

ICP DAS PACs (Programmable Automation Controllers)

- Untie the core power of PAC

Introductions

ICP DAS devoted in providing high quality Data Acquisition System and PC-Based Control Systems for almost one decade, all advanced PC-based embedded controllers released by ICP DAS possess all characteristics of a PAC (Programmable Automation Controller) defined by ARC (Automation Research Corporation) Advisory Group. Each of ICP DAS advanced embedded automation controller is truly a PAC which combines the best features of both PLCs (Programmable Logic Controllers) and IPCs (Industrial Personal Computers). According to a survey reported by ARC, traditional PLCs are still very much alive in many specific application fields and used in conjunction with IPCs to fulfill those functions PLCs lack. However, both capabilities of PLCs and IPCs are grounded in their natural architectures and limitations. The re-engineering PACs are the result of evolution of control, and help system integrators to reduce the need of hardware. One important issue people concern about is how to untie the power of PACs and how to get the benefits from PACs. For this reason, this paper would try to provide an overview of PAC and its anticipated developments in the future at first. And then it walks through PAC's core technology such as real-time multitasking and communication issues. Finally, it gives a brief introduction to ICP DAS PACs.

The Past of PACs

- **The PLCs (Programmable Logic Controllers)**
PLCs (Programmable Logic Controllers), which are

physically rugged and designed for reliable real time operation, are specialized industrial computers first introduced in the 1960s for automation control system. The typical PLC hardware architecture is proprietary, and the typical PLC software architecture is fixed to run predefined control loops to scan I/O, to execute user-defined logic, and to communicate to a field bus. And a lot of PLC software complies with the IEC-61131-3 international standard to provide specific languages such as ladder logic, digital logic, and sequential function charts for the control logics programming. The reliability of a PLC is mainly due to the hardware and software designed, but these characteristics also limit the extensibility and the flexibility of a PLC. It is true that PLCs are still alive and with potential increase in market, but PLCs need generation upgrade to provide more computing power, sufficient internal memory and storage, standard peripherals, networking interfaces, connectivity to business systems, and flexibility for OEM application software. This is why many factory floors today have PLCs used in conjunction with PCs.





- **The IPCs(Industrial Personal Computers)**

In the 80's and 90's, IPCs (Industrial Personal Computers) are introduced. Because of their powerful processing capacity, standard fancy peripherals, networking capacity and graphical interfaces, IPCs play a key role for supervisory, complex applications, advanced control, HMI, data logging, and enterprise communication. IPCs are derived from commercial PCs and have some improvements in hardware for harsh environments, but IPCs are still general-purpose computers initially designed to handle a variety of non-real time applications. Although IPCs cooperate with PLCs to benefit and complete whole system with flexibility, advanced functionality, connectivity, and whatever PLCs lack, what engineers dispraise most is their reliability and survivability. IPCs are eventually the same architecture of commercial desktop general-purpose operating systems, the unstable operations, non-determinism of operation system, OS crash, and hard drive crash are always the nightmares of control engineers. However, today's typical control systems are usually hybrid solutions which contain PLCs and IPCs to get the best feature of both PLCs and IPCs.

- **The PACs(Programmable Automation Controllers)**

Due to all above reasons and backgrounds, a new concept is emerged to direct the evolution in the control, the PACs (Programmable Automation Controllers). The Word, PAC, is coined by ARC (Automation Research Corporation) Advisory Group which is an international advisory company of thought leader in manufacturing, logistics, and supply chain solutions. ARC identified 5 main PAC characteristics to help users to define their application needs, and these criteria characterize the functionality of the controller by defining the software capabilities. And a PAC can be defined by the following features and capabilities:

