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Monitoring and Control of Data Processing in Modern Ships

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***Abstract*— This thesis aims at the study, design and construction of a system for monitoring and controlling the operation of power generators (PCs). A key feature of the design and implementation of this model will be the reception and transmission of data through communication protocols. The need to design, manufacture and adapt new wiring and sensors to the mechanical parts of PCs will be virtually eliminated. At the same time there will be an increase in data transmission reliability as these technologies guarantee the safe and fast transmission of information at any distance. This will overcome the problems of distortions of measurements or lost data that were encountered by older control systems.Using and combining these technologies will significantly reduce the installation time and cost of purchasing such a control system, making it more accessible to the users concerned.**

Keywords— Telemetry; Scada; Communication protocols; Data acquisition

I. INTRODUCTION (*Heading 1*)

In the 1960s, telemetry was introduced for surveillance, which enabled automated communications to transmit measurements and other data from remote areas with installed surveillance equipment. The term SCADA was created in the early 1970s, and the rise of microprocessors and PLCs during this decade increased the ability of businesses to monitor and control automated processes more than ever. The networks, as we know them today, were not available and each SCADA system was autonomous. These systems were what will now be referred to as SCADA monolithic systems. In the 1980s and 1990s, SCADA continued to evolve thanks to smaller computer systems, LAN technology, and HMI-based PC software.

SCADA systems were soon able to connect to other similar systems. Many of the LAN protocols used in these systems were proprietary, which gave suppliers control over how to optimize data transfer. Unfortunately, these systems were unable to communicate with other vendors' systems. These systems were called distributed SCADA systems.

on the 1990s and early 2000s, based on the distributed system model, SCADA adopted a successive change by adopting an open system architecture and communications protocols that were not specific to one supplier alone. This repetition of SCADA, called the SCADA network, took advantage of communication technologies such as Ethernet. Networked systems

SCADA enabled systems from other vendors to communicate with each other, minimizing the constraints imposed by older SCADA systems and allowing organizations to connect more devices to the network.

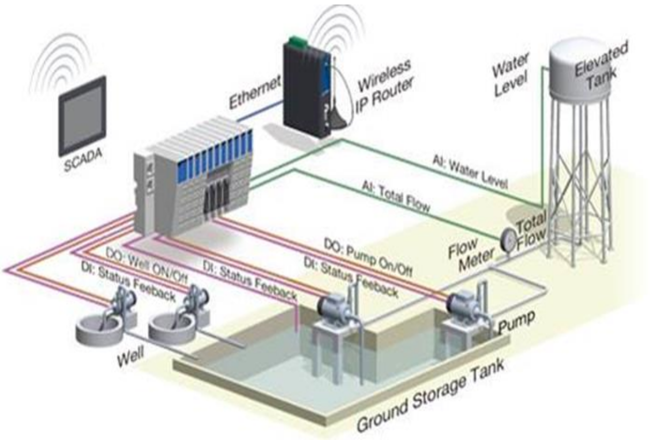

Fig. 1.. *Scada applications in industry*

SCADA systems are well-equipped to handle large geographical areas. This is a technology still in development. The system needs permanent stations and sensors that collect data at each point in the application. It also needs a central point of management for all data. The central system may be many kilometers away from the point where the data is collected.

II. SYSTEM DESCRIPTION

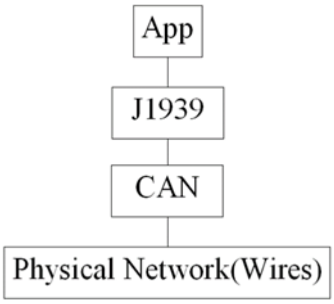

Fig. 2. *J1939*

A. *What is J1939?*

This is a standard supported by the Society of Automotive Engineers (SAE). This standard specifies how information is transmitted over a network so that the machine's ECU (brain) can communicate with the respective sensors (eg vehicle speed sensor). We can liken the J1939 as a software specification that runs on a CAN bus.

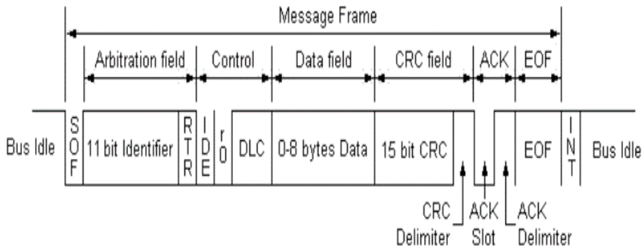

Fig. 3. *CAN 2.0A*

B. *What is Modbus?*

Modbus is a serial communication protocol developed and published by Modicon® in 1979 for use in programmable logic controllers (PLCs). Simply put, it is a method used to transmit information over serial lines between electronic devices. The device that requests 'Read' information is called Modbus Master and the device that provides information is Modbus Slaves. In a standard Modbus network, there is a Master and up to 247 Slaves, each with a unique address from 1 to 247. The Master can also write " write " information to Slaves.

