SCADA Solution by Installing DTM6000 and Trunking Tier Three

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Abstract—**The aim of this study is to provide the new solution for the SCADA system by using the DTM6000 with Tier three and the multipoint node topology for the application offshore mining industry. The application of the proposed design can provide the data as wind speed, machine temperature, sonar, vessel position. Applying the SCADA Software, NMS (network management system), and DWS (Dispatch Work Station), data can be monitored through the control Center. The SCADA system with radiofrequency can cover a wide coverage area (ie up to 60 km). The trunking base station, carry out the data, and able to transmit voice communication with good quality. The technical design and the installation as well as the trial for validation of the proposed system in the remote area offshore of the mining industry is provided. It is might be stated that the system enables the development and addition of more other SCADA equipment in the future.**

Keywords— SCADA, DTM6000, Remote Area, DWS, NMS.

I. INTRODUCTION

The control center based on Supervisory Control And Data Acquisition (SCADA) for offshore mining industry has been implemented in the control of the process since the early 1900. SCADA Systems evolved to form the industry (Manufacturing, Production, Fabrication, Refining, among others) to others facilities, such as infrastructures (wind farms, pipe line of oil and gas, transmission and distribution of electrical power system) and even to the buildings (airport, Ships,) controlling heating, ventilation, air conditioning system, energy consumptions, etc.

The most usual subsystems in a SCADA are the Human Machine Interface (HMI), which is a dashboard device that connects the person to the systems which technically can be used to any screen that allows the user to interact with a device. The working system, which is a computer system that gets data and sends the command to the process of Remote Terminal Unit (RTU) that converts sensors signal to digital data in order to send it to supervisory systems. The programmable Logic Controller (PLC) that are used as field devices, and the infrastructures of communication that connects to the supervisory of the RTUs. The concept of the SCADA was expanded to be a general means of remote access to a variety of local control modules, which could be from the manufacture of differences and the access permit through the protocols of automation standard. The master station indicates that the obtained data and permits the operator to do the remote control duties. Refer to the accuracy and timely data (normally real-time), it allows the operator of the plant process for conducting the optimization. Another benefit is more efficiently, reliably, and most importantly secure the operations. This study provides the results of operation in a lower cost contrasted to the earlier non-automated systems [2-3].

The background of the study is due to PT. SSS needs the equipment that able to bridge and/or carry-out the data SCADA from field site to the Control center and vice versa. Also, the corporate expected that the system can overcome the bad quality communication during receive and dispatching the data, also if there is a location with the distance is out of range, where which can not be reached or covered by GSM signal, then by using DTM6000 also able to do voice communication because it is equipped with an external microphone. PT. SSS has its own SCADA Software, hence all the parameters such as wind speed, machine temperature, sonar, vessel position, etc can be read in the Screen at the control center. Based on the advanced research result and discussion with our business partner in overseas, this issue can be solved by design and installing the Hytera DTM600. The proposed design method can be validated by a trial that has been agreed upon and approved by the end-user.

II. SCOPE AND OBJECTIVE OF WORKS

The scope of the study is to propose the new technical design and installation for the SCADA system as a solution for the industry by applied the Hytera DTM6000 Trunking Tier Three on Control Center. The SCADA system might be used for checking and determine the failure location or the position of the vessel in which the system has a problem.

The objective of this paper is to make the operator of PT SSS in Sumatera-Indonesia, will be easier to overcome the disturbances that arise on each field site or vessel, so it can support and assist the operational staff in overcoming these disturbances [1]. By using this proposed method, the data in the control room as, the vessel's position (GPS), vessel's speed, ship engine temperature, wind speed, and sonar and other data can be read. Hence the data, as the position of the vessel, wind speed situation, and other data related to the production can be recorded in the dashboard, in real-time to all the vessels and operators of the systems. .

