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THE USE OF MODERN TECHNOLOGIES IN THE DEVELOPMENT OF AUTOMATION SYSTEMS FOR ENGINEERING BUILDING SYSTEMS

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Introduction

BMS (Building Management System) is a system that consists of a number of special programs and devices. The combination of these tools allows you to control all operations and processes that take place in the building, as well as to constantly monitor the state of communications, notify staff of events and problems. Any engineering systems can be included under the management of this system. The most popular solutions usually include power, water, gas, ventilation, air conditioning, lighting, heating, and other life support systems.

The automated building management system is designed individually and can perform a huge number of functions, including the ability to change the operation of heating or other systems depending on the time of year, date, time, day of the week and external climatic conditions.

Building management systems allow you to reduce risks by reducing the impact of the human factor; to account for resources and ensure their rational use; to increase the reliability of engineering systems, thanks to constant monitoring of their condition, provide convenient centralized control.

1. Manufacturers of BMS systems

We will consider heating, ventilation, and air conditioning systems for BMS [1], through which the building works optimally in terms of energy efficiency. Each building requires an individual approach to the management system. In some cases, simple temperature control is required, while in another distributed system, hundreds of devices are managed on site.

When developing the building automation and dispatching system, we took into account the use of the latest advances in automation technologies, high-quality equipment that is easy to manage and easy to maintain.

The system provides an opportunity to combine internal engineering systems into a single management structure and provides reliable management of building systems and additional equipment (installations). The structure of the complex building automation system has the following characteristics: openness; modularity; distribution and scalability.

To date, engineers involved in the construction of BMS systems have a fairly wide range of software and hardware from various manufacturers at their disposal. The list of manufacturers is quite wide and provides integrators with the ability to perform projects from budget to multi-functional execution [2]:

1. Siemens, SBT. Examples of products: SCADA Desigo Insight, XWorks PLC
2. Honeywell. Product examples: SCADA Symmetry, EBI, PLC Care
3. CentraLine Honeywell. Product examples: SCADA Arena, COACH, PLC Care
4. METZ CONNECT. Hardware manufacturer BTR
5. Schneider Electric. Examples of products: TAC Vista, Xenta PLC

We opted for the products of the company Johnson Controls (USA). Metasys ® building management systems, developed by Johnson Controls, provide comprehensive management of building parameters and easier access to data than any other similar systems.

A similar selection of BMS systems from Johnson Controls provides:

- low operating costs;
- reducing the time to put the facility into commercial operation;
- extended service life of individual devices;
- lower maintenance costs;
- quick identification of problems;

- improving the efficiency of the staff.

The solution from Johnson Controls allows you to integrate equipment from different manufacturers and combines individual subsystems into a single common building automation system, which provides continuity / synchronization of operations and allows data exchange between all subsystems [3]. In addition, it is possible to control various control devices, whether it is a three-phase contactor or an electronic relay, which ensures the fastest possible implementation of various local control subsystems.

2. Levels of complex automation of building systems

The automation and dispatching system provides Autonomous and remote control and monitoring of equipment and internal engineering systems of buildings ' life support. The operator's automated workplace (APM), located in the Central control room, is equipped with a personal computer and software (human-machine interface) for managing and visualizing engineering systems in a convenient graphical form.

The structure of the automation and dispatching system consists of three levels.

Level 3 – peripherals – executive and measuring field equipment (sensors, switches, transmitters, valves, actuators) of engineering systems. It provides measurement and determination of the state of technological parameters (sensor, relay switches, transmitters) and impact on the technological process (valves, actuators, switching relays).

Were selected [4]:

VG 1000 x-way control valve;

M9208-GGA-1 electric spring return actuator for proportional control air dampers;

M9220-BDC-1 electric actuator with return spring for air dampers with two-position control;

LP-A995S000-submersible water temperature sensor -40/+1000C;

270XTAN-95008-frost protection relay in IP30 housing (-100C... +120C);

P499VBS-404C-electronic submersible water pressure sensor (0-30 Bar);

A99LY-200C-channel water temperature sensor;

P233A-4-PKC-differential pressure switch sensor (50-400Pa);

DP-2500-R8-differential pressure sensor (0-2500 Pa);

HT-9009-UD2-channel water humidity and temperature sensor;

CD-PRO-00-0 – air quality sensor (CO2).

