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PLC and their programming – 2. PLC, PAC, DCS – who whom?

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Proposed paper continues the first part of a series of publications on PLC systems called "PLC a ich programovanie – 1. Čo je to PLC ?". The aim of the article is clarify the concepts of PLC, DCS and PAC and may evoke discussion on this issue.

1. Introduction

In the previous article we focused on the explanation of the concept, features, architecture and programming of PLC's. So what is a DCS and in what way it differs from the PLC? DCS is an acronym of English term Distributed Control System. Distributed in the terms of input-output units, which are bus or network connected to the control system's CPU. Is DCS an acronym for PLC ? It's possible to connect distributed digital and analog modules (of course others) trough various communications, therefore in the terms of distribution of inputs and outputs it is a distributed control system. So, how it is?

2. History

The main difference between DCS and PLC stands in historical perspective. At the beginning the PLC was understood as a control system, which is connected to digital input-output units to control discrete assembly processes. Even the name itself suggests that: "Programmable logical Controller". The cause of their formation was to efficiently and cheaply replace the relay logic. But fast progress not only in computer science but also in the field of automation brought very soon a necessity of implementation of analog control int PLCs. That's why we should not call the modern PLC-based control systems PLC, but a new term arise: Programmable Automation Controller – PAC.

PAC's allow not only discrete control, but also support analog control e.g. using standard PID blocks, from computational reasons of course in discrete forms. PAC's standing for modern PLC's also have numerous communication possibilities, simple implementation into factory/office network, simple and efficient programming. They still allow efficient control of discrete or even mixed processes. On the other hand, DCS was established to control continues processes (so. Process automation) in which the PID algorithms were mainly used in the form of preconfigured function blocks (object-oriented programming). This DCS were able to measure and control tens to

hundreds of analog signals. They began to be used in petrochemical, in general in chemical, pharmaceutical and food industry, power engineering, etc.

The birth of first microcomputers which were used in control dates from 60years from the beginning of last century. An example is microcomputer IMB 1800 Data Acquisition and Control System, which was introduced in 1964 as computer which allows to control manufacturing lines, steel production or analyze the rocket states during test firings. DCS was introduced by Honeywell (TDC2000) and Yokogawa (Centum) in 1975 about the same time. Interestingly, the Centum system still exists and is commercially successful. In the same year Bristol company introduced system named UCS 3000 and in 1980 Bailey Controls Company introduced its system NETWORK 90.

Gradually, as the DCS moved from proprietary hardware to the PC began to expand workstations based on CRT monitors, mostly using text and weak graphics. The communication capabilities expanded of the previously used pneumatic and 4-20mA analog signals trough the bus up to the standard LAN technologies. Computers have brought more options to speed the implementation of applications, relation databases, tabular data display in multiple windows, etc.

Fig. 1: Virtual model of a control room consisting of more HMI stations

3. PLC vs. DCS

So what are the main differences between the PLC and DCS? In addition to the above mentioned differences, there are more directly related to their deployment. DCS systems are deployed in operations where downtime due to a malfunction may cause material and personnel losses. To prevent them it’s possible to include redundant solutions, with in turn are increasing the investments to the control system. Redundancy and sophisticated diagnostics are nowadays a standard built-in options for DCS and it’s not necessary for them to write a custom program. Downtime is related with online and offline application changes. A typical DCS runs non-stop for years.

The difference is also in principle of alarm messaging. PLC alarm messages alerts to the resulting failure (broken sensor, wrong product position, analog values outside the range), while DCS alarm messages can predict future behavior of the system and to warn and recommend appropriate actions to avoid undesirable conditions.

In the case of DCS, the center for control is HMI because for the continuous control

it’s not possible to see the product (it’s located in enclosed tangs, pipelines, …). On the other hand in PLC control used for discrete control, the operator can see the product. Therefore, the operator must have as much information about the process on the screens to know to monitor and control it.

If requested responses are tens of milliseconds, PLC control system is suitable. By programming (or configuring) PID loops the execution time is growing, therefore is more advisable DCS which usually uses 100 to 500 ms cycle time. Also the control algorithms are important as PID, cascade loops, MPC, ratio control, feed forward loops, etc. which need intend of DCS deployment.

In terms of software solutions in the PLC library are simple elementary functions with the option of creation self-programmed larger functions, while in DCS are prepared standard solutions with and extensive library of templates. Listed parts have “unlimited” functionality for repeatability and dependence, but for their own modifications often poses problems of compatibility.

PLC programmer often needs to harmonize two distinct databases during the development of the project. Tag (variable) database of PLC project and tag database for HMI, which are imported into HMI project or they’re linked. Tags are tied to a fixed memory location in the PLC. In the case of DCS, there is only one (or more databases for tags, alarms, …) database running on a central server with a possibility of ad-hoc access to variables by tag name (without knowing the need exact memory location).

PLC systems execute their program cycle cyclically, periodically or event-dependent. These options can be combined with the fact that the event program has the highest priority and the cyclical the lowest. Already a description of the program tasks express, that these programs runs serial, i.e. program with a higher priority interrupts the program with a lowest priority and when program finished the main (cyclic) program continues where the original program was interrupted. DCS system often uses multitasking operating system and can therefore be beyond of the real-time control run other applications.

4. Programmable Automation Controller (PAC)

PAC is a compact controller that has the characteristics of PLC and control systems running on PC. PAC is used for continuous control, data collection, remote monitoring, etc. . They are able to provide data for process-level for application software and databases. PLC and PAC have the same objective, but it’s possible to program them differently. PLC is programmed mostly in the ladder diagram (ladder logic) and PAC can be programmed in more languages (also in higher languages). In terms of input reading, PLC scans the inputs at the beginning of the program cycle as fast as possible. PAC using the existing tag database and logical addresses reads/writes only those addresses that are needed.

In Slovakia there are many suppliers of PLC (or PAC), for example Schneider Electric, Siemens, Allen-Bradley, B&R, etc. In general we can say that all current PLC have properties that may be incorporated into the PAC. The basic difference consisting in

terminology stems from the fact that the original PLC were designed to manage a purely discrete processes, as is apparent from its name. PAC allow to control not only discrete but also continuous processes thus are in terms of automation to the generalized process control. In practice therefore we often meet with the PAC concept that manufacturers uses more as a marketing tool to highlight features in a way higher, more powerful PLC products.

5. Conclusions

What to say at the end? In addition to continuous (DCS) and discrete (PLC) control, there is a hybrid control where manufacturers of DCS and PLC are also represented. This is due to the fact that the technology improves over time and are brought to market newer and newer products (CPU, modules, ...), which accomplish right out of the other portfolios. Whether will be DCS = PLC is a question of the future.

Next contribution: Languages for PLC/PAC programming

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