III. PRINCIPLES HYTERA AND SCADA SYSTEMS

A. Hytera Tier III (Three) Trunking.

Hytera Digital Mobile Radio (DMR) Tier Three Trunking is a device which developed by the European Telecommunications Standards Institute (ETSI). It is an Internet Protocol (IP) based on the Platform of Digital Trunked in particular designed to provide the data of receiving and dispatching, and capacity of management across the wide geographical areas and also to overcome the ungood quality of communication. With an all-IP architecture and centralized networking, the solution utilizes the infrastructure with the modular design of the component system in order to deliver high spectrum efficiency, fast access, foremost security, broad-coverage, supple networking, inexpensive infrastructure, slightly costs of maintenance, and smart systems. In this paper, the Trunking Lite (or DS-6211) will be used to address the customer needs.

Table 1. shows the feature and the technical capability of the Trunking lite. One can be seen that the technical and feature of the DS-6211 consist of so many items, functions, and features that can be available and applicable by the user as the advantages of the System proposed

Tabel 1. Feature and function of trunking lite.

Item	Function	DMR Trunking Lite Feature
Standard	Technology Standard	DMR ETSI Open Standard
Frequency	FB8 Required	Yes
	Frequency Range	VHF, UHF
Networking Capacity	Sites per MSO	10 Sites (For the Specific Market)
		"8 Carriers
	Carrier per BS	Channels Voice up to 15 channel
		1 Control Channel”
Reliability	Devoted Control Channel	Included
	Redundancy of Control channel	Included
	Base on Single Station Fallback Control	Included
	Sleep Unit Channel	Included

Item	Function	DMR Trunking Lite Feature
High Level Function	Listening of Discreet	Included
	Assign of Real Frequency	Included
	OTAP	Included
Mobility Management	Power-up Registration	Included
	Power-off Deregistration	Included
	Roaming	Included
Basic Data Services	Message of Short Data	Included
	GPS Data (Control Channel)	Included
	GPS Data (Auxiliary Control Channel)	Included
	Message of Status	Included
Basic Voice Services	Personal Call	Included
	Team Call	Included
	PSTN Call	Optional
	VOIP Call	Included
	Including Call	Included
	All Call	Included
	Broadcast Call	Included

Another benefit of using the Trunking Tier Three is, the system has the NMS (Network Management System) and DWS (Dispatch Work Station) so that the operator or worker in the room control can monitor the performance of DTM 6000. The function of NMS is, it has various management capabilities such as user management, the management, report of alarm systems, the management of authority, and the statistics of upgrade the performance of remote software as shown in Fig. 1.

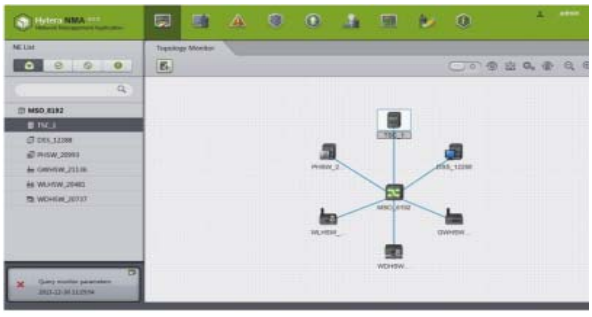

Fig. 1. Network Management System

The DWS is the Dispatch Workstation that offers system communication management including the call for an individual, the group call, a short message, and enhanced functions such as emergency call, the priority call, status of the call, voice recording & message note, which supply the customers more operation to be the option. The output display of the DWS shown in Fig.2.

Fig.2. Dispatching Workstation System (DWS) display.

B. Principles of Scada System

Supervisory Control and Data Acquisition (SCADA) systems are used to control dispersed assets where centralized data acquisition is as important as control [5]-[7]. A SCADA system usually consists of Human-Machine Interface (HMI), a remote terminal unit (RTU) that connects several measuring sensors in the above processes, computer-based surveillance system for data collection, communication infrastructure that connects remote terminal units with surveillance systems, and PLC or Programmable Logic Controller. The main functions of SCADA are as follows: Data acquisition is the process of receiving data from equipment in the field, Data conversion is the process of converting data from the field into a standard format, data processing is analyzing data received to be reported to the operator, supervisory control to allows the operator to control the equipment in the field, Tagging allows the operator to place certain information on certain equipment [4]

The tools for exchanging information with fellow operators/users of the SCADA system; Alarm and event processing: which informs the operator when there is a change in the system. And Post Mortem Review is to help to determine the effect on the system if there is a large disturbance in the network. The program software in smart SCADA systems is programmed, installed, and set to instruct the system to how to respond and what to do for taking the action, as, starting the observation, the ranges of the suitable parameter, and the response if the boundary conditions change the appropriate values.