Level 2 – the system is built on the basis of freely programmable controllers with the BACnet MS / TP communication Protocol and expansion modules for input and output. Developed in accordance with the ASHRAE guidelines for building automation systems, Johnson Controls FEC controllers use new communication standards and provide extensive capabilities for building engineering equipment control systems.

The following freely programmable Johnson Controls are selected:

MS-NAE5510-2E-BacNet network controller;

MS-FEC2611-0-freely programmable controller with 17 inputs (6UI-2DI-3DO-4CO-2-AO), BACnet;

MS-IOM4711-0-I/O module (6UI-2DI-3DO-4-CO-2-AO), BACnet;

MS-IOM2721-0-I/O module (8UI-2AO), BACnet;

MS-IOM3721-0-I/O module (16DI), BACnet;

MS-IOM3731-0-input/output module (8DI-8DO), BACnet.

Controllers are installed in automation cabinets located in close proximity to the controlled engineering equipment and engineering systems. All controllers are connected to a single network and connected to the network controller for data transfer to the Central control point of integrated automation. At the same time, all controllers of engineering systems work independently and continue their functionality in case of network communication failure. This level of complex automation provides the following functions:

- autonomous software management of engineering systems;
- transmitting information to the Central control room;

- collection and processing of signals about the state of technological parameters from measuring devices;

Level 1 of complex automation is performed in the form of an automated workplace (AWP) and is located in the control room of the building.