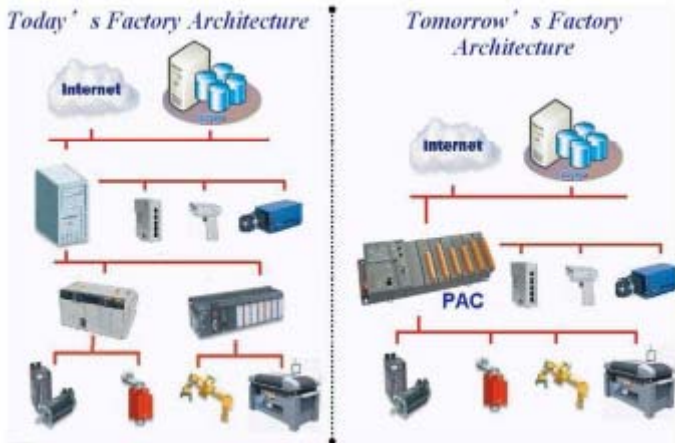
1. Multi-domain functionality—including logic, motion, HMI and process control—on a single platform

2. A common development platform for the design and integration of multi-domain automated systems
3. Allowing OEMs and end users to deploy multiple control applications on a single platform
4. Facilitating open, modular control architectures that enable highly distributed automated plant environments
5. Employing *de facto* standards for network interfaces, languages, etc., to allow data exchange as part of networked multi-vendor systems.

After ARC introduced the concepts of a PAC, lots of leading automation controller providers like Siemens, NI, GE Fanuc, AB and Rockwell, also introduced their PACs, which combine the functionality of PCs and PLCs, and engineers are increasingly using PACs to perform I/O, communications, motion control, and machine automation. The PAC concept will play a major role in plant and factory automation, today and in the future.

The Future of PACs

To examine today's architecture of control systems, you would see so many things and technologies required to do the functionality. Different PLCs are adopted in specific control applications, maybe extra discrete I/O devices and DCSs are required, and IPCs are used in conjunction with PLCs to log data, to communicate with other industrial I/O devices and software, to access fancy I/O devices with PC standard interfaces like USB, Ethernet, and Compact Flash, to connect to business systems, and to provide Internet services. Now a multi-functional PAC platform can run all applications in one single controller to reduce the need of hardware, technologies and trouble shooting for integration, and human resource for maintenance. One single PAC would replace several PLCs and one IPC of a previous hybrid control system.



With the popularization of PAC in industry control field, we anticipate the development of PAC based on its architecture will make further progress toward four directions.

- **General-purpose PAC**

General-purpose PAC which inherits today's open language design, open communication architecture, and the feature of embedded HMI will apply to data acquisition system or environment monitoring system which is not sensitive to real time feature.

- **Specific-purpose PAC**

Compared with general-purpose PAC, specific-purpose PAC unites more power of real-time multitasking system by adding real-time multitasking middleware and specific know-how to build cost-effective specific machine such as motion control system and vision detection system etc.

- **Extensive-purpose PAC**

Extensive-purpose PAC, the mix of general-purpose PAC and specific-purpose PAC, combines the feature of general-purpose PAC and specific-purpose PAC via local bus to build the high-end PAC.

- **Extensive-purpose platform**

With the popularization of PAC, customers will push PAC manufacturers to provide extensive-purpose platform for integrating PACs provided by different manufacturers. The protocol of this platform will be defined by all leading manufacturers.

The core technology of PACs

Five main PAC criteria identified by ARC are based on software capabilities to characterize the functionality of the controller. As to implementation of a PAC, a PAC must combine the best features of both PLCs and IPCs to achieve these five functionalities. To summarize it briefly, a PAC should provide ruggedness and reliability like a PLC and flexibility and functionality like IPC. For this reason, we divide three parts, real-time multitasking system, communication technology, and embedded HMI, to discuss these PAC core technology issues.

- **Real-time multitasking system**

Before discussing real-time multitasking system, we have to clarify the relationship between 'real-time system' and 'multitasking system'. Generally speaking, 'real-time system' means a system which is sensitive to the response time. Within this kind of system, response time must be smaller than timeout setting. That is to say, the logic correctness of real-time system does not only depend on the correctness of computing but also decide by the timing of computing. As for 'multitasking system' compared to traditional single task system DOS means a system which can execute several tasks simultaneously by system scheduling.

