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THE IMPLEMENTATION OF FAULT MANAGEMENT IN DISTRIBUTION SYSTEM USING DISTRIBUTION AUTOMATION SYSTEM (DAS) IN CONJUCTION WITH SCADA

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Abstract- **In general, the electric power distribution system is responsible to deliver the power from a set of distribution substation system to the customers. The operation of controlling and monitoring of electrical power activity or condition in distribution side, typically take place at the distribution substation system. However the distribution substation system, often facing a problem such as required longer time to restore back the electric supply when power outage occurred. The engineer and technician manually have to locate the fault position and spend plenty of time. In addition the acknowledgement system used by Tenaga Nasional Berhad (TNB) such as Supervisory Control and Data Acquisition (SCADA) only indicate the event such fault through certain panel. Therefore, the implementation of proper fault management is highly important to be utilized such as by applying automation system in distribution system. Up to date, in Malaysia there is no automation technique being used for maintenance work in distribution system. Those problematic issues as mentioned above motivated the authors to propose the idea for implementation of Distribution Automation System (DAS) in distribution side. The major consideration in this work is to identify fault management strategy for switching circuit breaker to be implemented as new algorithm technique in SCADA. Finally, the secondary plan is to apply the new algorithm to the DAS for small scale of experimental study. It is expected the propose strategies will improve recent fault management specifically distribution system in Malaysia.**

Keywords- **Supervisory Control and Data Acquisition (SCADA); Distribution Automation System (DAS); Human Machine Interface (HMI); Low Voltage Distribution System.**

I. INTRODUCTION

Nowadays, the electrical power industry is become important due to the demand of the electricity from the consumer is getting higher. According to World Bank report [1], the electricity power consumption (kWh) in Malaysia was 100,996,000,000 in 2009. This value indicates the maximum point that has been reached over the past 38 years starting from 1971. The [2] reported that Malaysia's electricity consumption is expected to increase by about 30% from its present value to 124,677,000,000 kWh by 2020. Furthermore in 2008, the first sectors that use larger amount of electricity energy in Malaysia are industrial and transport, followed by accounting sector which indicated the second largest. The residential and commercial sector was the third larger sectors that use electricity energy. Finally, the agriculture sector consumed only 1% from the value of electricity energy in Malaysia [2].

Malaysia had suffered a long duration and total power blackout in 29 September1992 which was expected due to lightning strike to the transmission facility and causing main failure in the transmission and distribution system . This incident lead to the high concerned especially among the government leader and business leaders about how it would affect investor as well as the reliability of Malaysian infrastructure [3, 4]. The second accident was occurred on 3 August 1996 due to tripped at a transmission line near Paka power station in Terengganu that cause all power stations in Peninsular Malaysia collapsed and resulting in a massive power failure [4]. Based on this accident, TNB proposed the alternative way to improve the quality and security of supply by install the Supervisory Control and Data Acquisition (SCADA) in distribution network on 1998 [5].

SCADA encompasses the collection of information (data acquisition), transferring the data over physical mediums (the field of the telemetry/data communication) and the processing and display of the data at the master station. SCADA is received the

collecting information from a field devices such as current sensor, voltage sensor or other via Remote Terminal Unit (RTU), transferring it back to the central site, carrying out any necessary analysis and control and then displaying the information on a number of operator screen or displays. The required control actions are then conveyed back to the processor [6].

A SCADA system usually consists of the following subsystems:

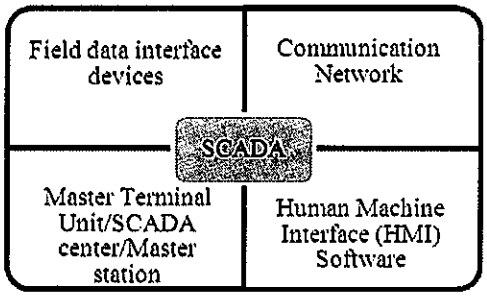

Figure 1. SCADA component

A. Field data interface devices

Devices such as power meter consumption, temperature transmitter and others provide information that can tell an experienced operator the performing of distribution system. So, to pass the information to SCADA, RTU or PLC is needed to convert the information to a form that is compatible with the language of the SCADA systems. The function of RTU or PLC is to convert electronic signals received from field data interface devices into the language (known as communication protocol) used to transmit data over communication channel). The difference between RTU and PLC are shown in table 1. In this research, RTU was choose as field data interface devices because this research will be apply in wide range area.

Table 1. Difference between RTU and PLC

RTU(Remote Terminal Unit)	PLC(Programmable Logic Control)
Electronic devices that controlled by microprocessor	Digital computer
Suitable for wider geographical telemetry (can use wireless communication)	Suitable for local control (e.g.: assembly lines in factories, light fixtures, etc.)

B. Communication Network

Communication network means the equipment needed to transfer data to and from different sites. Based on table 2, it is show the types of communication media and also their advantages and disadvantages.

