The Next Link in IPC Evolution—Embedded Systems for Industry

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The industrial world has always had the need for control schemes to handle manufacturing and management processes, with even the earliest generations of engineers inventing machinery to put their control designs into practice. The development of PCs towards the end of the last century presented engineers with an important tool for implementing complex control algorithms that blend multiple sensor signals into actuator commands. However, people soon realized that PCs designed for the office and home environments had severe limitations when used in harsher industrial settings.

The Emergence of the IPC

The realization that computers built for consumers were not appropriate for use in factory-type environments led to the development of the IPC (Industrial PC) in the mid 1990's. Initially, the types of design modification that were made addressed usage issues, and hence were more cosmetic in nature. Such changes included reducing the size of the motherboard and converting from horizontal placement to vertical placement to accommodate the smaller amounts of free floor space available at industrial sites. This trend of tailoring PCs for industrial settings caught on quickly, leading to a big demand for IPCs in industrial markets.

What Industrial Applications Really Need

Precisely what kind of computer does the industrial world need? To begin with, we know that equipment used for

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About MOXA

The MOXA Group manufactures one of the world's leading brands of device networking solutions. Products include serial boards, USB-to-serial Hubs, media converters, device servers, terminal servers, Modbus gateways, industrial switches, and Ethernet-to-fiber converters. Our products are key components of many networking applications, including industrial automation, manufacturing, POS, and medical treatment facilities.

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industrial applications is often expected to operate continuously—24 hours a day, 365 days a year. Since equipment failures can cost companies thousands of dollars even for stoppages lasting just a few minutes, industry has adopted a zero tolerance mindset. In other words, it's cheaper to invest more money for rugged and/or redundant equipment at the outset than suffer the consequences resulting from a breakdown during normal operation.

To drive home the point, let's consider two non-industrial scenarios. In the old days when TVs still used vacuum tubes, the first step in any DIY troubleshooting activity was to smack the side of the TV a few times. Most of us wouldn't think twice if the TV returned to normal operation immediately and then continued working fine for several months before the next incident. A more modern scenario is when computer software crashes while modifying a document. We all know what to do of course—reboot the computer, restart the software, and then pick up where we left off. For everyday situations, most people accept the occasional failure as a mere nuisance, with the inconvenience suffered just a minor disruption of our lives.

For industrial applications, as the consequences of failure get more severe, the more critical it is to install stable and robust equipment. In fact, most engineers probably have a good idea of what's needed to help guarantee the stability and robustness of computer equipment. The following factors may not look like much, but the difference in MTBF (Mean Time Before Failure) of the equipment involved can be dramatic.

- **No fan**—If you aren't aware of just how effective fans are at cooling things down, sit in front of a fan when you're all sweaty after a good workout. Fans, however, pose two problems for computer equipment used in an industrial environment. The first problem is with the motor used to power the fan. Since the motor is moving continuously, it's hard to predict the lifetime of the fan—in fact, you should expect it to fail eventually. The second problem is with the

environment. The fan acts as a 1-way door, continuously sucking dirt and dust into the interior of the computer's enclosure. As you can imagine, it wouldn't take long for the components inside the device to become covered with dust and grime.

- **Dust-proof**—Even without a fan, if the enclosure used to house the guts of a computer is not air-tight, then dust will eventually get through.
- **Low power**—For industry, electric power is money, and if you're the one spending it, then the less you use the better. This one factor increases the attractiveness of small sized computers that don't require a keyboard and monitor to operate.
- **Linux OS**—The Linux TCP/IP protocol stack is well-known to be more stable than the stacks provided by other popular operating systems. Overall, the fact that an embedded Linux OS is less apt to crash makes it a better programming environment for industrial control applications.
- **Small size**—Using small sized equipment makes the equipment easier to install, and lets you install more devices at the same location.

Can IPCs Meet Industry's Requirements?