Actually one CPU just can execute one task at one time, that is why the system has to use scheduling mechanism to make system look like executing several task at the same time. There is a contradiction between 'real-time system' and 'multitasking system'. For this reason, specialist discriminates further between 'soft real-time system' and 'hard real-time system' according to the effect of timeout. If a task does not finish before timeout, it is acceptable for soft real-time system. Because at most that just lowers the efficiency of system. However, it does not to be allowed for hard real-time system because the consequence of system is unexpected even ruinous. That is why the controller which is multitasking or not is not so important in industrial control field. On the contrary, the

controller which is hard real-time or not is more important.

As above, we can not declare PAC is a real-time multitasking system just because putting a real-time multitasking operating system inside. We have to consider three requirements in industrial control field:

- 1.The requirement of hard real-time
- 2.The requirement of customizing task by user
- 3.The requirement of on-line debug and on-line changing procedure

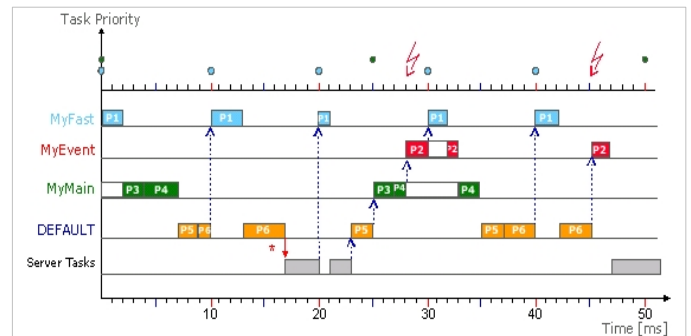
● Communication technology

Due to broach Ethernet and wireless LAN to PACs, the variety of IT technology will accomplish on PAC such as the integration of UPnP, SDP, and SNMP, and the application of GSM GPRS, and GPS. Furthermore, ICP DAS develops FRNet series DI/DO modules to satisfy the access requirement of a large number of DI/DO points. This kind of communication technology can satisfy the need of long distance, fast DI/DO access, and a large number of DI/DO points communication rely on the specific FRNet communication chip. For connectivity to other devices, legacy systems, and business systems, ICP DAS PACs also provide industrial Ethernet, Windows TCP/IP sockets, XML, web server, FTP server, Telnet server, and SQL server CE edition to support engineers to build their web-enabled applications, database applications, or files processing applications. And ICP DAS of course provides necessary SDKs (System Development Kits), including OPC server, Modbus libraries, I/O accessing libraries, and proprietary VxComm protocols, to support all sorts of ICP DAS local and discrete PLC-style I/O modules, to connect to third party I/O devices, or to interface 3rd party software packages. All of above shows the PAC will go toward the open communication architecture rapidly in near future.

● The Cost-Effective Embedded HMI

HMI will not be an expensive and independent accessory out of PAC. Combined with high performance CPU and

graphic chip, PAC provides a cost-effective way to achieve the embedded HMI design through simple VGA port. To utilize the embedded VGA port for display, the WinCon-8000 and KinCon-8000 series PACs are separately embedded with InduSoft and ProVisIT runtime to provide HMI/SCADA solutions. The InduSoft Web Studio and ProVisIT are powerful integrated collection of automation tools that includes all the building blocks required to develop modern Human Machine Interfaces