Table 2. Communication network

Types	Advantages	Disadvantages
Twisted Pair Metallic Metal	-Economical for short distances -Relatively high channel capacity (up to 1.54 MHz) for short distances	-Failure may be difficult to pinpoint -Inflexible network configuration -Subject to breakage, water ingress and ground potential rise due to power faults and lightning
Coaxial Metallic Cable	-Economic for short distances -Higher channel capacity than Twisted-Pair Metallic	
Fiber Optic Cable	-Immune to electromagnetic interface and to ground potential rise -High channel capacity -Low operating cost	-Immune to electromagnetic interface and to ground potential rise -High channel capacity -Low operating cost
Microwav e Radio	-High channel capacity -Transports high data rates -Circuit added at low unit cost -Simple installation than cable technology	-Line of sight clearance required -Specialized test equipment and training required -Limited capacity -More expensive site development
Satellite	-Wide area coverage -Easy access to remote sites -Costs independent of distances -Low error rates	-Total dependency on remote facility -Less control over transmission -Transmission time delay -Reduced transmission during solar equinox
Very High	-Frequency assignment	-Low channel capacity

Frequenc y Radio (VHF)/Ul tra High Frequenc y Radio (UHF	available -Propagation over non-line-of-sight paths -Low cost radios compared microwave -Less stringent waveguide and antenna	-Low digital data bit rate -Limited transmission techniques available
Power Line Carrier(P LC)	-Located where the circuit is required -Equipment installed in utility owned land and structures -Economically attractive for low number of channels extending over long distances	-Not independent of the power distribution system -Carrier frequencies often not protected on a primary basis -Expensive on s per channel basis compare to microwave(normall y over 4 channel

C. *Master Terminal Unit (MTU)/SCADA center/Master station*

MTU is consists a single computer or a network of computer servers that provide a human machine interface (HMI) to the SCADA system. MTU use to process the information received from and sent to the RTU sites and present it to human operators in a form that operator can work with.

D. *Human Machine Interface (HMI) software*

Successful SCADA systems will likely produce when software is well defined, designed, written, checked and tested. Visual Basic (VB) software is a one option for programming a HMI application. Besides that, a SCADA software package is designed specifically for HMI application. Examples of SCADA software packages have in the market such as InTouch by Wonderware Company, WinCC by Siemens Company, RsView by Rockwell Company and others. Table 3 shows the advantages and disadvantage between VB software and SCADA software packages.

Table 3. HMI software

Software	Advantages	Disadvantages
Visual Basic	-No runtime licenses (cheaper) -More flexible to design layout follow what system need	-More difficult to code and requires higher level code skills -Use longer time to code
SCADA packages	-Quicker application development. -Communication network to RTU/PLC already built in. -Contain library of standard HMI control (buttons, dials, sliders, etc.). So, just drag the icon and use it.	-Expensive because need to buy runtime license -Less flexibility

II. METHODOLOGY

This paper is focused on the management strategy for switching circuit breaker to be implemented in as new algorithm technique in SCADA for DAS. This research is based on open loop distribution system which means that the loads are connected to two feeders and any section of feeder can be isolated without interruption. Then, the average outage time is reduced to the time required to locate the fault and do necessary switching restore the service.

Based on figure 2, it show the flowchart to indicate the sequence of operations were determined with the visibility of all the automated equipment and their parameters. The logic programming is based on this flowchart and C language programming is used. There are five major actions which are the status of 'power input', mode state, the status of 'reset program', execute 'Operation of Logic Up-Counter (OLUC)', and execute "Operation of Logic Down-Counter (OLDC). First step is to check the power input whether it is turn on or turn off. The power input is referred to digital relay output.

If no fault condition is detected by the relay, the power input is turned on (Normally Close-NC). When the relay detect the fault condition, power input is turned off (Normally Open-NO). In this case, the

relay is reset by using a delay timer and power input is turned on automatically.

There are two mode of operations in developed system which are manual mode and automatic mode. If automatic mode is selected, when fault occurs, the fault point is isolated automatically by activating the 'start low check' and 'start high check'.

'OLUC' and 'OLDC' are executed only when the fault point is isolated and unaffected point is operated as normal condition. Once the fault point is operated as normal, the 'reset program' button is pressed. This button reset back the counter to initial value and executes the 'start low check' and 'start high check' again.

'OLUC' check the logic of up-counter which is from left to right while 'OLDC' checks the logic of down-counter which is from right to left. Then, if manual mode is switch on, when fault occurs, the checking will be done by the operator. The developed Graphical User Interface (GUI) provides buttons to control the switching of the loads.

