



USING NEW TECHNOLOGIES TO IMPROVE MANAGEMENT CONTROL OF ELECTRICAL POWER PLANTS OF RAILWAYS OF THE REPUBLIC OF SRPSKA

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Abstract – *The paper will show the advantages of using a more technologically advanced and better software quality system of remote control of electric traction substation on the Railways of the Republic of Srpska, which replaced the old remote control system, and new methods of data collection were realized, a greater number of appropriate communication protocols in the operation of the system itself, reduced need for regular maintenance. Comparative values, the number of working hours on maintenance, and the advantages and disadvantages of both devices, for the reception and transmission of data in the remote control of electric traction substation compared to the former remote control system at the Railways of the Republic of Srpska, are shown in a table. The development of technology has expanded the requirements of the end user, so the upgrade of the control devices and the new approach to the exploitation of the devices can be viewed through the prism of economic profitability and maximum utilization of the devices, as well as increased safety of railway traffic.*

Keywords – *railways, maintenance, remote control, electric traction substation.*

1. INTRODUCTION

The remote control center (CDU) of the electric power system of the Railways of the Republika Srpska serves to manage stable electric traction plants on the tracks Šamac - Doboj and Doboj - Banja Luka - Novi Grad. The CDU located in Doboj supervises and manages 6 EVP plants, 7 PS plants and 5 PSN plants located along 310 km of electrified railway, Figure 1. The primary task of the remote control center is to manage the associated power grid in order to ensure stable operation and maintain the integrity of the system. The primary task of the remote control center is to implement the management of the associated electric power network in order to ensure stable operation and maintain the integrity of the system. These tasks are achieved by the management and communication functions, that is, by the analytical functions implemented in the CDU. The management functions enable the operational staff to review the state of the EES, provide quick and complete

information on all events in the process, and ensure the mechanisms by which the staff will intervene in the process. This presupposes the introduction of media for the presentation and manipulation of data. In addition to managing the process, operational staff should have insight into the state of the information system. Communication functions primarily involve data exchange with the process. It should ensure the accuracy of collected data and control signals, timely yield and protection mechanisms. Communication with the process is achieved through information equipment installed in substations (remote stations and local guidance systems). The working and technological life of the system configured for the needs of Railways of the Republic of Srpska has expired, which is why the maintenance costs have increased significantly. It is not possible to install a newer version of the software on existing hardware, for which spare parts are no longer produced. The existing configuration does not provide the possibilities offered by modern systems, such as:

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remote control of all system elements, more efficient and faster diagnostics, as well as data transfer through new communication protocols.

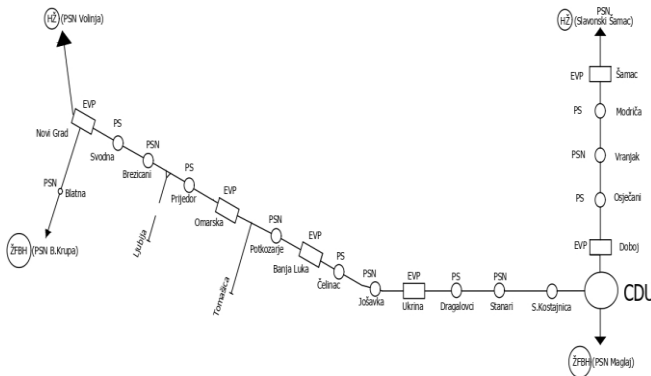


Fig. 1. Disposition of managed electric power plants on the Railways of the Republic of Srpske

2. ADVANTAGES OF THE MODERNIZATION OF THE DU SYSTEM ON RAILWAYS OF THE R.SRPSKE

At the Railways of the Republic of Srpska, a new DU system was installed, based on modern devices and appropriate software applications that use client-server communication. The configuration of the newly installed system consists of personal computers with associated communication equipment for connection with substations (EVP, PS and PSN). DU equipment in plants consists of remote stations. Local control in EVP, PS and PSN is realized through the control panel, while the remote control function is implemented through the remote terminal unit (RTU). At the Railways of the Republic of Srpska, a new DU system was installed, based on modern devices and appropriate software applications that use client-server communication. The configuration of the newly installed system consists of personal computers with associated communication equipment for connection with substations (EVP, PS and PSN). DU equipment in plants consists of remote stations. Local control in EVP, PS and PSN is realized through the control panel, while the remote control function is implemented through the remote terminal unit (RTU). A major drawback of the old system was the massive and complicated cabinets in power plants. This was overcome by the installation of modular devices (Figure 2) which, thanks to their technical characteristics, provide great opportunities for optimization, significantly reducing the number of elements of the system itself.

