**PC BASED PROTECTION SCHEME**

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# PC-BASED PROTECTION SCHEME

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**A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering (Industrial Power)**

**Faculty of Electrical Engineering**

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**MAY 2009**

I declared that this report entitle "PC-Based Protection Scheme" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 22 APRIL 2009

To my beloved mother and father

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# ABSTRACT

As power industry enters the new century, the need for extensive simulation is becoming more and more inevitable. Expanding services into a real time measurement and monitoring becomes an increasingly important requirement in the power system protection network. These needs grow further as new remote real-time protection and control applications become more feasible. This project presents a real-time, PC-based Supervisory Control and Data Acquisition (SCADA) of an electrical power protection scheme. The SCADA was developed with the aims of meeting the real time acquisition and remotely control needs of electrical power protection while solving the limitations of traditional manual monitoring and control method. The input for the SCADA system is power system protection scheme hardware. This hardware is developed by using the principle of the overcurrent protection with an additional communication infrastructure; transducer to give a real-time value to the SCADA. The hardware's real-time operational and several electrical parameter reading such as current and voltage can be observed and monitor via a PC. This project will use the LabVIEW as the platform or development environments in extensive support for accessing protection scheme hardware. LabVIEW is a graphical programming for measurement and automation. The programming called Virtual Instrument (VI) will be design to manipulate the acquired data from the hardware and control this protection hardware. All the data acquired from can be monitored and control via the graphical user interface (GUI).

# ABSTRAK

Semakin industri sistem kuasa memasuki era baru, keperluan sistem untuk menjalankan tugas dengan lebih baik adalah semakin diperlukan. Pengembangan keperluan untuk mengawasi sistem kuasa dalam pengukuran masa nyata adalah sangat penting di dalam rangkaian perlindungan system kuasa. Kepeluan yang bertambah ini lantas menyebabkan aplikasi baru dalam pengawasan dan pengawalan sistem kuasa dari lokasi yang jauh dapat dilaksanakan.Projek ini mengunapakai keperluan mengawasi informasi masa nyata dan mengaplikasikan sistem mengawal dah meperoleh data (SCADA) dengan mengunakan komputer dari jarak jauh. Sistem SCADA ini telah dibangunkan dengan tujuan untuk pengambilalihan system untuk memperoleh data dan mengawal perlindungan system kuasa tenaga elektrik sambil sebagai penyelesaian kepada had-had bagi pengawasan dan kaedah kawalan manual yang tradisional. Input kepada sistem SCADA merupakan perkakasan system perlindungan kuasa. Perkakasan ini dibangunkan dengan menggunakan prinsip perlindungan arus lebih dengan satu prasarana komunikasi tambahan; transduser bagi memberi nilai masa nyata kepada sistem SCADA. Operasi perkakasan dan bacaan beberapa parameter elektrik seperti arus dan voltan boleh diperhatikan dan dipantau melalui sebuah PC. Projek ini akan menggunakan LabVIEW sebagai platform atau persekitaran pembangunan dalam penyokong perkakasan sistem perlindungan LabVIEW merupakan satu perisian pengaturcaraan untuk pengukuran dan automasi. Pengaturcaraan yang dipanggil Virtual Instrument (VI) akan direkabentuk untuk memanupulasi data yang diperolehi daripada perkakasan dan mengawal perkakasan. perlindungan tersebut. Semua data yag diperoleh daripada perkakasan dapat dipantau dan dikawal melalui antara muka pengguna grafik (GUI).

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## CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Power supply is one of the most important resources to the human society development [1]. The cost of power outage is on the order of millions of ringgit. However, power system can become vulnerable in the face of possible system abnormalities such as control, protection or communication system failures, disturbances and human operation errors [2].Therefore, to keep power supply stable and reliable is a very critical issue for power systems design.

