Academicia Globe: Inderscience Research

ISSN: 2776-1010 Volume 3, Issue 2, Feb, 2022

A GENERAL-PURPOSE COMPUTING PLATFORM AND ITS USE AS A HARDWARE BASE

Barakaev Nusratilla Rajabovich
Doctor of Technical Sciences, Professor Bukhara Engineering-Technological Institute

Avliyakulov Khayot Nodirovich
Probationer Teacher Bukhara Engineering-Technological Institute
urinov1960@mail.ru

Annotation
The article describes the possibilities of using hardware tools for implementation of a logical control task, security control, input and output of volumetric data, device interaction, as well as the possibility of using available real-time operational systems.

Keywords: logic control, computing platform, IT-technology, programmable logic controller, industrial automation, intelligent hardware device, high-speed communication protocol, wireless access, operational system.

Introduction

The progress in the field of computer technologies and IT industry has a direct impact on the development of logic control systems. Changing the form-factors and increasing the power of computing platforms expands, including, the possibilities of control systems. At present, software solutions in the field of building systems in the form of ready-made modules and libraries allow transforming any commercially available computing platform that supports RTOS operation into a universal control system. The increase in the power of computing resources and changes in software and hardware technologies are constantly taking place, while the new products support the functionality of previous solutions. The introduction of new IT-technologies in the field of industrial automation systems occurs with serious time delays. According to the information presented in the catalogs of manufacturers of programmable logic controllers (PLC), it can be concluded that the clock frequency of the most productive PLC microprocessors is estimated at tens of MHz, while modern programmable controllers (PCs) have multi-core processors with a clock frequency of several GHz. The problem of using less efficient microprocessors is associated with the complexity of heat removal in industrial systems, in connection with which elements with a low energy consumption coefficient are used. These indicators reflect the delay in the development of PLC hardware compared to the PC in 3-4 years. In addition, PC are produced in mass quantities, which reduces the cost of each product, while PLC are produced in a limited edition (compared to PC). In this regard, the use of general-purpose computing systems as a hardware platform will allow the implementation of products that correspond to advanced solutions in the field of computer technologies and will lead to a decrease in the cost of control systems. PC hardware also has the property of interchangeability, which allows always having

ISSN: 2776-1010 Volume 3, Issue 2, Feb, 2022

analogs of components that are removed from production. At the same time, end users of control systems will be able to upgrade and repair the hardware base without capital expenditures and changing the control system as a whole.

Main Part

The Use of Software-Implemented Logic Controller to Implement a Logic Control Problem

Most of the world leaders in the field of logic controllers have software-implemented logic controllers in the list of automation tools. This trend is directly related to the use of general-purpose computing platforms as a hardware base. To implement the principle of “controller based on a computer” it is necessary to have a hardware calculator and software. In this case, the logic controller software at the system level implements the controller's cycle. Among the world leaders in the field of industrial automation, which have software-implemented controllers, one can distinguish: Siemens, with the S7-1500 Software Controller, Bosch-Rexroth, with the Soft Control product, Rockwell, with the SoftLogix controller, etc.

Use of Specialized Hardware Tools to Implement Security Controls

Modern automatic control systems must be equipped with emergency protection tools (EPT). The specified type of systems must be implemented in accordance with GOST R IEC 61508-1-2007 (international standard IEC 61508-1: 1998, Functional safety of electrical, electronic, programmable electronic safety-related systems) [1]. EPTD systems imply yellow marking of hardware, the presence of devices for direct opening of electrical circuits (for example, emergency fungus), duplication and redundancy of critical processes and security processes, the implementation of algorithms for verifying critical calculations, the use of a specialized industrial data transfer protocol, which assumes guaranteed packet delivery over a specified period of time (e.g. Safety over EtherCAT protocol). In contrast to Russia, European and American legislation imposes rigorous requirements to the developers of control systems regarding the use of emergency protection systems, and therefore the “Safety” systems of Western manufacturers differ in wider functionality. Among world class manufacturers, there are a number of products used to ensure safety in control systems, including: “Safety integrated” by Siemens, “Safety technology” by Bosch-Rexroth, “Guard PLC” by Rockwell, “CC-Link Safety” by Mitsubishi, “openSAFETY” by B&R, etc.

