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INDUSTRIAL COMPUTER NETWORKS OPPORTUNITIES IN THE CONTEXT OF DEVELOPMENT OF ELECTROMECHANICAL EQUIPMENT COMPLEXES PROTECTION SYSTEMS

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Considering the possibility of using industrial computer networks and IEC-61850 in order to improve efficiency and enhance the abilities of electromechanical equipment complexes protection systems.

Key words: protection equipment, IEC-61850, industrial computer networks.

МОЖЛИВОСТІ КОМП'ЮТЕРНИХ ПРОМИСЛОВИХ МЕРЕЖ У КОНТЕКСТІ РОЗВИТКУ СИСТЕМ ЗАХИСТУ ЕЛЕКТРОМЕХАНІЧНОГО ОБЛАДНАННЯ

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Розглядається можливість використання промислових комп'ютерних мереж і стандарту МЕК-61850 з метою підвищення ефективності та розширення можливостей систем захисту комплексів електромеханічного обладнання.

Ключові слова: захист електрообладнання, МЕК-61850, промислові комп'ютерні мережі.

INTRODUCTION. During the operation of electromechanical equipment emergency situations may occur. They lead to emergency operating modes and, consequently, to malfunctions and general operation failure. Faults in its turn may be the result of parts and materials depreciation and aging, and of violation of the rules of technical operation. Often the same faults occur due to various reasons, and sometimes due to their joint action, which leads to the abnormal operating modes of equipment. In order to prevent failure of the electromechanical equipment protection system are being installed.

Today the main protection systems for industrial electromechanical equipment are devices and systems of relay protection and automatics (RPA), in particular, based on microprocessor element basis. Equipment that requires such different systems of protection, is various and therefore the selection of protection types is carried out in accordance with the rules of electrical equipment installation. The large number and variety of used equipment requires different protection systems that are supplied by different manufacturers. This leads to problems of compatibility among various protection systems due to lack of their single standard.

With the growing implementation of microprocessor relay protection systems (MRP) [3–5] the use of industrial computer networks extends in protection systems of electromechanical equipment, allowing new ways to organize protection of equipment complexes.

Overview of the abilities of the industrial computer networks for electromechanical equipment complexes protection systems in order to enhance their protection potential and flexibility.

MATERIAL AND RESULTS OF THE STUDIES. Microprocessor relay protection systems have several advantages over relay protection devices of other types. Besides the main functions – emergency disconnection of equipment, MRP have additional functions of emergency situations registration, transmission of operation mode information of equipment in real time, programmable control and more. These functions can not be implemented in electromechanical or analog based relay protection devices.

MRP has the feature of transfering data between components of the protection system by industrial computer networks, including industrial Ethernet. A typical scheme of an industrial computer network shown in Fig. 1.

The usage of computer networks opens a number of new opportunities of electromechanical equipment complexes protection systems, especially allowing the information transfer between system components (sensors, terminals, etc.) using industrial protocols. Also among the advantages of the usage of industrial computer networks one should pay attention to new and wide opportunities in the field of incoming data and even more accurate control of a whole system and its individual components. Advantages of computer networks usage in relay protection systems is shown in Fig. 2.

Computerization of protection systems has led to the appearence of specific software systems in SCADA-systems that use network protocols to transfer information. The most widely used protocol is MODBUS, and a number of industrial networking protocols PROFIBUS.

MODBUS – communication protocol developed by Modicon company, based on the "client-server" architecture. Widely used in industry for communication between electronic devices. Can be used to transfer data over serial communication lines RS-485, RS-422, RS-232, and network TCP / IP (MODBUS TCP). The first protocol specification was published in 1979.

PROFIBUS industrial network is a complex network that is based on several standards and protocols, including IEC 61158 and EN 50170. The prototype was developed by Siemens AG.

PROFIBUS network allows the simultaneous use of several data transfer protocols:

– PROFIBUS DP;
– PROFIBUS PA;
– PROFIBUS FMS.

All PROFIBUS industrial network protocols use the same technology and common bus data access method,

so they can operate on one bus.

MODBUS and PROFIBUS data transfer protocols are different, supported by separate development teams and pecialists, and is therefore incompatible with each other.

