# PC & EMBEDDED CONTROL TRENDS

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***Abstract*** *- The trend to reduce machine size and cost while increasing productivity requires new approaches to control systems. Thanks to the increased reliability of Industrial PC technology, traditional rack-based PLCs can be replaced with more powerful PC-based control systems. While Industrial PC's provide the highest performance and control capacity, new generations of PC technology based on open embedded operating systems, combine the functions of a PLC and an operator panel in one unit which is applicable to smaller scale applications. This paper describes the differences in control capabilities, operating systems, HMI capacity, communications and system flexibility between different classes of PC and embedded control systems. The paper also describes the differences between these types and traditional PLC based systems*.

## I. INTRODUCTION

The trend to reduce machine size and cost while increasing productivity requires new approaches when designing control solutions.

Thanks to the increased reliability of main stream PC technology traditional rack-based PLCs can be replaced with more powerful PC-based control systems. The next pages highlight some of the features and user benefits of this new technology.

## II. THE CONTROL PANEL CONCEPT

A new generation of rugged, industrialized Windows CE or embedded XP-based Control Panels combine the functions of a PLC and an operator panel in one compact and powerful unit (see figure #1). These units have the size and appearance of an operator panel and feature fast CPUs that range from 200MHz to 1.1GHz. The high processing power can handle demanding control applications and the integrated RAM and storage memory exceeds those of full size PLCs by factors larger than 10x. Other advantages are:

- Reduced design time as HMI tags only need to be entered once
- Only one single data base between the control program and the HMI makes program changes easier to track
- Less components to install and fewer connections to be made resulting in a reduction in labor cost

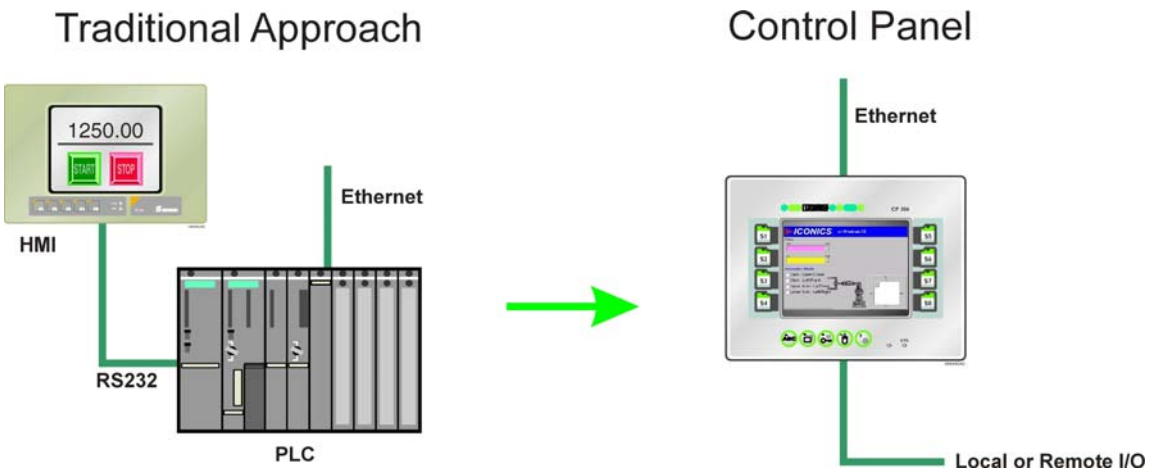


Figure #1, Traditional vs. Control Panel Approach

The Control Panels bridge the gap between PCs and the traditional PLC. This makes them ideally suited for applications that do not require the high-end performance of a PC but still have a need for comprehensive display of vital machine information (see figure #2).


Figure #2, Control Panel bridges gap between Industrial PC and traditional PLC

The flexible Microsoft Windows CE or embedded XP operating system permit the integration of almost any compatible control or HMI software.
Use of the same control and HMI software over various platforms allows for scalable control solutions that can be tailored to performance requirements and do not require platforms specific software packages (see figure #3).