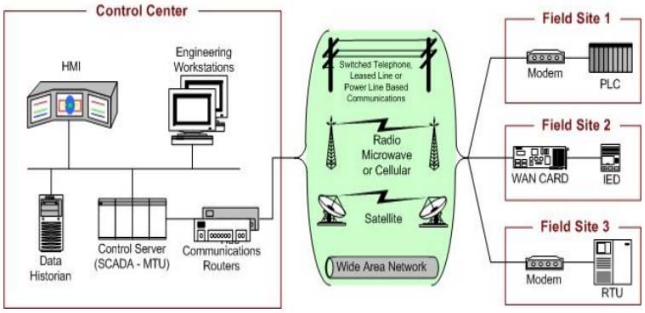

Fig. 3. Scada System General Lay Out

Fig. 3 provides the SCADA general configuration. Generally, there is consist of three-unit Cluster i.e, Control Center, Wide-area Network and the Field site. The control center collects and records the detail of data which is put together by the field sites, displays the information to the HMI, and it may produce the actions based on the detected events. The control center is also accountable for concentrate on the disturbing, analyses of trend, and make the reporting.

The local controls of actuators and monitors sensor at the field site is investigated and monitored by the site field operator. Normally, the sites of the field are frequently equipped with the capability of remote access to allow the operators to conduct the remote examined and improvements, generally by the separate modem of dial-up or the WAN connection. To transport the information among the control center and field sites using telemetry techniques such as telephone line, metallic and fiber optic cable, and radiofrequency such as broadcast, microwave, and satellite, using the standard and proprietary communication protocols that are running over serial and network communications. For the mining industry in a remote offshore area, it should be better if employed the SCADA system with WAN connection of the trunking tier three. The SCADA System General Layout in general proposed shown as in Fig. 3. It can be divided into three main areas, as Field Sites, Radio Trunking, and Central Station. In more detail, the structure of the SCADA solution proposed by Hytera shown in Figure 5 (One Vessel)

C. Design Method of the Devices Implemented

C-1. Hytera DTM6000.

Hytera DTM6000 is a modem data equipment that provides wide-range data communication and adequate data services, which allow different equipment, such as RTUs, PLCs, and meters to allow interface connections with SCADA Systems via IP / Ethernet or serial ports. It also supports standard protocols used in various industries such as IEC60870-5, IEC 60870-5-104, DNP3, and Modbus.

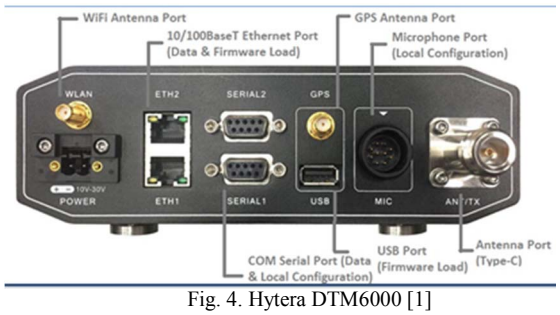

Fig. 4. Hytera DTM6000 [1]

Table 2. Technical Specification of DTM6000

Model Number	DTM-6000
Frequency Range	VHF :136 - 174MHz UHF-1 :400 - 470 MHz UHF-2 : 450 - 520 MHz
Power	1-25 Watt
Dimension	199 ×188 × 58 mm
Weight	1900 gr
Frequency Stability	±0.5 ppm
Operating Voltage	10-30 Volt DC
Dust Proof & Waterproof	IP40 Stadard

The advantages of Hytera DTM6000 include Data and Voice integrated into one device, the ability to transmit data with high efficiency, Multiple data modem interfaces, Wide Area Coverage, High priority for Emergency Data, and Easy to configure. The technical specifications and the structure of DTM6000 shown in Table 2 and Fig. 5. [6-9]. Besides, the GPS, DTM6000 also equipped by Microphone, this is similar to Radio Base, hence from the control room, the operator can talk directly to the vessel without any additional device. So it can be informed that these tools can have three functions in parallel as a modem of SCADA, communication radio, and GPS positioning tracker.