In January 2005, a massive breakups of the transmission lines on the East Coast of Malaysia [3] system cost up billion ringgit direct and indirect loss. The incidents demonstrated the importance of real time information for the control system strategy design. Real time can be highly valuable information source for automatic control to maintain system stability. It can also be used as a guide to immediate operating decisions in support of system recovery and for extensive analysis.[4][5]

As the electric power industry enters the new century, new services are compelling electric utilities to make dramatic changes in the power system information infrastructure design. Expanding network services such as real time monitoring are also compelling the need for more increasing bandwidth in the communication network backbone. These needs will grow further as new remote real-time protection and control applications become more feasible and pervasive[6].

Computer networks and data communication play important roles in power systems [7]. SCADA (Supervisory Control and Data Acquisition) systems are essential parts of the Power system and employ a wide range of computer and communication technologies.

Applications from SCADA (Supervisory Control and Data Acquisition System) system, remote measurement, to monitoring, and control, protection, are critical to the proper operation of power system in order to maintain system reliability and stability [8].

## 1.2 Project Objectives

The major objectives of the study are to implement the SCADA application in a power system protection scheme; develop a protection scheme model and a PC-based system communication infrastructure to associate with model's real-time information. The main research topics are summarized as follows:

1. To design a protection scheme hardware.
   Hardware of protection scheme will be design; this hardware will be used as monitored system by SCADA software.

2. To develop software that can be use to monitor and control the protection scheme.
   This software is developed to apply the actual concept of SCADA that had been used in industry. This software must have ability to monitor and control the hardware of protection scheme that will be design also.

## 1.3 Project Scope

1. The hardware for the system is a overcurrent protection.
2. The software will be used for;
   a. Monitoring
      i. Current and voltage reading
      ii. Position and status of Breaker (open/close)
      iii. Trip Indication and Location
      iv. Fault Information
      v. Energy usage

b. Supervisory Control
   i. Breaker operation (trip/reset)
   ii. Acquisition speed

## 1.4 Problem Statement

1. Traditionally, measurements are done on instruments of various types- oscilloscopes, multi meters, counters etc. However, the need to monitor the measurements and process the collected data for visualization has become increasingly important.

2. The demand to gather reliable and instant information in power systems have greatly increased. Requirements to remotely monitor and control the power system operation becoming more important. With this ability, operator can respond instantaneously thus improving the power system performance.

## 1.5 Project Arrangement

In general, there are 6 chapters in this project report. Some basic principle, theories, design, result and discussion are included in this 6 chapter based on content requirement for each chapters.

Chapter 1 is the introduction of the research project. Overview and the main objective of this project will explain in this chapter. This chapter also will explain about scope and problem statement for this project.

Systematic study on the research project will be explained in chapter 2. This literature review chapter will cover the all the principle or concept that will be used for the project. All the information is extremely important in accomplishment of this project.

Chapter 3 is the methodology chapter for this project. In this chapter all the step or method that used in this project will be explain in detail. The designing process also will be covered in this chapter.

Chapter 4 and Chapter 5 is and very crucial chapter. Chapter 4 is a result chapter while chapter 5 is the analysis for the result gain. The entire finish product on the project will be shown in figure in these 2 chapters.

Chapter 6 will conclude all the works and studies that had been presented in the previous chapter. It will also suggest idea for additional research for this project.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Real Time Value

Real time date can be highly valuable information source for automatic control to maintain system stability. It can also be used as a guide to immediate operating decisions in support of system recovery and for extensive analysis [9]. According to the research [1], the widespread power outage in the western United States on 10 August 1996 could have been avoided if 0.4% of the wide area loads had been shed for 30 minutes. The 1996 breakups as well as other outages demonstrate that wide area, comprehensive and real time information exchange is becoming a critical factor for the future power system reliability and stability.

Figure 2.1 illustrates the relationship between measurement, information, and decision making. The real time data applications range from very rapid control function to the very slow functions such as expansion planning [1]. With high-speed real time measurement, proper protection and control actions could be taken to ensure the reliability of power system when event occurs [10].