When IPCs first hit the market, they were only slightly modified from the consumer PCs used at home and in the office. For example, IPCs used the same power-hungry x86 CPU, and couldn't be operated without connecting a keyboard, monitor, and hard disk—all of which use a substantial amount of power. In addition, today's IPCs use standard power adaptors with wattage starting at 300W, and since x86 CPUs produce a lot of heat, an extra fan is required just to keep the temperature of the CPU below an acceptable level. Another drawback not readily apparent when viewing the outside of the computer is the cables used inside the IPC's enclosure. The type of cable that is required can be a real headache to install, making it hard to build and set up the computer. Another problem is that the hard disk limits placement options, since

hard disks cannot endure a high degree of heat, and cannot survive being subjected to frequent vibrations and jostling. The combination of these issues puts a limitation on which applications are suitable for using IPCs.

A Device Built for Industry

In recent years, manufacturers of computer hardware have been paying closer attention to the needs of industry. One significant result of this attention is that RISC (Reduced Instruction Set Computer) processors have become the first choice of CPU for embedded applications, since RISC processors use less power, can operate without a fan, and have a wide operating temperature range. For example, if we consider equipment used as part of a traffic light control system, when used near the equator, the temperature could reach as high as 40°C, but farther north, the temperature could drop as low as -20°C. The x86 family of CPUs cannot endure either of these temperature extremes.

The current trend for industrial communication front-end management applications is to look for economical, all-in-one computers suitable for use in a wide range of computing applications. Typical requirements include several serial ports, at least two Ethernet ports, and an embedded Linux operating system, which is often the first choice for creating efficient communication management applications. Engineers also know that the typical hard drive is not a good data storage device for industrial communication and control applications. Better choices are to use an internal Flash card, external CF (Compact Flash), or external USB storage device. Having a sufficient number of external connection ports is also a must if you will need to add additional peripheral devices.

Moxa Technologies has been involved deeply in the industrial communication field for a long time, and is currently one of the top three providers worldwide of industrial communication products. We understand the needs of industry, and have taken great care to design a computer well-suited for industrial control applications. This new computer, which goes

by the name of "Universal Communicator," satisfies industry's many requirements. Foremost among these are the no-fan requirement and an airtight, dust-proof enclosure. Moreover, Universal Communicator does not have a hard disk, uses less power than an IPC, and hence provides users with more stable operation.

The computer's eight serial ports, two 10/100M Ethernet ports, and Compact Flash and USB storage expansion slots make it ideally suited to meet all requirements posed by automatic industrial control applications. Since floor space (or the lack thereof) is always an important consideration, the largest of our Universal Communicator products has dimensions of only 197 x 125 x 44 mm, which is much smaller than the usual PC or IPC. Finally, Universal Communicator's RISC processor needs only 12W to operate, whereas the typical IPC requires at least 300W.

UC-7400 Series—Front-end Embedded Computer for Industrial Device Networking

Moxa's UC-7400 is a RISC-based Universal Communicator that uses a Linux OS, and comes with 8 Serial Ports, Dual Ethernet ports, USB, PCMCIA, and CompactFlash. The following features make UC-7400 an excellent choice for your industrial front-end computing applications:

- Intel Xscale IXP-422 266 MHz processor
- On-board 128 MB RAM, 32 MB Flash Disk
- 8 RS-232/422/485 serial ports
- Dual 10/100 Mbps Ethernet ports
- PCMCIA wireless LAN expansion (optional)
- LCM display and keypad for HMI
- Pre-installed Linux communication platform
- Robust, fanless design

Conclusion

Industrial control applications need rugged computers that are built to operate in adverse environments. Some of the more essential hardware requirements are no fan, no hard drive, low power consumption, all-in-one hardware (i.e., does not require a keyboard, mouse, or monitor), and the ability to

withstand a wide range of temperatures. In addition, to make the computer suitable for many different applications, many users insist on a device with several communication ports, pre-installed Linux OS, small volume, and ability to use CompactFlash or USB storage expansion slots. Since network communication is essential, it is helpful to have at least two Ethernet ports, 802.11g wireless LAN option, encryption by hardware, and be Web server ready. Products that meet these requirements, such as Moxa's Universal Communicator series, are fast becoming the next link in the ever-changing industrial computing arena.