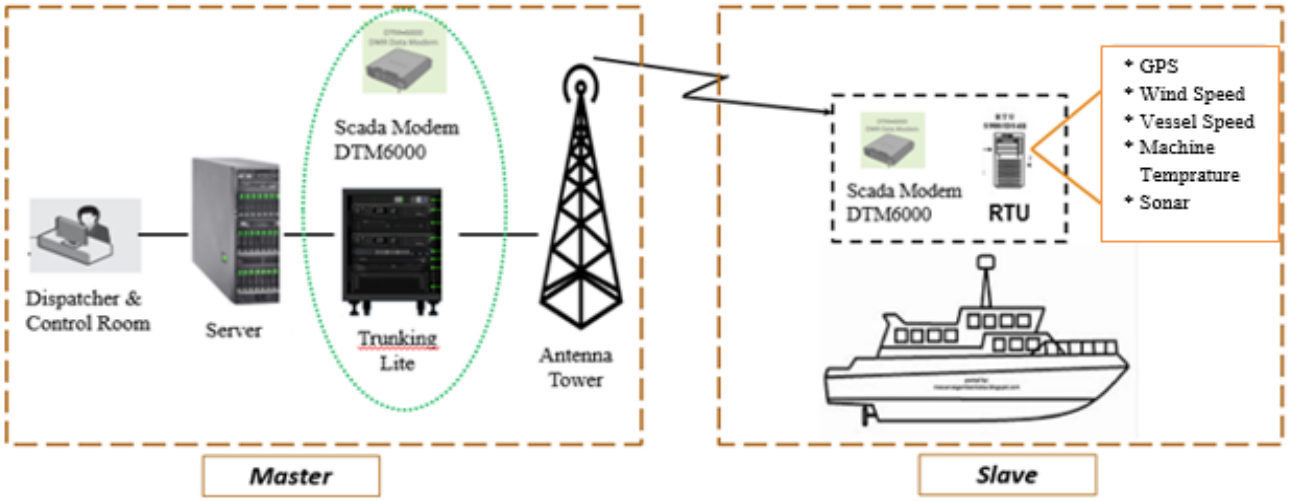

Fig. 5. Structure of SCADA solution Proposed from Hytera (One Vessel)

IV. Research Method and Results

A. Quantitative Method

To obtain accurate data about the location of Device of SCADA System or the Vessel (using latitude and longitude) along with the current and voltage distribution of each vessel for the area of research, by using quantitative research methods. Quantitative methods are generally used to prove the hypotheses. The research steps are as shown in the figure below. This research was carried out at the island of Bangka Belitung (BB) in cooperation with PT SSS and planned to be carried out the trial on August 2020. In mid-2019 a visit was conducted to PT SSS, include with the explanation of our proposal for overcoming the problems by the installation of the telemetry devices in this industry. The proposed solution is by installing SCADA using RF (Radio Frequency) media to overcome the constraints and limitations of conditions in an offshore remote area.

The method of collecting data is to look for variables or things that can be targeted and compared in this study. A preliminary survey is an activity carried out before the start of the study. In this survey, the activities carried out included selecting and viewing locations to be studied. From this survey data on the number of substations will be obtained and determine the point where repeaters/base stations will be installed to obtain an effective number of repeaters/base stations installed

B. Collecting Data

All the data sources examined in this research are both the data of Primary and the data of secondary. The data of primary are data obtained directly from the field. This data can be obtained through direct observation or the results of interviews with informants based on interview guidelines made by researchers. While the data of Secondary were obtained through written relics carried out by reading-literature books, documents, and writings that the researchers considered which have related to the problem being studied.