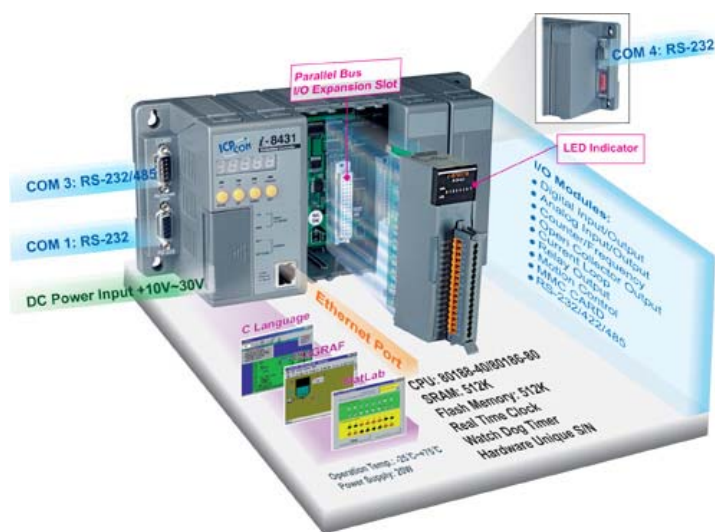
(HMI), Supervisory Control, and Data Acquisition System (SCADA) applications that run natively on Windows XP, 2000, NT and CE/CE.NET or in an Internet/Intranet environment. A simple drag and drop, point and click development mimics the most complex behavior of your live processes. The WinCon-8000 series PACs and KinCon-8000 series PACs provide a bundled driver to integrated the application performance and easy to use of software and hardware. It can play as an intelligent distributed data acquisitions in PC and then download and apply them to the WinCon-8000 series PACs and KinCon-8000 series PACs. Moreover, InduSoft Web Studio also allows you to save your application screens in HTML format and export them from embedded http server of WinCon-8000 series PACs to web browsers like IE (Internet Explorer). Since WinCon-8000 series PACs and KinCon-8000 series PACs provide an open architecture, standard software support, and industrial standard protocols like OPC server and Modbus protocols, WinCon-8000 series PACs and KinCon-8000 series PACs can easily connect and communicate with other third party HMI/SCADA software. Besides InduSoft and ProVisIT, there are over 10 international or native third party HMI/SCADA software vendors have ported or are

porting their software solutions onto the WinCon-8000 series PACs for international or local market.



The ICP DAS I-8000 series PACs

The I-8000 series PACs are the most compact PAC released by ICP DAS. There are modular network based systems with the capability of connecting I/O either through its own local bus, an I/O expansion, or network extension. Each of I-8000 series PACs is comprised of a main control unit with a range of standard communication interfaces, and an I/O bus permitting I/O expansion. The bus is hybrid in nature providing the facility to connect either through serial or parallel I/O modules. The parallel bus is used for high-speed data transfer. The unit can communicate using serial communications (RS232, RS485), Ethernet, or CANbus. The Ethernet version of the product supports an integrated web server permitting Internet and Intranet applications. The I-8000 can be used as an intelligent distributed data acquisition front end connected to a host machine running a standard SCADA package, or alternatively it can be user programmed as an autonomous controller running an embedded software application. Significant non-volatile memory is available for data and program storage. The product is made up of four basic components, Main Control Unit (MCU), I/O Expansion Unit, I/O modules, and an embedded proprietary operating system. The proprietary operating system, the MiniOS7 embedded OS, is developed by ICP DAS and compatible with DOS. MiniOS7 has more features than regular DOS in embedded applications, such as shorter power-up time, built-in hardware diagnostic function, direct support for I-8000 and I-7000 modules without a library, and direct support for internal or movable memory devices.



The ICP DAS WinCon-8000 series PACs

The WinCon-8000 series PACs are leading edge embedded platforms with an ARM-core RISC CPU running a Windows CE.NET embedded hard real time operating system. When compared to the standard Window O.S., Windows CE.NET has some advantages, including hard real-time capability, small core size, fast boot up, interrupt handling at a deeper level, and achievable deterministic control. The WinCon-8000 series PACs built of COTS (Commercial Off The Shelf) industry-grade components with series considerations about high performance, low power consumption, reliability, availability, survivability, and highly protected. Besides the excellent hardware design, the WinCon-8000 series PACs also provide both capabilities of PC software and PLC software such as Visual Basic.NET, Visual C#.NET, Embedded Visual C++, SCADA software like InduSoft, and SoftPLC like ISaGRAF. Also one set of WinCon utilities are of course embedded for system configuration, monitoring, diagnostics, and system upgrade. The embedded VGA pot of WinCon-8000 series PACs allow the user to choose a regular LCD monitor instead of the need for an expensive HMI or Industrial PC. They are all-in-one (WinCon-8000 = IPC + PLC + HMI) cost-effective solutions to replace today's hybrid control systems which build up with lots of regular PCs and traditional PLCs. The embedded real time operating system is resident in the

flash memory embedded in the MCU (Main Control Unit) of a WinCon-8000 PAC. User programs and data can be saved in external storage areas such as Compact Flash Card and USB drive, or downloaded to RAM at run time through the LAN or USB. The WinCon-8000 series PACs are flagship PACs released by ICP DAS, these PACs provide both best hardware features of IPCs and PLCs.