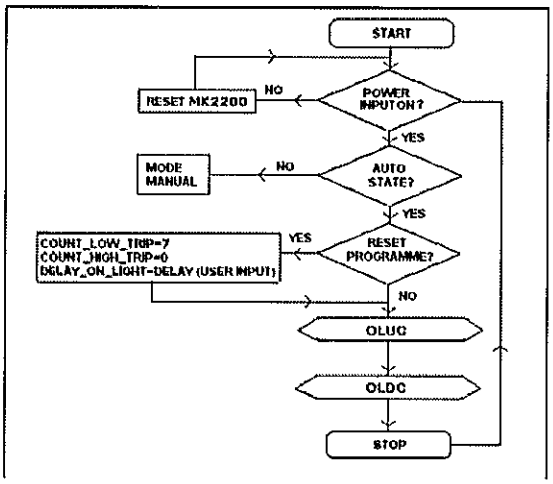

Figure 2. General Flow Chart

Figure 3 shows the strategy to be used in this research. Firstly, healthy condition is occur which means all loads which is called zone #1, #2, #3, #4, #5, #6 and #7 is turn on. But, they will turn off automatically when fault is occurring. This situation they call 'trip occurred'. Then Low Side Checking (LSC) will start to turn on each zone starting on zone #1 until it reaches to the fault zone. Once the fault zone is detect, second trip will occur and all zones will switch off once again. Then, LSC will start again to turn on all zones accept the detected fault zone. After that, when LSC reach the detected fault zone it will stop and High Side Checking (HSC) will turn on the zone from the back order and stop after reach the detected fault zone [7,8,9].

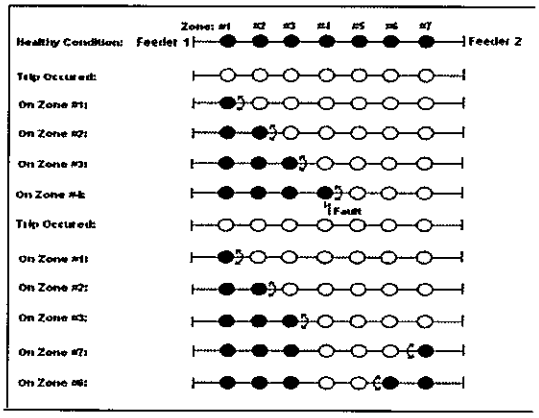

Figure 3. Fault isolation method

III. RESULT

The result for this method will display on Graphical User Interface (GUI). As shown in figure 4 is healthy condition for all output that show green color which is means the communication status has no error with the modules and power analyze. Then, in figure 5 shows that all output is change color to red which is means fault is occur and circuit breaker are turn off. That figure also show the triggered alarm and display on the screen. Lastly, in figure 6 shows that the zone that fault is occurring will not turn on until was repaired.

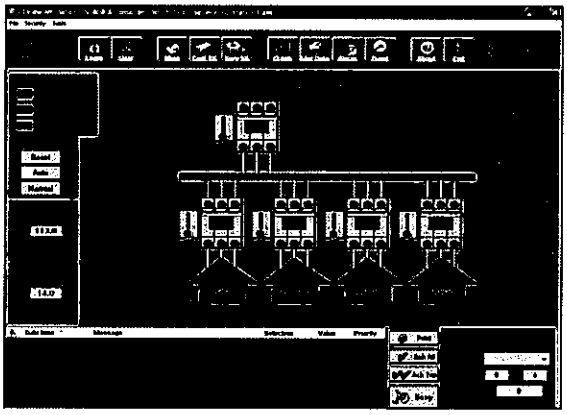

Figure 4. Healthy Conditions at Service Substation Panel

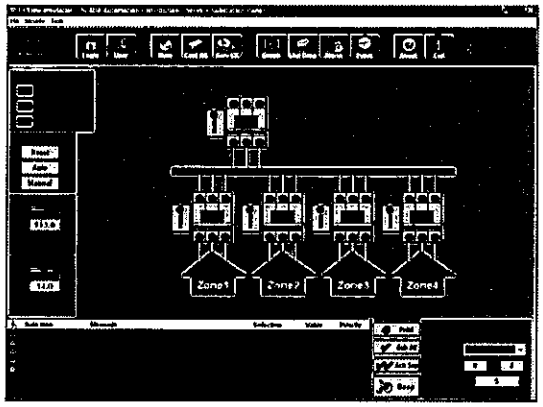

Figure 5. Unhealthy Conditions at Service Substation Panel

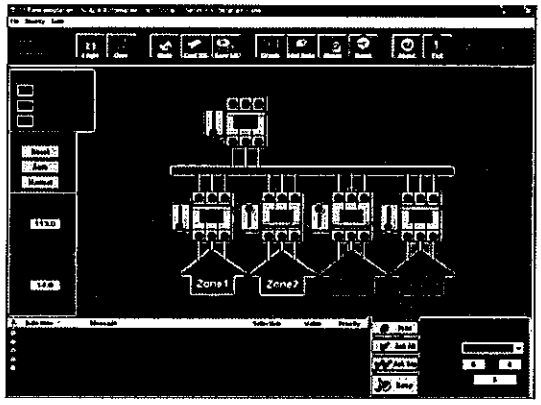

Figure 6. Fault Isolation at Substation

IV. CONCLUSION

The contribution of this paper is to give the overview of the SCADA system while developing DAS. The development system processes the data, store the data for analysis, and operate it independently through intelligent programming. The operating system described here can reduce the number of customers that experience outages. Customers still experiences a short term outage during low side and high side checking until appropriate switching function is completed.

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