CDU equipment can be functionally divided into two parts:

- SCADA servers and workstations, i.e. computer nodes,
- computer network (network equipment) and communication equipment

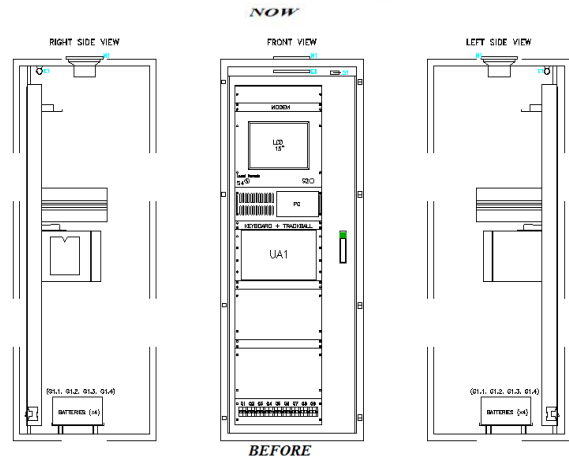


Fig. 2. The appearance of the old and new device

SCADA servers are industrial-grade personal computers made of high-quality components with high MTBF (mean time between failures). In the system, there are two server computers with identical basic configuration that function as dual computers.

A computer network is a system designed and implemented as a computer network with the Ethernet circuit standard and the TCP/IP communication protocol. In the network, no server computer has been defined for the computer network, but the workstations are peer-to-peer. Server computers are not network servers but only SCADA servers. The parts of the network configuration are:

- network cards in computer nodes
- cable network distribution - UTP cable
- network switch
- modems.

In computers, the network card is integrated on the motherboard. It is a network adapter with full duplex functions. The connection to the network is made with a cable with twisted pairs without a jacket over a UTP cable that enables simultaneous transmission and reception of data at a speed of 100 to 1000 MBps. The switch enables a star network configuration and enables full duplex transmission (as opposed to a coaxial cable configuration where network nodes are connected in a loop). The device is equipped with local signaling (LEDs):

- device in operation
- failure on the switch
- transmission error
- state of individual channels (workstations).

For the connection to monitored facilities (EVP, PS and PSN), modems with optical outputs for connection to the optical cable and modems for connection to the STKA cable are installed.

2.1. The advantage of simultaneous communication via copper and optical cable

In terms of transmission, the system is designed in master-slave communication between servers and remote control devices in power plants (master-slave communication with request - Request and direct response - Response) and adapted for communication via copper and optical transmission paths. While communication with the old system was realized exclusively through copper cables, the new system for the transmission of information and commands uses devices that allow the use of copper and optical cables. In this way, the previous modems were replaced, which ensured greater reliability of the system. Due to the deterioration of the copper cables, in the period before the installation of the new system, an increased number of interferences were recorded on the transmission path of the remote control system. A graphic representation of the number of disturbances (drive disturbances), by year, directly caused by the failure of integrated circuits in the power cabinet is shown in Figure 3 [1].

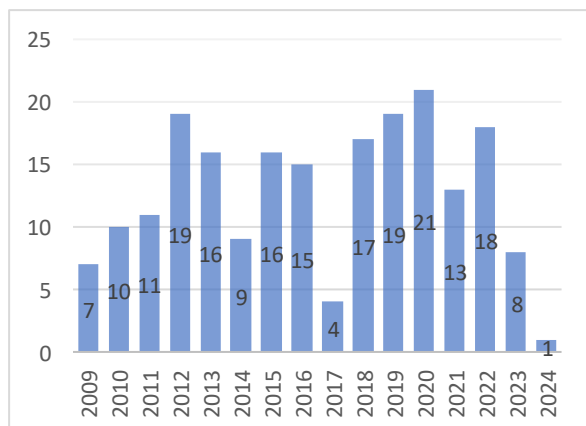


Fig. 3. Number of operating disturbances on the DU device from 2009 to IV 2024

2.2. Comparative capabilities of the new and old remote control system

By installing a new device for remote control, we managed to unify all the process actions of the centralized system and improve the work itself, as well as get the ability to upgrade power plants with digital devices for which the former system did not have the ability to support. The EE cabinet consists of a remote control device, modular units, 2 communication units for both transmission paths, multiple input/output boards, interface protection relays and devices for both types of power supply (DC/AC) in a metal DIN rail housing.