Several types of surveys were conducted to obtain primary data, namely the vessel location and condition survey. This survey covers the location of vessels and conducts pointing for the latitude and longitude of each vessel, in order to obtain an effective coverage area for repeater/base station installation. And distributed stress survey of each vessel. This survey is intended to get distributed load data from each vessel. The general survey implementation process can be explained as follows: Officers and researchers visit the survey site, recording of data production of an existing vessel. The recording number is written in the survey form. The note taker must also include the time and location of the observation as well as environmental conditions such as weather and special events such as sudden peak productions. The research execution is conducted based on the shown in the diagram of step research below.

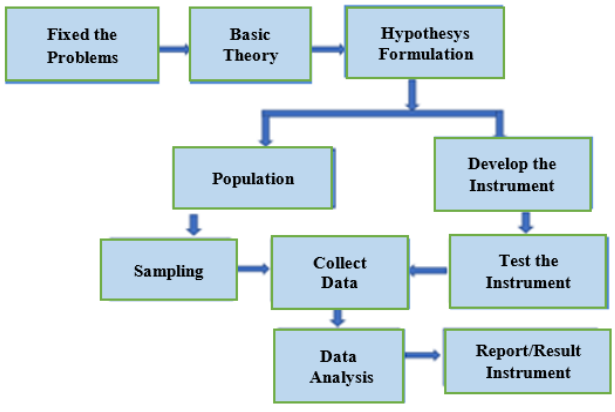

Diagram of the Steps Research

V. TOPOLOGY AND ARCHITECTURE DESIGN

The proposed design and Topology of the SCADA DTM6000 Trunking Tier Three with Smartdispatch system for this study shown in Fig.6. This specific system of SCADA consists of the main control center and thirty(30) local center at field different location. It is common, to anticipate that in case the main control center in malfunction, the company has to install the second backup control center as a prepares redundancy. For all control centers to the field site communications with two connections using radio telemetry used by the multipoint connections. By using the Radio device, the communication from the field sites as a local control center to the dispatcher and the control center can be executed.

The control center lives above the main control center for a supreme level of supervisory control is called a regional control center. All the control center centers can be accessed by the company network via the WAN, and the field sites can be retrieved remotely for troubleshooting and maintenance operations purposes. In order to send a necessary new set point to a field device, the main control center chose the devices of the field for data at defined intervals (e.g. 5 seconds until to 25 seconds). The control server also observes for priority interference coming from the field site alarm systems, as the additional to select and spend the high-level commands systems.

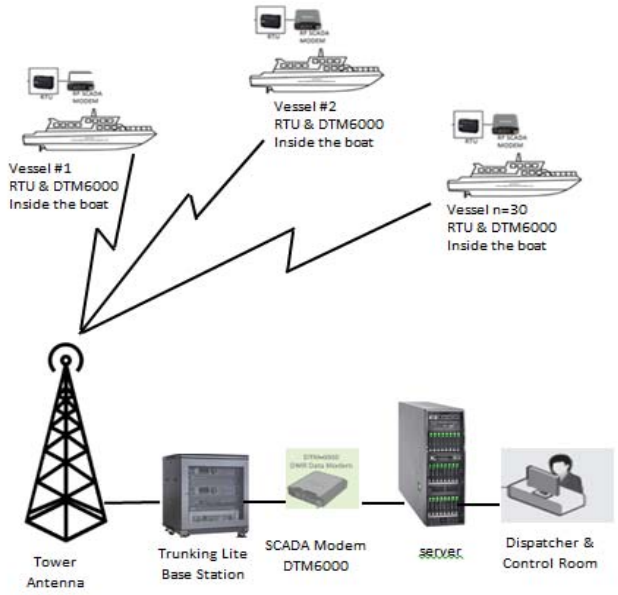

Fig. 6. Topology Propose Design for 30 units Vessel

The SCADA DTM6000 modem is installed one unit in the control center room and one unit installed on the vessel with the longest operational distance at 60 km, assuming that if the experiment was successfully carried out with the farther distance, so for the closer distance definitely it will be no problem. The data SCADA will be read and voice communication alternately or Half-Duplex (HDX) can be done, as well as installing one unit of Trunking Lite base station (product code: DS-6211) with the frequency band 410 - 420 Mhz paired with 420 - 430 Mhz, where the allocation is indeed preferably for the use of Radio Trunking [1]

Fig.6 shows all the instruments or devices used consists of this design and study. The device consists of Dispatcher & Control room, Server, SCADA Modem DTM6000 production Hytera Communications, Co, Ltd., Repeater, Antena, and RTU and DTM6000 inside the vessel. The smart dispatch software used for the Dispatching Data easier for the operators. (user-friendly). This software is used to predict areas that can be covered or which can be used in determining the most efficient location for Antenna installations.