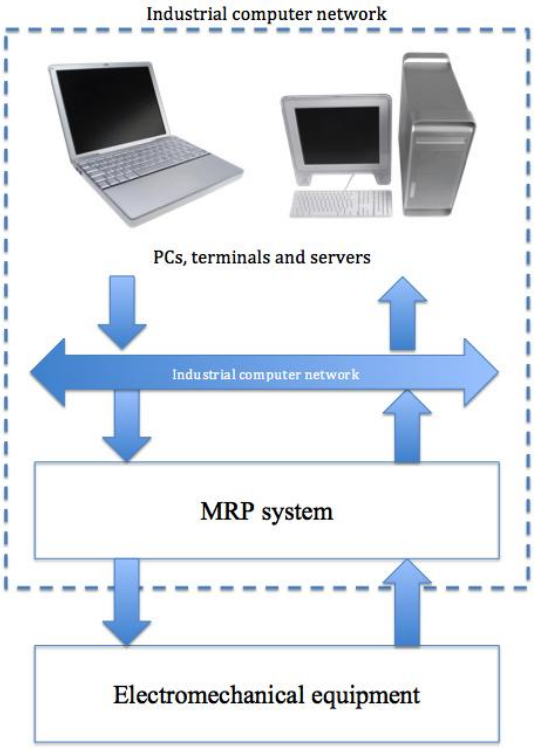

Figure 1 – A typical scheme of an industrial computer network

To achieve compatibility of electromechanical equipment protection systems the data transfer standart IEC 61850 is being currently implemented [7]. Subject to the requirements of IEC 61850 – developed message transfer protocol in an industrial Ethernet network protocol called GOOSE [8]. According to IEC-61850 relay protection devices are combined by a bus, through which most devices communicate among themselves and transmit this data on the upper level. Data from relay protection terminals can be transferred to the upper level of the operator by a station bus, in addition, there is an opportunity to obtain operational data from any substation and from any MRP terminal with the supervisory authorities or appropriate level of access. The information goes to the terminals, offers the most complete description of the equipment at the current time, and makes intime conclusions, which increase the reliability of energy facilities in general.

Generalized scheme of GOOSE-messages transfer is shown in Fig. 3.

Interchangeability of individual system components is achieved by standardization of data transfer protocols, and also due to strict requirements on the compatibility of equipment. Systems based on IEC-61850 are easier to support by reducing the number of cable lines, which positively affects the reliability of the system as a whole. System architecture is intuitively understandable, as a result developers and integrators spend less time understanding the architecture of a particular object and, consequently, the cost of design and integration is greatly reduced. Maintenance of such systems in comparison with standard ones are generally easier, although it makes some other requirements for staff qualification.

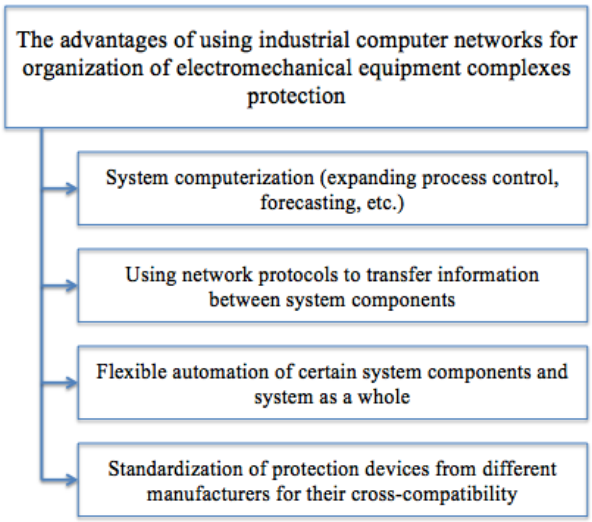

Figure 2 – Advantages of computer networks usage in relay protection systems

Possibility of flexible configuration of information flows in devices MRP is achieved due to that part of the standard, which is dedicated to data transmission. The basic protocols of data transfer, according to the standard IEC-61850, are MMS and GOOSE protocols. MMS is used to transfer data from the relay protection system terminals in SCADA-system for subsequent visualization and GOOSE – for data exchange between terminals. An important feature of these protocols is a guaranteed messages delivery, and their data transfer speed is higher than other data transmission protocols such as, for example, MODBUS [9].