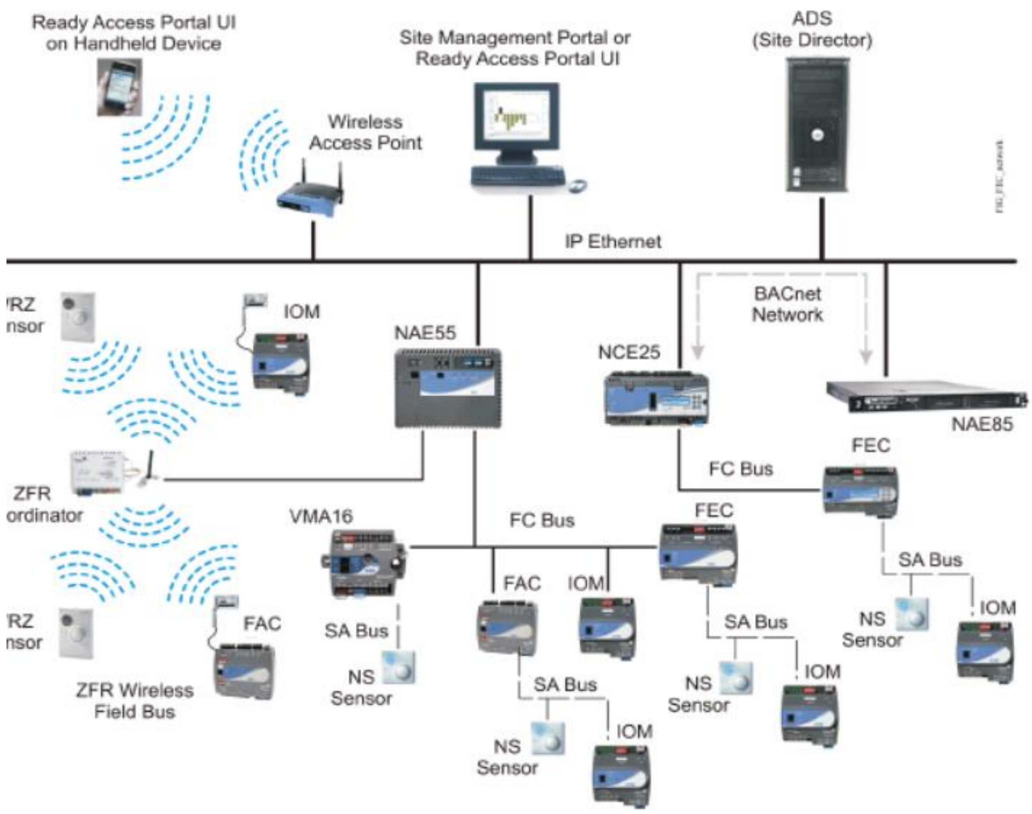

Fig 1 Diagram of an automated workplace

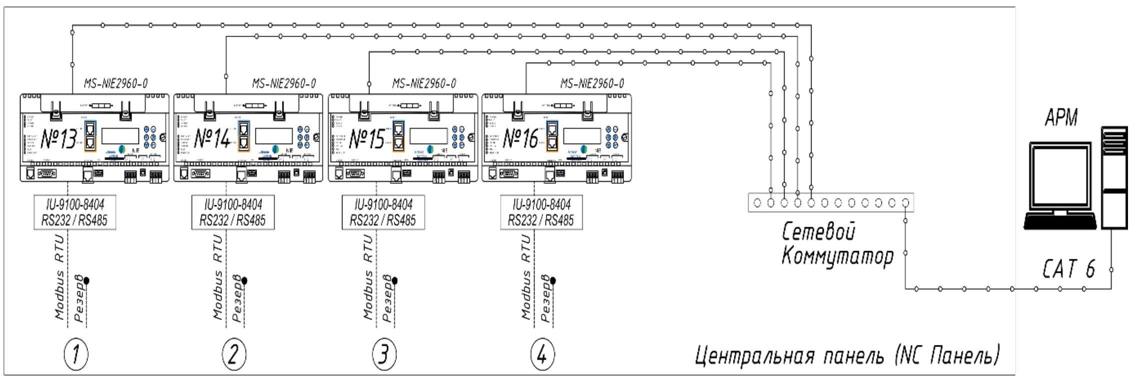

Fig 2 Diagram of an automated workplace

1. Means and methods of communication between system components.

Communication between the elements of the 3rd (sensors, valves, etc.) and the 2nd (field controllers and modules) level is carried out by transmitting various signals (0-10V, 4-20mA, Ohms, 0/1, 24V). Physical connection and signal transmission is provided via signal cables 2x0,75mm2, 4x0,75mm2. Data transfer between levels 1 (network controllers) and 2 (field controllers) is provided via the BACnet MS/TP Protocol. Physical connection and data transmission is provided via 4x1mm2 signal cables.

Data transfer between layer 1 (network controllers) and AWP (SCADA) is provided over the BACnet IP Protocol. Physical connection and data transfer over the BACnet IP Protocol is provided by the Ethernet standard (UTP Cable, RJ-45 connector).

BACnet (Building Automation and Control Network) is an open network data transfer Protocol designed for building automation systems and control networks. The Protocol specializes in building engineering systems. The main concept of BACnet is the implementation and standardization of communication and interaction of various devices and software for automation systems from various manufacturers.

Integration of third-party equipment to the integrated automation system is carried out using the following protocols:

- Frequency converters of pumps (ITP and cold supply) - BACnet MS/TP (signal cable 4x1mm2);
- Electronic weather compensators (ITP) - Modbus RTU RS485 (signal cable 4x1mm2);
- Heat metering unit (ITP) – MBus or Modbus RS485 (signal cable 4x1mm2);
- VRV system (S) – BACnet IP gateway (CAT6);
- Parking ventilation system (supply fans, smoke exhaust fans and blowers) Systemair-Modbus RTU (signal cable 2x1mm2);
- Server room air conditioners-BACnet MS / TP (signal cable 4x1mm2);
- Electricity meters (section EM2, EM4, EOM) - Modbus RTU (signal cable 4x1mm2);
- Cooling center – cold Supply) - BACnet IP gateway (CAT6);

The project provides for the creation of a modern open and fully distributed system of integrated building automation, based on the standard open data transmission Protocol BACnet (BACnet – Building Automation and Control Network, communication Protocol for data transmission networks of building automation systems). The system, based on the BACnet data transfer Protocol, provides high fault tolerance, anti-interference protection and compatibility with equipment that integrates with the system of leading manufacturers of industrial equipment. The developed project provides for modular management of individual engineering and technological systems, admission and subsequent expansion both in terms of the number of automation objects and the number of implemented functions. The versatility of the system is ensured by the use of freely programmable controllers and expansion modules for input and output.