Fig. 7 shows the map location of the Control Centre and the tower position, and one of the locations of that the trial is conducted, where the location is the nearest to the Control Center, while in Fig. 8, it shows the map obstacle. It is mean that even the location is closed to the control center, it is does not guarantee that the communication quality always the best, but due to the obstacles the communication will have distortion or noise.

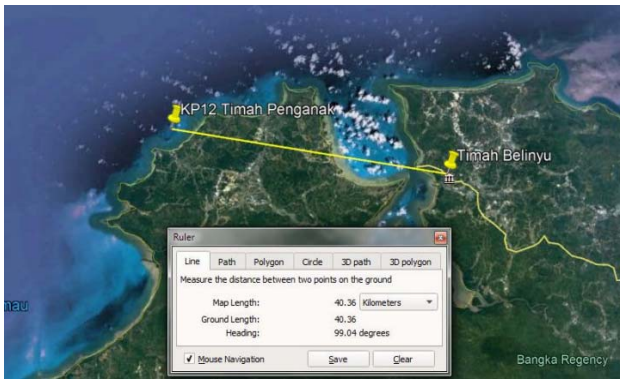

Fig. 7. Location Controlled Center tower position

The process of receiving and transmitting the data, by using the existing software scada, DTM600 and the smart dispatch system will provide good quality communication when the failure or disturbance occurs since the operator can receive and dispatch the good quality of communication. It,s mean that the operator clearly catches the information on the real-time, especially for remote areas of offshore in Bangka Belitung Island. With the Smartdispatch software is a system with integrated software that enables us to control, monitor, and communicate with the radio fleet. It's designed to allow businesses and organizations to dispatch workers and manage their fleet more efficiently, as an example of the mining industry in a remote area application.

Fig. 8. Map obstacle.

Figure 9 shows the RTU and the Instrument Panel of SCADA device which exist on the vessel. This is RTU which has the interface GPIO to the sensor. The RTU links communication by using the serial RS323 and connected to the every sensor applied,.

Fig. 9. RTU and Instrument Panel

VI. Result and Discusions

It is found that from the software GPS positioning tracker, the Coverage area will be radius or a distance up to 60 km by GPS positioning tracker. In order to fulfill the user's requirement that the 60 km distance can be reached, then it needs to consider the factors or as a parameter might be considered and calculated, i.e., Land of Sight (LOS), Effective Isotropic Radiated Power (EIRP) and Bit Error Rate (BER).

The application of the SCADA system with the DTM600 and the smart dispatch system will provide good quality communication when the failure or disturbance occurs since the operator can receive and dispatch the good quality of communication. It,s mean that the operator clearly catches the information on the real-time, especially for remote areas of offshore in Bangka Belitung Island.

Several obstacles such as hot spot, bad weather, and difficult terrain to obtain the location of the disturbances, by using this tool or system, these things can be overcome easily or making it easier to control interference. Also, it is found that the system is more stable because it does not depend on signals from cellular operators. And there are no fixed costs every month that must be paid to the provider company.

VII. Conclusion and Remarks

The proposed new solution for SCADA system was validated by the trial installation of Trunking Lite (or DS-6211) of the Hytera DTM6000 Trunking Tier Three and the SCADA software on Control Center for the SCADA system proposed and it succeeds.

The advantages of the implementation using the SCADA DTM6000 with Trunking Tier Three and the instruments for the mining industry in a remote offshore area are all existing data in the form of the amount of data will be transferred to Control Centre Room, hence the operator/administrator can see all the information by using SCADA software.