Use of Intelligent Hardware Input/Output Devices

In modern conditions of technology development, there is a constant increase for data received from the control object, which is a reflection of the Industry 4.0 concept, one of the fundamental features of which is working with Big Data. This approach involves processing information at all stages of working with it, including directly at the control facility. Until recently, in logic control systems, pre-filtering and signal processing were performed only for analog input types. In modern control systems, it became possible to use hardware inputs/outputs, which have additional functions that significantly expand the

ISSN: 2776-1010 Volume 3, Issue 2, Feb, 2022

intellectual capabilities of information processing directly at the control object. The capabilities of intelligent input/output devices include the following: filtering input signals and eliminating contact bounce effects, support for specialized communication protocols with sensors (for example, EnDat), the ability to combine various types of inputs/outputs into single groups for preliminary processing of incoming information, etc. To implement work with intelligent input/output devices, manufacturers of automation systems offer various technologies, including: IndraControl InLine from Bosch-Rexroth, SIMATIC IOT 2000 from Siemens, DeviceLogix from Rockwell Automation, IoT from B&R.

Use of High-Speed Communication Protocols Based On Ethernet Technology

At present, passive devices for organizing inputs/outputs are available on the market, which support data exchange using one of the standard high-speed communication protocols using Ethernet technology, which at the physical level of industrial systems has become the de facto standard. These devices are an order of magnitude cheaper than standard PLCs because they do not contain intelligent modules capable of organizing the processing of equipment control algorithms. If the logical controller, based on the control system is implemented, supports a standard high-speed communication protocol, then a number of passive hardware input/output modules, including those located at a considerable distance from the main elements of the control system, can be connected to it, and thus organize a full-fledged logical control system. The world leading manufacturers of control systems support one of the most common high-speed industrial communication protocols. For example, based on Ehternet technology (SERCOS - manufacturers belonging to the SERCOS association [2,3], EtherCAT - by Beckhoff [4], Profibus and Profinet - manufacturers belonging to the PI association, Ethernet IP is supported by Rockwell Automation and Opto 22, Modbus TCP by Fastwell and OWEN).

Distributed principle of building logical control systems. Distributed Control System is a solution in the design of control systems that appeared at the end of the last century due to: an increase in the number of parameters (sensors) controlled by a control object, an increase in the territory on which individual elements of a control object are located, as well as complication of control algorithms. Modern distributed control systems, in addition to basic functions, allow implementing:

- One or more high-speed communication protocols for connecting remote hardware input/output O modules.
- Multi-rank industrial networks on the “master-slave” principle, which allows controlling heterogeneous technological equipment within a single system with the ability to distribute control functions between nodes within the specified network.
- Work in local and global computer networks. The controller, which provides support for Ethernet technology and implements the TP/IP protocol, is capable of operating within the corporate computer network. In this case, support is provided for working with standard network hardware devices (switches, routers, gateways, etc.), which allows implementing, including, a multi-rank network.
- Support for wireless access. At present, a useful option for the hardware platform of controllers is support for wireless access (for example, Wi-Fi). This allows, using mobile terminals, access to auxiliary functions of logic control systems, such as configuration, setting, setting of constant values, etc. In this

ISSN: 2776-1010 Volume 3, Issue 2, Feb, 2022

case, the operator, having one mobile terminal, can perform preventive maintenance of automation units one by one.

• Remote configuration and diagnostics (including over the Internet, being at a distance from the control object). Based on the access channel to the global network, communication with the diagnostic center, which can be located anywhere in the world, is determined. Experts carry out remote collection of information about the control object, including during its operation.

• Possibility of remote loading and debugging of logic control programs, which allows implementing a single terminal from which a logic control program is debugged for a group of systems, usually located within the same workshop.

Use of real-time operating systems. There are a number of real-time operating systems available in the system software market today that are installed on general-purpose computing platforms. As a result, a full-fledged logic controller is obtained, which is used as a node of automation systems for solving a wide range of tasks. As such operating systems, Siemens uses Windows 7 version Legasy (adapted version for Siemens controllers with real-time extension) and Embaded, Rockwell Automation - Windows 10 IoT, B&R - Windows 7 Embaded, Windows 10 IoT, Debian 8, Russian company Fastwell – Windows XPe, Linux RT, QNX [5], etc. The specified operating systems (OS) support, among other things, real-time operation on mobile platforms. Open source real-time operating systems (RTOS) are developing rapidly, dynamically and faster than highly specialized operating systems designed to work with specific hardware options. When using publicly available RTOS in industrial control systems, it is necessary to take into account the legal aspect, according to which a license for an RTOS can only be purchased by control system developers who sell ready-made equipment with pre-installed OS to end users. Sale and resale of the OS separately from the finished device is not possible. The use of a publicly available RTOS offers a number of advantages, among which the following can be highlighted:

• Work in a familiar user interface based on windowed applications when designing and debugging program code. Most RTOS systems have analogs among general-purpose operating systems (for example, Linux - Linux RT, Windows - Windows Embaded, etc.), in which applications can be developed and debugged. The user's style of work will not differ from the style of work with home PC and will be intuitive. At the same time, standard libraries of elements are available for programmers of interface applications (for example, operator terminals), which greatly facilitate development. For general-purpose operating systems, the instrumental support of software development is at a high level, there are well-proven development tools, including hose used for large projects [6, 7].