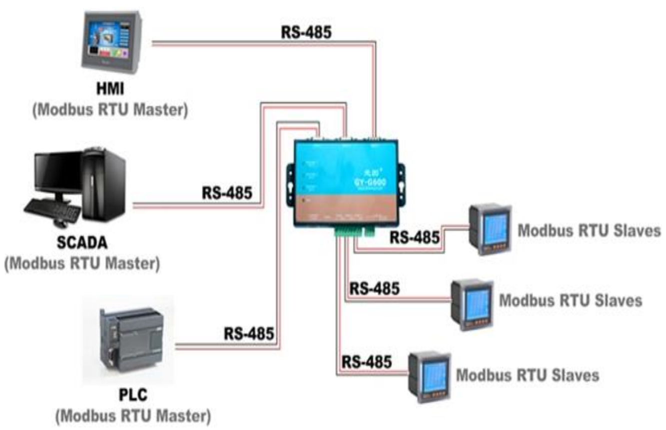

Fig. 4. *Modbus RS-485*

III. THE PROPOSED SYSTEM DESIGN

Since the development and advancement of technology has already enabled autonomous driving and operation

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- Cars https://autoagora.gr/news/data/nea-montela/To-aytokinhto-ths-GM-xwris-timoni-vid_162581.asp
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Then we realize that we are in a transition period when the need to connect all devices to the cloud is becoming more and more urgent.

My 15 years of experience in shipping has led me to conclude that existing technology in internal combustion engines is changing year by year. It tends to be connecting friendly with other machines in the engine room, but also with SCADA systems control centers that may not be placed inside the facility.

Realizing this change, ship-owners are increasingly demanding the benefit of the ship's machinery connectivity. In this way they aim to save resources (costs, materials, personnel) and to build ships that are well-controlled, with reliable systems, with a high safety index, more friendly to the personnel handling them.

Fig. 5. *Construction platform*

The system we propose is designed with emphasis on the adaptability of the control and display modules to the specificities of each plant and machine. In this way we have been able to make it easy and safe to use, ensuring that it can in no way interfere with the proper operation of the facility. In order to be able to design and implement the remote monitoring and control project we had to assemble electrical equipment and modules from generator sets and simulate their operation. For the system we would like to receive processing and sending data to and from the generator, we provided electronic units capable of imaging and controlling machines.

The next step was to install all of these units in a wooden panel as well as construct the wiring for their interconnection. To supply the units with 24volt dc DC we used 2 220vdc to 24vdc transformers to avoid the heavy weight of the 12volt batteries used in optimum operating conditions. A precursor study of ampere consumption in real time preceded. We found that the full operation of these units required 8 ampere per hour. In the laboratory environment the consumption was reduced to 2 ampere and thus the two, 4 ampere and 1.5 ampere power supplies were considered appropriate without noticing a significant voltage drop during system startup and operation.

The cabling was made of three different colors of 1mm cross-section cables of which each color represents a specific function. Red + 24vdc, black - 24vdc, white signal. The cabling that is built constitutes a very small percentage of the actual cabling of a PC, however it provides us with a satisfactory sample of the readings and functions we have worked out to accomplish the task.

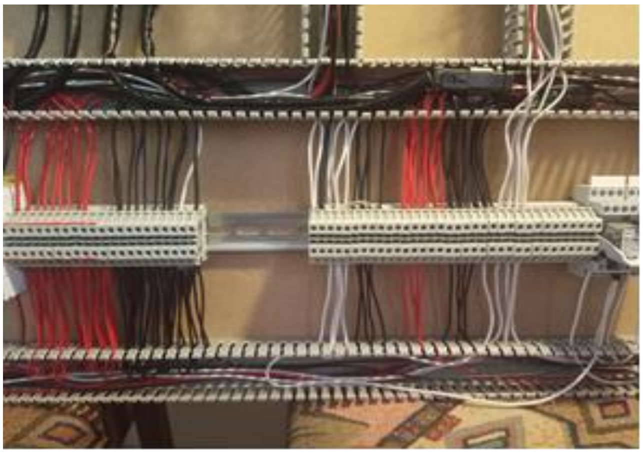

Fig. 6. *Wiring*

A Caterpillar C32 model ECM controller was used to simulate the operation of the engine as well as an EMCP 4.2 control panel responsible for local control of the generator set. Four sensors, 2 pressure and 2 temperature, were connected to the ECM so that we could receive real-time measurements that could be varied. A PWM signal generating unit was also connected to the Desire speed variable engine demand.

