ADVANTECH
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White Paper

Programmable Automation Controllers Find Their Niche…Everywhere!

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In the beginning there was the relay and the timer. And in the process industries, there was the hardwired controller. A generation ago, digital electronics made the hardwired relay and controller obsolete in favor of the PLC, the programmable logic controller. Made to be fully deterministic and have limited control functions, PLCs were able to sweep hardwiring into the dustbin because they were easy to program in the "ladder" style of electrical wiring diagrams, and they were easily re-programmable so that they could accommodate changes on assembly lines and in batch processes.

But PLCs are limited. Ladder-logic programming cannot be used for complex mathematical formula, such as the basic PID algorithm found in every single loop controller in a process plant, for example. Then, along came the PC. Inexpensive computing power became ubiquitous and easily affordable. PCs were tried early on in industrial control, but early operating systems and hardware were not up to the stresses and standards of the industrial workplace.

One of the biggest issues was determinism. In many industrial automation environments, especially in motion control and other discrete automation applications, it is absolutely required that an instruction get where it is supposed to go, when it is supposed to get there. PC operating systems are non-deterministic and have variable latency, depending on processor loading or the requirements of the operating program.

The Rise of the PAC

Several companies, including Advantech, have produced a powerful and useful hybrid of the programmable controller and the PC. This device is generally called a PAC, or programmable automation controller. ARC Advisory Group is generally credited with coining the name PAC, and analyst Craig Resnick defines a PAC as having these characteristics:

- "Multi-domain functionality, including logic, motion, drives and process on a single platform.
- Common tagging and a single database.
- Software tools that allow design by process flow across several machines or process units.
- Open, modular architectures that mirror industry applications from machine layouts in factories to unit operations in process plants.
- De-facto standards for network interfaces and languages, etc., allowing data exchange as part of networked multi-vendor systems."

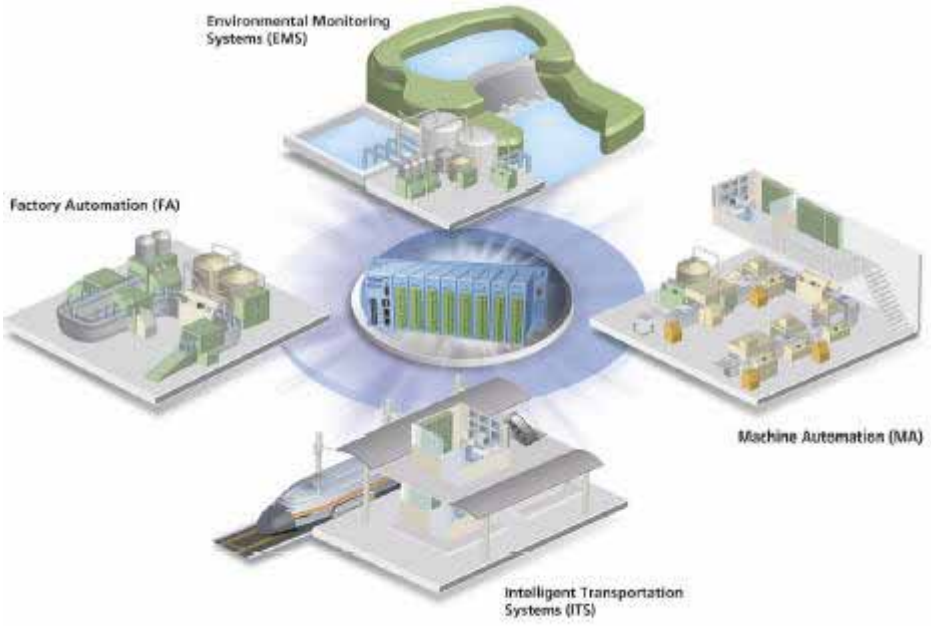
These characteristics taken alone or together are the reasons why PAC devices have grown dramatically in market acceptance since 2001.

About Determinism

High speed, powerful processors drawn from the PC world and more sophisticated operating systems have made it possible for PACs to operate in various modes and with different deterministic speeds. PACs combine Real-Time Operating Systems (based on Windows CE 5.0 or its successors) with the ability to conduct multiple loop operation, and handle execution priorities in a much more sophisticated manner than a PLC, but with all of the deterministic safety and reliability by means of built in system triggers and a more complex and useful way of handling I/O and system timing. This makes it possible to have both the deterministic safety, reliability and speed of the PLC combined with the power and reliance on COTS and standards-based products of the PC. The modern controller for automation applications has emerged as the PAC.

One Platform, Multiple Domains

Many OEMs and end users of automation systems and controls work in more than one domain. For example, even a highly process oriented plant such as a fine chemical manufacturer or a pharmaceuticals manufacturer has requirements within the plant for motion control, packaging, inventory management, and automated identification systems, as well as continuous and batch process control requirements. The need to integrate Laboratory Information Management Systems (LIMS) and Process Analyzer Technology (PAT) Initiatives, and sampling initiatives around the plant have made it necessary to network multiple domains. In addition, increasing emphasis on quality and conformance management systems as well as the need to conform to increasingly detailed requirements for records and validation, such as the U. S. government's 21 CFR Part 11 and the Sarbanes-Oxley Act, have made companies' desire for fewer and more networkable systems grow in intensity.