The ICP DAS KinCon-8000 series PACs

The ICP DAS KinCon-8000 (KinCon-8045/8345/8745) is a WinCE based SoftLogic PAC, with Windows CE.NET OS and popular, flexible programming software, including KW-software, Microsoft EVC++ and VS.NET 2003(VB.NET and C#.NET). KinCon-8000 provides KW-software with multitasking and online change features, which can fast design multitasking real time PLC control system, and online change PLC tasking. These features let the world leading automation companies (such as ABB, Fuji, Hitachi, Mitsubishi, Kuka...) rely on for years. KinCon-8000 also provides cost-effective HMI solution, ProVisIT, which is a low cost alternative to HMI and VB programming. It features with hierarchic mapping of screens and available in Traditional/Simplified Chinese, English, German...language. Conjugating with Touch panel (GA-700YY-UOM/USB), it is a complete and integrated HMI automation system.

For satisfying the requirement of hard real-time, the middleware ProConOS in KinCon-8000 fully uses the www.icpdas.com

real-time feature of Windows CE.NET and also supports multitasking, interrupt and preempted task programming to ensure every task can be achieved in timeout limit. Furthermore, for heaving the behavior of real-time in the system, Windows CE.NET can expend to be an interrupt task in ProConOS. For satisfying the requirement of customizing task by user, the programming software MultiProg based on IEC61131-3 introduces multitasking programming procedure in it which allows users designate control code to specific task. By adjusting four system tasks (Event/System/Default/Cyclic Task) and setting two watchdogs, KinCon-8000 can be a stable real-time multitasking system. Finally, by generating primary and secondary control code, KinCon-8000 can satisfy the requirement of on-line debug and on-line changing procedure.

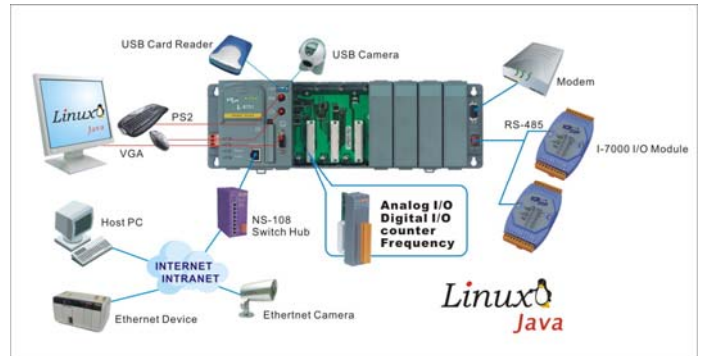


The ICP DAS LinCon-8000 series PACs

ICP DAS also provide a series of PACs powered by Linux, the LinCon-8000 series PACs. The hardware of the LinCon-8000 is identical to the WinCon-8000, and all the ideas and concepts of design of LinCon-8000 are the same as WinCon-8000. All LinCon-8000 series PACs are powered by embedded Linux to provide a robust real time platform for PLC software and functionality like a desktop PC installed with desktop Linux. The LinCon-8000 also support all sorts of ICP DAS local or remote I/O modules including I-7000, I-8000, and I-87K series. Same as WinCon-8000, the LinCon-8000 provides LinCon SDKs (System Development Kits), including Modbus libraries, I/O accessing libraries, and proprietary VxComm protocols, to support all sorts of ICP DAS local and remote PLC-style I/O modules, to connect to third party I/O devices, or to interface third party software packages.



In contrary to .NET Compact Framework capability (Visual Basic.NET and Visual C#.NET) of WinCon-8000 series PACs, the LinCon-8000 series PACs provide JAVA programming capability for hardware independent program development. And in the future, the ISaGRAF version LinCon-8000 PACs would be available soon. ICP DAS just try to develop and release the LinCon-8000 series PACs for those engineers come from Linux world, or for those system integrators who want to use PACs in their Linux legacy systems. ICP DAS would like to also bring the benefits of PACs to the industrial Linux world.



For more information about ICP DAS PACs, please visit: <http://www.icpdas.com>, or contact with our services via service@icpdas.com

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