Fig. 7. *Sensors*

The local EMCP control panel has wired a 220 volt A / C input so that it can display and send data on the generators power output.

Fig. 8. *HMI*

The system we chose to receive and process the data comes from Allen Brandley and consists of a micro820 plc model, a T4T 4inch HMI monitor from a J1939 to Modbus converter, and an Ethernet switch.

Fig. 9. *Converter*

The converter receives the data through communication protocol J1939 and is responsible for converting it to Modbus Tcp protocol to allow communication with the logic controller. The plc receives through the RS485 port the Modbus translated data, processes it and sends it via Ethernet to the HMI display where it is displayed to the user. Pages have been created on the screen interface are able to display, warn, and control the system.

The user through HMI is able to start and stop the machine, verify that it is functioning properly, be notified of any damage, check similar functions of the machine and finally add its own preferences according to the needs of the installation. With the Ethernet switch the data can travel to any location the user wants through the internet, wireless or wired network. The terminals will use Allen Brandley software that performs visualization on any computer installed.

Through the three protocols we ensure reliable data transfer using ECM and control panel measurements and thus avoid the costly placement of additional sensors and cabling that burden the proper functioning of the system and increase installation and maintenance costs.

It is worth noting that there are now integrated HMI display units on the market that incorporate plc and converters into one device further simplifying their installation.

IV. Conclusion

Early intelligent ships that have been manufactured for over 10 years with "unmanned engine room certification" have encountered various problems that make it difficult for machines to be connected to surveillance systems. The result is an increase in the cost and time of their installation in newbuilding's, the underutilization of their capabilities and the difficulty in the process of certifying the systems by the Certification Authority.

In conclusion, the existence of many different communication protocols and the tendency of the market to dominate different protocols in different domains make communication between machines difficult. In this paper we present the analysis and study of Modbus and J1939 protocols. Both are widespread in the majority of industry sectors. In recent years, advances in technology have created the need to communicate with one another, without the prevalence of one being evident. Our aim is to provide the basis for the development of a tool that enables stakeholders to easily and quickly collect data from internal combustion engines (generators and motors) regardless of the protocol they support. For this reason, we will next develop algorithms on databases that allow developers to distinguish between the vast lists of many thousands of addresses, the addresses of the machine they want to communicate with.

As far as internal combustion engines are concerned, I estimate that manufacturing companies are still hesitant about the most protocol to follow for interfaces with the outside world. The existence of up to 3 different J1939 or CAN, MODBUS, CDL protocols in one machine testifies that the early stage of the internet of things is called to mature.

The aim of the construction part of the project was to study, design and manufacture a monitoring model capable of combining the reception of data from different communication protocols. This was achieved in full as our system was able to read through the J1939 data sent by the ECM. It also receives and sends data via the Modbus protocol to and from the power generator control panel.

The innovation of the system is due to the fact that the existing cabling and sensors are exploited eliminating the need to install floating cables even in the case of remote control "startup, shutdown command". Also via Ethernet the received data is sent through an internet router user has the ability to monitor the operation of the machine from anywhere in the world.

When it comes to saving resources, it's worth noting that eliminating the need to install extra materials makes the system environmentally friendly, in addition to making it more economical and reliable than older systems. Customizable to suit the needs of the installation, it provides users with flexibility and convenience in on-board automation to optimize generator systems operation.

V. Future Work

With regard to the future prospect of such systems, we believe that the integration of protocols is one way in the development of telemetry systems, as this will allow greater ease of data collection and processing. On the other hand, through the era of internet of things, there could be no shortage of simplified means of disseminating information aimed at improving environmental health and energy services. This bibliographic research could provide the basis for the future development of easily adaptable interconnected data collection units to improve supervised technology products. By properly processing information and collecting it in databases, any technological sector will be able to improve significantly by providing better services that are more human and environment friendly. Research and development of products and services departs from the rigorous laboratory environment and goes directly to real-world conditions providing useful information that would otherwise be impossible to derive.

Acknowledgment

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