Disadvantages include increased complexity and the standart novelty. Developers and integrators have little experience in building such systems, but this disadvantage is obviously temporary. Another disadvantage of systems based on IEC-61850 is an increased cost of MRP microprocessor equipment, but the use of IEC-61850 offers several advantages, so the number of stations around the world, based on IEC-61850, increases.

Currently, all major equipment MRP manufacturers (ABB, SIEMENS, ALSTOM, GE, SEL) support IEC-61850. Each hardware manufacturer offers its own decisions regarding data collection and processing. However, many system integrators use independent SCADA-systems.

This is due to the fact that independent SCADA-systems are more universal and flexible, and system integrators can solve almost any problem using this software.

On the other hand, manufacturers of most universal SCADA-systems do not support the IEC-61850 because of the specificity and complexity of the protocol

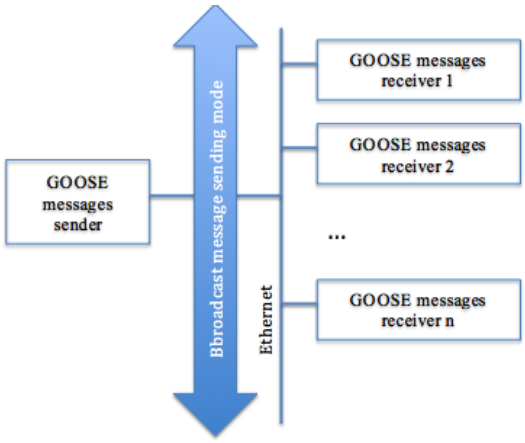

Figure 3 – Generalized scheme of GOOSE-messages transfer in an industrial computer network

standard. But there are independent decisions on the market [8] that can integrate IEC-61850 support in virtually any SCADA-system.

Each of these options (the use of solutions from the manufacturer and application independent decisions) has its advantages and disadvantages.

Despite the declaration of full support for IEC-61850, hardware and software from different manufacturers practically incompatible with each other.

For example, if a system built entirely on SIEMENS (including software top level) add a terminal from ABB, it is likely that technicians will face certain difficulties in the integration of this terminal in SCADA.

Independent suppliers of software solutions usually support equipment from different manufacturers due to 100 % support for IEC-61850 based implementation of specific protocols in each manufacturer's standard equipment.

The advantage of using the software manufacturer's equipment is that the system integrator is devoided of questions about finding an independent software solution. This additional burden organization, and run into the risk of unfair provider forces companies to pay more for software, referring specifically to MRP equipment manufacturers.

Moreover, the decision of MRP manufacturers are always more expensive because the cost of software is embedded in the price system. When the budget for the creation is hundreds of thousands dollars, in case of refusal of such software can save a fairly substantial amount of money.

Due to other advantages the independent solutions can not only reduce cost but also significantly reduce the time of implementing objects in exploitation.

Thus, configuration flexibility, price and ease of use are the main benefits of choosing an independent provider of software solutions.

CONCLUSIONS. Implementation of IEC-61850 standard and industrial computer networks and network equipment will nr able to significantly enhance the ability of electromechanical equipment protection systems, including control of equipment complexes, its power, speed of response to abnormal equipment operating modes and based on the received information to make predictions of abnormal situations thanks to modern and high-performance computer servers.

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ВОЗМОЖНОСТИ КОМПЬЮТЕРНЫХ ПРОМЫШЛЕННЫХ СЕТЕЙ В КОНТЕКСТЕ РАЗВИТИЯ СИСТЕМ ЗАЩИТЫ ЭЛЕКТРОМЕХАНИЧЕСКОГО ОБОРУДОВАНИЯ

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Рассматривается возможность использования промышленных компьютерных сетей и стандарта МЭК-61850 с целью повышения эффективности и расширения возможностей систем защиты комплексов электромеханического оборудования.

Ключевые слова: защита электрооборудования, МЭК-61850, промышленные компьютерные сети.

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