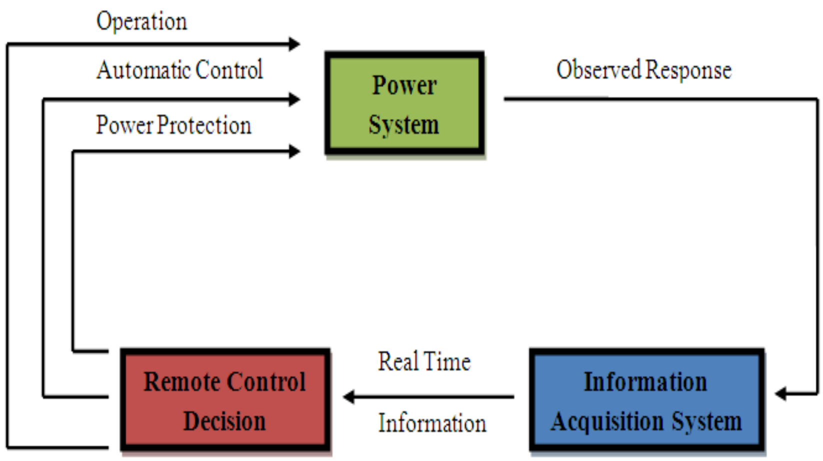


Figure2.1: Relationship between measurement, information and decision making

## 2.2 SCADA

SCADA is an acronym that stands for Supervisory Control and Data Acquisition. SCADA refers to a system that collects data from various sensors at a factory, plant or in other remote locations and then sends this data to a central computer which then manages and controls the data. [8]

SCADA is a term that is used broadly to portray control and management solutions in a wide range of industries. Some of the industries where SCADA is used are Water Management Systems, Electric Power, Traffic Signals, Mass Transit Systems, Environmental Control Systems, and Manufacturing Systems [8].

### 2.2.1 SCADA as a System

There are many parts of a working SCADA system. A SCADA system usually includes signal hardware (input and output), controllers, networks, user interface (HMI), communications equipment and software. All together, the term SCADA refers to the entire central system. The central system usually monitors data from various sensors that are either in close proximity or off site (sometimes miles away) [8].

For the most part, the brains of a SCADA system are performed by the Remote Terminal Units (sometimes referred to as the RTU). The Remote Terminal Units consists of a programmable logic converter. The RTU are usually set to specific requirements, however, most RTU allow human intervention, for instance, in a factory setting, the RTU might control the setting of a conveyer belt, and the speed can be changed or overridden at any time by human intervention. In addition, any changes or errors are usually automatically logged for and/or displayed. Most often, a SCADA system will monitor and make slight changes to function optimally; SCADA systems are considered closed loop systems and run with relatively little human intervention [8].

One of key processes of SCADA is the ability to monitor an entire system in real time. This is facilitated by data acquisitions including meter reading, checking statuses of sensors, etc that are communicated at regular intervals depending on the system. Besides the data being used by the RTU, it is also displayed to a human that is able to interface with the system to override settings or make changes when necessary.

### 2.2.2 User Interface

A SCADA system includes a user interface, usually called Human Machine Interface (HMI) or Graphical User Interface (GUI). The HMI of a SCADA system is where data is processed and presented to be viewed and monitored by a human operator. This interface usually includes controls where the individual can interface with the SCADA system [11].

### 2.2.3 SCADA Software and Hardware Components

SCADA systems are an extremely advantageous way to run and monitor processes. They are great for small applications such as climate control or can be effectively used in large applications such as monitoring and controlling a nuclear power plant or mass transit system.

SCADA can come in open and non proprietary protocols. Smaller systems are extremely affordable and can either be purchased as a complete system or can be mixed and matched with specific components. Large systems can also be created with off the shelf components. SCADA system software can also be easily configured for almost any application, removing the need for custom made or intensive software development [11].

## 2.3 Power System Protection

Power system protection is that part of electrical power engineering that deals with protecting the electrical power system from faults by isolating the faulted part from the rest of the network [12].

The main objective of a protection scheme is to keep the power system stable by isolating only the components that are under fault, whilst leaving as much of the network as possible still in operation. Thus, protection schemes must apply a very pragmatic and pessimistic approach to clearing system faults. For this reason, the technology and philosophies utilized in protection schemes are often old and well-established because they must be very reliable [13].