Freely programmable controllers installed in automation cabinets are located in close proximity (in one room) to the corresponding controlled engineering systems. The controllers are used for software and logical management of engineering and technological systems, as well as data transfer to network controllers of the Central control room for displaying, managing and monitoring engineering systems in the human-machine interface. The controllers provide Autonomous control (in case of a break in communication with the upper level of the system) and remote control from the control room.

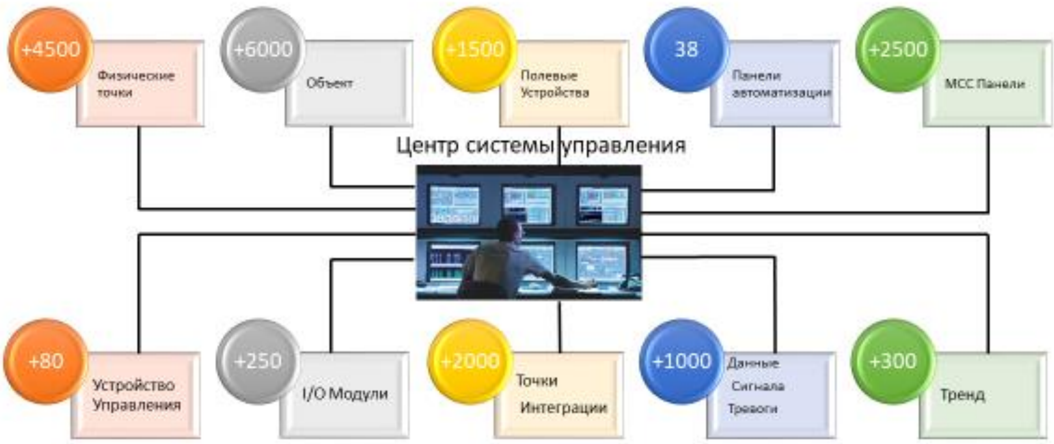

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Fig 3 The amount of used equipment

Comprehensive automation allows you to quickly manage and monitor the above systems in real time.

Literature

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DEVELOPMENT OF A ROBUST ASYNCHRONOUS ELECTRIC DRIVE CONTROL SYSTEM

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Improvement of technological processes and production, improving process equipment productivity and quality increased requirements for the quality of manufactured products have been determined. automated electric drives. This is particularly true for increase the accuracy of output coordinate regulation in steady state and transient modes.

Thus, the task of building systems is relevant today electric drives that provide the specified quality of regulation in the changing parameters of the object and the environment without serious complexity of design methods and resulting control algorithms.

A comparison of the most common synthesis methods of traditional and robust automatic control systems (ACS) made it possible to isolate, and later to use effectively, the method of polynomial equations (PE), which has recently gained popularity, and is distinguished by its simplicity, convenience, and wide capabilities [1,2,3].

Imagine the system of equations of an induction motor [4,5,6,7], provided that the rotor ($\Psi_{rx} = \Psi_r, \Psi_{ry} = 0$) is oriented along the flux linkage vector in the interval form:

1. equations of stator and rotor chains

$$u_{sx} = \tilde{R}_{se}\left(\tilde{T}_{se}s + 1\right) \cdot i_{sx} - \omega_{\psi_r} L_{se} i_{sy} - \frac{k_r \psi_r}{\tilde{T}_r},$$
$$u_{sy} = \tilde{R}_{se}\left(\tilde{T}_{se}s + 1\right) \cdot i_{sy} - \omega_{\psi_r} L_{se} i_{sx} + z_p \omega_1 k_r \psi_r ;$$

2. equations of the rotor chains

$$k_r \tilde{R}_r i_{sx} = \frac{\tilde{T}_r s + 1}{\tilde{T}_r} \cdot \psi_r ,$$
$$k_r \tilde{R}_r i_{sy} = \left(\omega_{\psi_r} - z_p \omega_1\right) \cdot \psi_r ;$$

3. equation of the electromagnetic moment of an asynchronous motor (AM)