• Use of unified execution environment in which the main functional modules of the control system operate. In the frame of single execution environment, the operation of the logical control kernel, operator terminal, programming subsystem and other modules is assumed, one of the standard mechanisms (shared memory, TCP / IP protocol on the local bus) provides the interaction of which.

• The control system allows implementing a connection based on supported network protocols (for example, TCP \ IP, UDP, etc.) of external devices, such as mobile operator terminal, remote monitoring and configuration system, etc.

• Reducing the cost of the control system by reducing the cost of developing specialized system software.

ISSN: 2776-1010 Volume 3, Issue 2, Feb, 2022

• OS installed in hardware management systems has a long sales and support cycle. On average, based on data from various RTOS vendors, a full support cycle lasts about fifteen years since the last update was released. At the same time, full support with the provision of development tools and licenses lasts about ten years, then partial support is provided, which includes the transfer of critical updates and the availability of licenses limited in time. However, the use of RTOS in the frame of control systems also has its drawbacks, which include the following:
• The cost of the control system must include the cost of the RTOS.
• Compatibility of versions of software used in the control system is provided by the system developer.
• Technical support for end users, including on issues related to RTOS operation, is provided by the manufacturer of the control system. This presupposes the availability of certified specialists responsible for the operation of the RTOS in the technical support department of the management system developer.

Use of single interface for device interaction based on OPC UA technology

In the early 90's of the last century, the idea of developing a universal communication toolkit for devices from different manufacturers, operating based on different industrial protocols, arose. In this regard, the OPC standard (English Open Platform Communications, formerly OLE for Process Control) arose. OPC technology provides developers of industrial automation applications with a universal interface for exchanging data with industrial devices that support this technology. Developers of industrial devices to support OPC technology implement a special application OPC-server, which acts as an intermediate link between technological equipment and external automation applications. Early solutions in the field of OPC technology were focused on working within the Windows OS (COM / DCOM, ActiveX, OLE, etc.), modern solutions are platform independent (OPC XML DA and OPC UA). To coordinate the development and support of OPC standards in 1994, the leading developers of automation tools created the international non-profit organization OPC Foundation [8].

Conclusions

At present, the most commonly used is the OPC Unified Architecture (OPC UA) cross-platform technology. It is the first OPC protocol that is not based on COM / DCOM technology, supports secure communication through client and server validation, and has tools of countering external attacks. The operating principle of OPC UA is based on client-server technology. The system can have many clients and servers, while the client can be connected to several servers and the server can support multiple clients. User-implemented application can combine groups of clients and servers to forward messages. The client makes requests to the OPC server through the internal interface, the communication stack converts the requests into messages to call the required service, which it sends to the server. After receiving a response to the requests, the communication stack transfers them to the client program. The OPC server address space is the set of nodes available to the client program using the OPC UA services. "Nodes" represent real objects, their definitions, and cross-references.

ISSN: 2776-1010 Volume 3, Issue 2, Feb, 2022

References

1. GOST R IEC 61508-1-2007 Functional safety of electrical, electronic, programmable electronic systems related to safety. M.: Standartinform, 2008 – 58 p.
2. Official resource of the SERCOS trade association [electronic resource]: The official resource of the SERCOS trade association - Access mode: http://www.sercos.com/ (access date 16.10.2017).
3. Official web page of the SERCOS communication interface [electronic resource]: Official resource of the Bosch-Rexroth company. Access mode: https: //www.boschrexroth.com/en/xc/products/engineering/communication-interfaces/sercos/index (access date 16.10.2017).
4. Official portal of the EtherCAT developer's association [electronic resource]: The official portal of the EtherCAT developer's association - Access mode: https://www.ethercat.org/default.htm (access date 16.10.2017).
5. Official site of "Wind River Systems, Inc." company [electronic resource]: the official site of the company "Wind River Systems, Inc." - Access mode: http://www.rtlinuxfree.com/ (access date 16.10.2017).
6. Official page of Visual Studio integrated development environment [electronic resource]: the official website of Microsoft Corporation - Access mode: https://www.visualstudio.com (date of treatment 16.10.2017).
7. Official website of the developers of the Eclipse integrated development environment [electronic resource]: the official website of The Eclipse Foundation - Access mode: http://www.eclipse.org/ (date of access 16.10.2017).
8. The official website of the OPC Foundation consortium [electronic resource]: the official website of the OPC Foundation consortium - Access mode: https://opcfoundation.org/ (access date 15.01.2019).