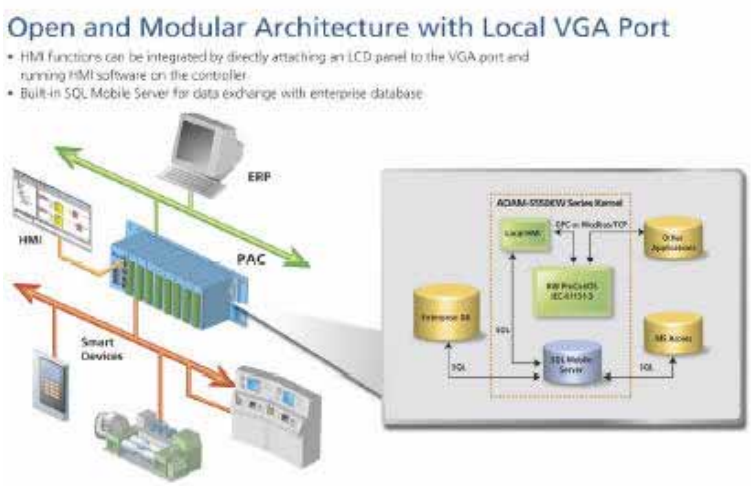
A PAC can be used as shown in the figure in a wide variety of applications in a wide set of domains within the manufacturing enterprise from inside the facility management system, in the environmental monitoring and handling system, in the factory automation systems themselves, and in the networks necessary to transfer the data from the plant floor and auxiliary control systems to the automation software and control centers and from there to the enterprise management systems themselves.

Single Database Functionality
One of the significant differences between PLCs and PACs is the way they handle input/output functions. PLCs constantly scan all the I/O in their systems continuously at a very high scan rate. While this enables very fast I/O response, it also limits the number of I/O points a PLC system can handle. PACs, by contrast, use a logical address system and a single tagname database very similar to traditional SCADA and DCS systems. Thus, a PAC can identify and map I/O points as needed.

The fact that PACs handle I/O and data in the same manner as traditional SCADA and DCS systems means they can more easily be interfaced directly with those systems. PACs are often used as substitutes for SCADA RTUs (remote terminal units) and DCS field controllers, just because they work in a logically similar manner with data.

Powerful Software Tools
To extend the capabilities of field automation controllers, the IEC has created programming software standards, IEC 61131-3 and others. These standards take the ability of programming in about twenty ladder-logic commands and replace it with a full featured programming capability. In addition, there's the concept of function blocks. A late addition to the world of PLCs, function blocks come directly from the Distributed Control System (DCS) world. PACs are designed to utilize function blocks and function block programming rather than the more limited ladder-logic programming of the PLC.

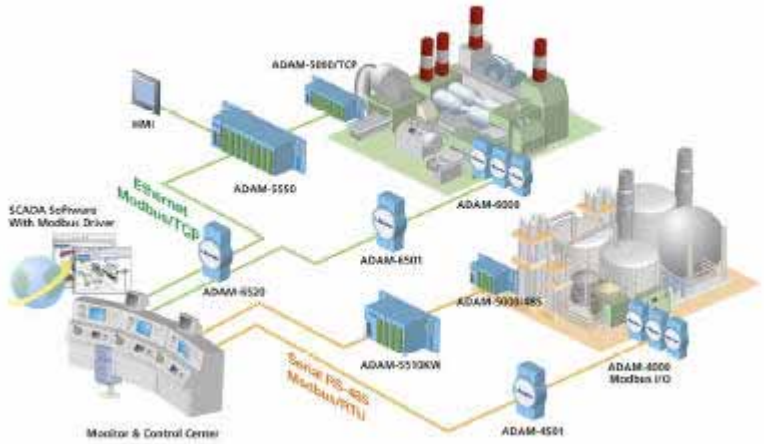
Because PACs are in essence PCs, they are capable of being programmed in a variety of higher order programming languages. Suppliers of PACs have produced complete suites of programming software tools to enable very sophisticated operations to be controlled by PACs. For example, Advantech produces software for PAC programming, HMI creation, SCADA, data acquisition and distributed control architectures, and an OPC server for connection to other control systems and even to MES and enterprise integration systems.



Open Architectures
Notice in the figure the multiple form factors of the PACs pictured. PACs are based on open architectures that permit a variety of form factors to be used yet the devices themselves are the same or similar. A PAC can be used as a motion controller, a data logger, a process controller, and other devices with a minimum of design and configuration changes. And the PAC can handle control, communications, data logging and can communicate multiple types of information through multiple information gateways simultaneously.

Standards-Based Systems
In the figure, all of the PACs are interconnected using standard networks from Modbus and Modbus/TCP on the factory floor to Ethernet throughout the plant, to TCP/IP and .NET to connect to the Web and the enterprise. It is this ability of the PAC to use standard and standards-based

networking and communications that has driven the PAC to its pre-eminence as the factory automation controller of the future.



Thus, a machine control PAC can communicate with its sensors or other I/O via Modbus, with other PACs in the same factory cell with Modbus/TCP, or CANbus or CANopen, or Profibus. It can communicate with other PACs or HMI/SCADA or DCS via Ethernet or through the use of an OPC Server, and with the enterprise through the use of various OPC or .NET services, depending on what data it is serving and to where, simultaneously.

The Power of Open Systems

The PAC has provided incredible power to OEMs, system integrators, and end users interested in procuring the best possible automation solution using best of breed products and software. PACs can be used for data acquisition, for communication control, for process control… for nearly any control related task in the manufacturing environment. Data can be acquired, processed, used for field-level control, and reported higher in the enterprise using integrated hardware and software.

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