The proposed method monitor and control the data transmitted (receive and dispatching) on the dispatching and control area by employed the SCADA software and Hytera Smartdispatch. So that if there is a failure or interference in the vessels and/or the local station will be easily determined the location where the disturbance is occurring, and either the operator in the control room or the person at the vessel can do voice communication with each other if necessary. So, it will make it easier to carry out repairs while minimizing operating costs. The system is very stable because there are no disturbances from the signal from the cellular operator device, which is usually when the remote area always no signal or it can always find the blank spots.

The SCADA system with Radio Frequency is very useful in remote areas where telecommunications network infrastructure is inadequate because it can cover a wide coverage area (ie up to 60 km) with Radio Base station, where, the trial also has been a success on site. The next research is to collect the results of the obtained data after this system is operated, and it will be analyzed and compared with the capabilities of the equipment at each station.

References

[1] Dhian Krisna Wahyudi, Marsul Siregar, Optimization of Scada system in a Remote Area By Using DTM6000 and Trunking Tier Three (case study in Papua), International Jurnal of Advanced Science and Technolgy Vol 29, No 7s(2020) pp 3445-3456.

[2] Dr. Salih Mohammed Salih, Practical Implementation of SCADA System for Falluja Substation, AJES-2009, Vol. 2, No. 2

[3] Design, Development, and Commissioning of a Supervisory Control and Data Acquisition (SCADA) Laboratory for Research and Training,

[4] Bonar Pandjaitan, 1999. Technology Control System of Power system based on the SCADA system. Jakarta: Prenhalindo (Indonesian)

[5] Bailey, David, and Edwin Wright, Practical SCADA for Industry, Vancouver: IDC Technologies, 2003.

[6] Boyer, Stuart, SCADA: Supervisory Control and Data Acquisition. 4th ed. Research Triangle Park, North Carolina: International Society of Automation, 2010.

[7] Keith Stouffer, Victoria Pillitteri, Suzanne Lightman, Marshall Abrams, Adam Hahn, Gude to Industrial Control Systems Security, SCADA, DCS, and PLC, NIST Special Publication 800-82. May 2015.

[8] Anonim, 2018. User Manual DTM6000, Hytera Communications, Co, Ltd, Shenzhen

[9] Anonim, 2014. User Manual Smart Dispatch, Hytera Communications, Co, Ltd, Shenzhen

[10] Anonim, 2014. User Manual Trunking, Hytera Communications, Co, Ltd, Shenzhen.

[11] Burningham, J.S. [W2XAB], (2015), —Introduction to Digital Mobile Radio (DMR), || in ARRL. The National Association for Amateur Radio. (Oktober 2015).

[12] M. N. Lakhoua, SCADA applications in thermal power plants, International Journal of the Physical Sciences Vol. 5(6), pp. 1175-1182, June 2010.

[13] R. Kumar, K. Saini, Dr. M. L. Dewal, Trends of SCADA in Process Control, National Conference on Recent Advances in Electrical and Electronics Engineering (RAEEE 2009), Upload Research Gate, September 2014.

[14] Florentina Magda Enescu and Nicu Bizon, SCADA Applications for Electric Power System, Book, Reactive Power Control in AC Power System pp 561-609, Power System DOI: 10.1007/978-3-319-51118-4 15. April 2017

[15] K.Vinay Kumar, Dr.R.Balakrishna, Supervisory Control and Data Acquisition (SCADA) in sub-transmission and distribution levels in Power System, Research Gate; https://www.researchgate.net/publication/270159134, Article May 2013.

[16] Shuangshuang Li, Baochen Jiang, Xiaoli Wang, and Lubei Dong, Research and Application of a SCADA System for a Microgrid, Technologies 2017, 5, 12; DOI:10.3390/technologies5020012

[17] Win, K.T.Z.; Tun, H.M. Design, and implementation of SCADA system based power distribution for primary substation (control system). Int. J. Electron. Comput. Sci. Eng. 2014, 3, 254–261.

[18] Yuanliang Fan, Qinhua Wang, Kajiun Fan, Yu Chen, Goose over UDP Transmission Mechanism for Real-Time Data Fast Transmission in Distribution Netwrok, 978-15090-5117-5/16/IEEE