmission line in Malaysia is either 275kV or 132kV. The distribution network in Malaysia is 33kV and below and until low voltage side is reached 415V and 240V for three phase and single phase systems.

This project will focus on distribution part of 415V and 240V for single phase.

1.3 Objectives

Objective of this project is to initiate (monitor and control) the SCADA system for operation at the downstream network. Ensure that the SCADA system can communicate with the RTU and automatic by-pass switch. This project also can acquire the necessary information about the parameters such as voltage and current, accurately, quickly and with relative ease, it can also indicate and instruct the automatic by-pass switch at the faulted line. To improve the power management at the distribution side so that it is more efficient and systematic. This project also can control the substation automatically only from the control station and can minimize the use of human resources. It can save time and cost and improve the quality performance of the distribution lines operating switches.

1.4 Work Scope

The SCADA system will concentrate on monitoring and controlling the distribution side. The SCADA system will be connected to the RTU and the automatic by-pass switch. This project focuses on the 240V or single phase line. The control room can communicate with the RTU and automatic by-pass switch through the communication cable that is a RS232 communication link. The control room can send and receive the data from the two devices.

1.5 Project Contribution.

Currently, the SCADA system in Malaysia is only for monitoring and collecting data from the substation and transmission line. This project will upgrade the current system to more enhanced version and the first version for SCADA at the distribution side. This project is not only meant for monitoring the system, it is also meant for controlling the substation by the Remote Terminal Units (RTU) and automatic by pass switches. The control room also can get the accurate and quick parameters from the two devices such as a voltage and current.

So, only from the control station, the switch can be opened or closed and also can get the data required from the substation and distribution line.

1.6 Overview of Supervisory Control and Data Acquisitions System (SCADA).

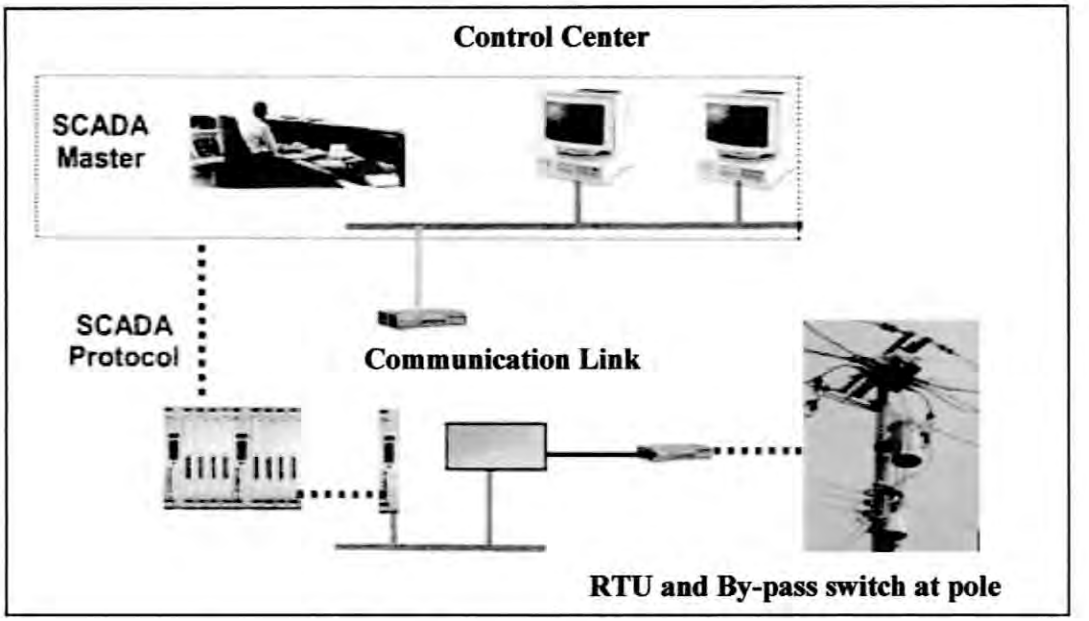

Figure 1.1 : System Overview

1.7 Overview of Distribution Automation System.

Distribution automation is basically a system that allows for automatic, computerized control of a utility's distribution facilities with little or no human intervention. Before automation, actions such as opening and closing the switches required physical, on site interaction from linemen, which often taken a considerable amount of time. With a Supervisory Control and Data Acquisitions (SCADA) devices, operators are able to open or close the switches from a remote location, even if they are miles away from the actual device's location. With the implementation of distribution automation, these actions become automatically controlled by a computer-based system. The computerized controlled makes these decisions almost instantly and immediately implements the necessary course of action.

The SCADA devices mounted on the pole throughout the system communicate with master stations at their respective substations via a fiber optic, wireless access points, cables, or some similar form of communications. SCADA sends or receives the information from the RTU through the communication link. Control center operators also can manually send out commands if deemed necessary. SCADA devices are capable of collecting data from the field to keep in track of the power factor, voltage, current, power and the frequency.

The distribution automation is also used to prevent the failure and outage from ever occurring. The information gathered by the SCADA can also be utilized by engineering and planning departments for load forecasting. [2]

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter explains the research related to the distribution management system, distribution automation system, implementation of SCADA and the ability of the communication network. The principle ideas are established before the design of the communication network and the basic concept of the RTU and switches. This chapter also briefs about the software used to develop the interface of SCADA.