Protection systems usually comprise five components:

1. Current and voltage transformers to step down the high voltages and currents of the electrical power system to convenient levels for the relays to deal with;
2. Relays to sense the fault and initiate a trip, or disconnection, order;
3. Circuit breakers to open/close the system based on relay and autorecloser commands;
4. Batteries to provide power in case of power disconnection in the system.
5. Communication channels to allow analysis of current and voltage at remote terminals of a line and to allow remote tripping of equipment.

### 2.3.1 Overcurrent Protection

Protection against excess current was naturally the earliest protection system to evolve [14]. From this basic principle, the graded overcurrent system, a discriminative fault protection, has been developed. This should not be confused with ‘overload’ protection, which normally makes use of relays that operate in a time related in some degree to the thermal capability of the plant to be protected [15]. Overcurrent protection, on the other hand, is directed entirely to the clearance of faults, although with the settings usually adopted some measure of overload protection may be obtained. There of 3 type of overcurrent protection relays that’s operates when the faults current is higher than its current setting [14].

1. Instantaneous relay – operates in typically 20ms – 40ms
2. IDMT relays – time delay operation. Delay depends on the current setting, fault current and time-multiplier setting.
3. Definite time relay – operates when current exceeds setting for present time.

# CHAPTER 3

# METHODOLOGY

## 3.1 Overall Planning

A necessary project methodology should be followed to complete this project. Figure 3.1 shows the flow of project methodology in conducting this project. All the schedule activities should be done on time to make sure project is on the right progress and not affecting other activities.

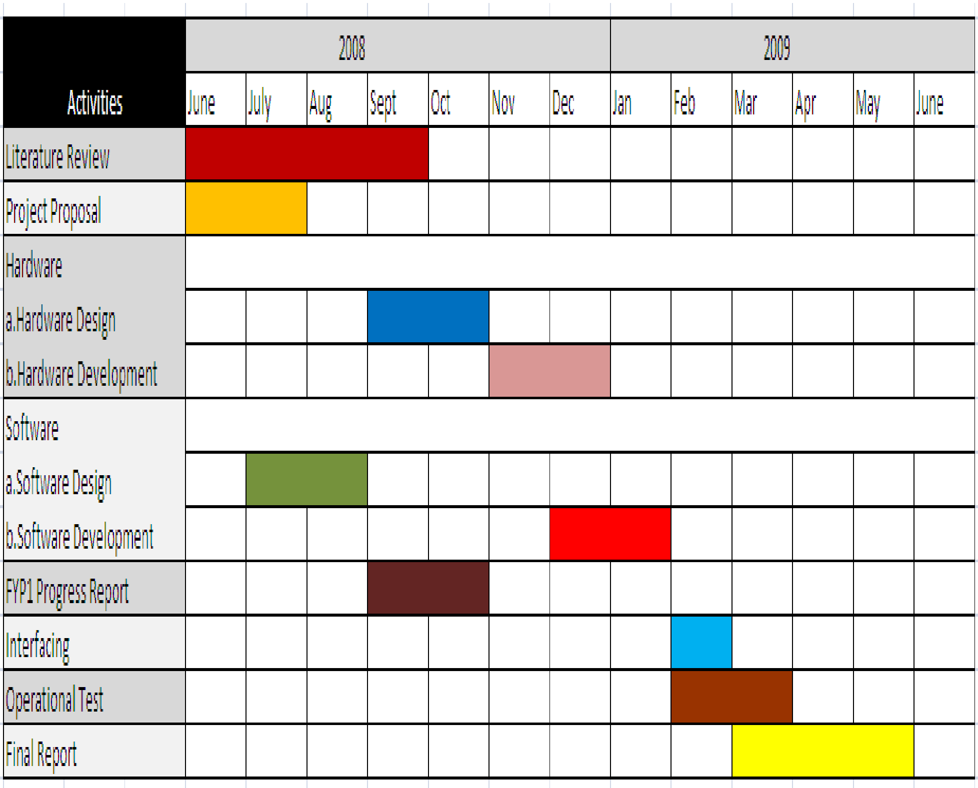


Figure 3.1: Gantt chart of overall project planning