The key functions of the device are:

1. Receiving analog input signals (mA/V signals),
2. Receiving digital input signals,

3. Sending binary commands (with the help of a relay),
4. Management and control of input/output boards via serial port,
5. Loading process events from input units,
6. Printing commands to output units,
7. Communication with control centers and local networking systems by the man-machine system (MMI) through the integrated serial line interface and the applied Ethernet interface 10/100BaseT LAN,
8. Managing the time base for the remote control device and synchronizing the input and output panels,
9. Handling the dialog between the remote control device and the Web Browser via the LAN interface.

The two microprocessors represent the key parts of the control boards and have the following tasks:

- The MPU is a 32-bit main processing unit,
- SLC 8 bit serial line connector,
- I/O 8-bit input/output controller.

Tab. 1. Comparative capabilities of the two systems

SYSTEM CAPABILITIES	Old system	New system
Reception of 8 analog input signals	•	•
Reception of 16 digital input signals	•	•
Management of the input and output panels of the device via the serial port	•	•
Printing commands to output units	•	•
Loading precess events from input units	•	•
Printing commands to output units	•	•
Management of the time base for the station i	•	•
Synchronization of input and output panels		•
Integration of multiple communication protocols		•
Functional system of work with copper and optical cables		•
The possibility of connecting to new digital devices		•
Connection via ethernet network		•
Dialog handling between device and web browser via LAN		•
Management of the time base for the station i		•

The SLC (Serial Line Controller) works as a master for the serial peripheral bus of the RTU. Single-pole and double-pole values are resolved in 4096 steps (12 bits + sign) for 100% of the measurement signal. Differential inputs are protected from static and dynamic overvoltages by protection circuits. A low-pass filter reduces non-linear AC interference. The AD converter working on the basis of the sigma/delta method has the possibility of

scanning with a higher resolution and additional algorithms for reducing the line frequency and interference voltage of line harmonics. Even for a deviation from the line frequency of $\pm 10\%$ there is a reduction of $>45\text{dB}$. The internal high resolution enables scanning of all measurement ranges with the same resolution on the board. Table 1 shows the basic difference between the old DU device and the new DU device, table 1.

2.3. The cost of owning an EE plant

Knowing that every malfunction and interruption of communication causes the impossibility of controlling remote plants, the obligation of possession of the plant by the power plant maintenance staff is prescribed. Figure 4 shows the costs of owning the plant, expressed in the net wages of workers, for the duration of operating disturbances, caused by the wear and tear of the old remote control system. It should be noted that hiring workers for these needs simultaneously reduces the number of hours of regular maintenance of other power plants. [2].



Fig. 4. Shown cost of owning an EVP plant expressed in euros

The advantage of the new system is a significantly lower number of hours of mandatory regular maintenance. Figure 5 shows a comparison of the required number of maintenance hours per month for the old and new remote control systems. The number of hours of maintenance is prescribed by the technical documentation of the equipment manufacturer and the Normative for ongoing maintenance of electro-technical devices and facilities of the Railways of the Republic of Srpska. [3].



Fig. 5. Number of maintenance hours old system/new system

3. CONCLUSION

Within the framework of the new remote control system, the possibility is left for possible circuit and functional expansions. Upgrading is possible in terms of expanding the monitored power system, adding new facilities and introducing new information. This enables the capacity of the program system, whose database can contain up to 100,000 pieces of information. Expanding the space for data archiving is simply done by increasing the number of disks (internal or external). The system allows expanding the configuration by adding new workstations, local or remote. Local workstations can be new operator sites, development sites, or maintenance service sites. The system is also open for program extensions. The necessary software support for data transfer is simply upgraded by installing computers with appropriate tools (data processing and presentation programs) on the network. The architecture of the software system enables the development and implementation of specific user applications, by the user or the system supplier. The system supplier has left the possibility of upgrading the system with functions that will be developed in the future. The designed remote control system is equipped with communication and software for communication with other control centers. The installation of the new system provides the possibility of using an optical cable for connection with remote facilities, which will significantly advance and improve the operation of the RS Railways power network management system. Savings were achieved on spare parts and less need for manpower to maintain the device. The biggest advantage is the reduced possibility of failure due to the simplicity of the design itself and the smaller number of elements compared to the complicated old system that used to manage power plants in the past.

LITERATURE

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