2.2 Automated System

For the sake of electrical power distribution reliability, sectionalizing switches are provided along the way of primary and secondary feeders. By adding the fault indicator to the sectionalizing switches (automatic by-pass switch) along with circuit breaker and protective relays at the distribution substation, the system is comfortable and easy to determine fault sections. If a power failure occurs at the primary line, the switch automatically changes to the secondary line to save time and reduce the losses. The switches are used for supply restoration process and to prevent the black out. The action of these switches is controlled from the control center through the Remote Terminal Units (RTU'S). [3]

Automation at the consumer's location includes the ability to remotely: read meters, program time-of-use (TOU) meters, connect/disconnect services, control consumer load and send TOU signals. The expected benefits from automating consumer locations are:

a) Reduced Operation & Maintenance (O&M) cost
b) Deferred capital expenditures
c) Improve consumer satisfaction
d) Better information for planning and engineering

2.2.1. Reduced (O&M) Cost

Operation & Maintenance costs are reduced through reduced labor requirements and processing of consumer claims. It's saving in time for each task, the number of times each task is performed and the cost to perform for each task. Saving is initially realized in decreased purchased power costs resulting from regulatory legs and rate design practices. These savings are the result of reduced peak demand due to load management and TOU programs. They should be considered to be highly transitory in nature and are more conservatively represented as deferred capital investment for peaking generation. The present value of a short term decrease in power costs may be considered a benefit of consumer automation.[3]

2.2.2 Deferred Capital Expenditures

Through load management and TOU incentive, customer peak demand is reduced and the need for additional facilities is deferred. The present value of the deferred capacity requirements is used to quantify this benefit.

2.2.3 Improve Costumers Satisfaction

Automation system installed in distribution side will improve the costumer's satisfaction. The fault occurs on the line, its just take a minute to solve the problem by automations system. So the costumers still can get the electricity by another supply.

2.2.4 Better Information for Planning and Engineering

All the events happened will record on the database. So the engineer and the operator can do analysis of the system. For the future planning, most of the systems need to be improved. The data on the database will help to make the future planning.

The operators or the technicians can get ready to take action on the field, easy to do maintenances and identify the fault location.

2.3 Load Management in Distribution Management System (DMS)

This occupies controlling system loads by remote control of individual costumer loads. Control consists of suppressing or biasing automatic control of cyclic loads, as well as load switching. Load Management can also be effected by including customers to suppress load during utility selected daily periods by means of time of day rate incentives. Distributions Automation provides the control and monitor ability required for both the load management scenarios and direct control of customer's loads and the monitoring necessary to verify that programmed levels are achieved. Execution of load management provides several possible benefits to the utility and its customers. The function of DMS are shown in Figure 2.0

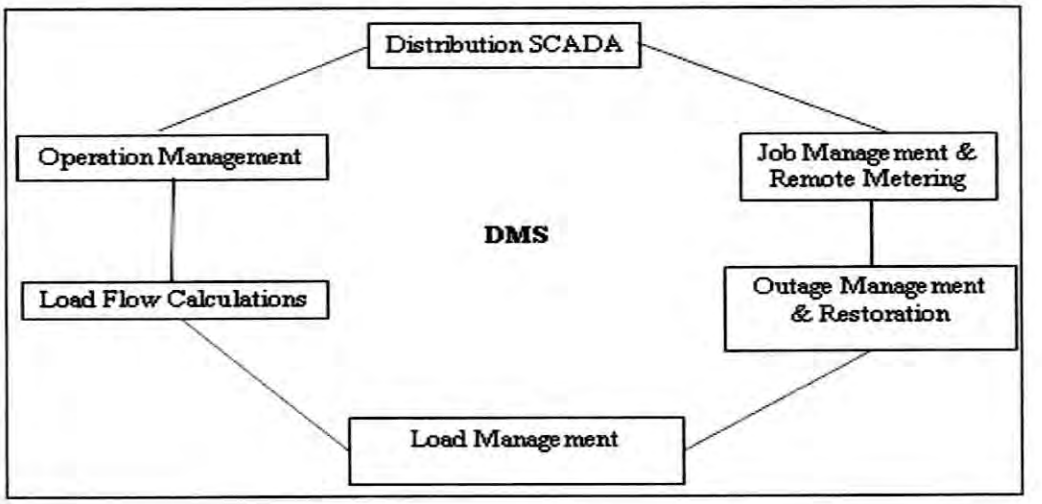

Figure 2.0 : Distribution Management Systems

2.4 Distribution Automation System (DAS)

The various parameters such as current, voltage, frequency, switch status and powers are recorded in the field at the substation and at the line feeder using a data acquisition device called Remote Terminal Unit. All this parameters are transmitted directly to the control station through a communication media interface. Graphic user interface (GUI) is used to display all the data to the computers.

For any controlling action, like opening or closing the switch or circuit breaker, it must be through the RTU and the control station by the communication channel to remote the action. For this automatic vacuum by-pass switch it can operate automatically, but the SCADA can take over the action if more efficient action or solution is needed. The connection between the distribution, control, and communication system is shown in Figure 2.1