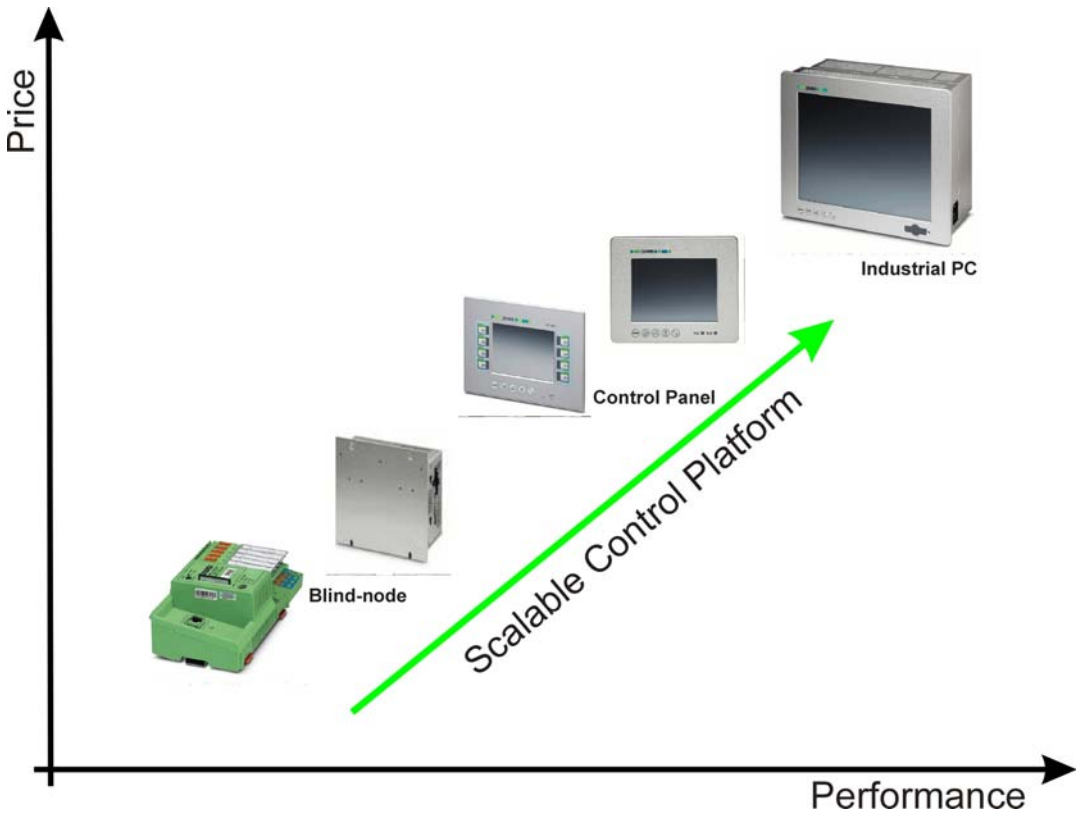


Figure #3: Scalable control platforms

The new Control Panels reflect one of the first major steps towards reaching this goal. State of the art object oriented control software and the use of a common OPC tag database allow fast program development. The runtime of both control and HMI visualization software is already pre-installed and pre-integrated, so the user can start programming their application immediately.

For applications that do not need an integrated HMI so called ”blind-node” versions are available.
Some models even offer features such as direct I/O connection allowing fast design of compact distributed control stations. Regardless if the target is a “blind-node” or visualized unit the control program is developed with the same control software.

## III. THE EMBEDDED OPERATING SYSTEM OF THE CONTROL PANEL

Embedded operating systems are typically of a more compact size than regular operating systems such as Microsoft Windows 2000 or XP. The reduced size of embedded operating systems allows for smaller storage mediums such as compact flash cards (CF Flash). Another benefit of CF Flash cards is the elimination of traditional rotating hard drives reducing the chance for failure and machine downtime.

Since embedded operating systems can be tailored in size and function to suit specific application needs and hardware platforms, they do require more engineering effort to implement when compared to a regular operating system on a PC. When adding other software packages to an embedded device it must be observed that all required drivers and utilities are actually present to achieve the desired functionality. However by purchasing pre-integrated and pre-tested devices “off the shelf” the end user is not required to do the hardware/software integration. The device is simply ready for use “out-of –the-box” and the user can focus on creating their application.

Another advantage of an embedded operating system is the added security from data corruption as the critical software portions are typically protected from accidental user error or potential virus attacks. Since there is no rotating media, issues such as hard drive crashes become a thing of the past. A properly designed system might look like a PC from the outside but offers the data security of a PLC inside.

Since the Control Panels are based on state of the art PC technology they offer many advanced features such as (see figure #4):

- A large user program memory that exceeds the capacity of the largest PLC’s by factors of 10x
- High-performance CPUs that go up to 1.1GHz.
- Built-in device level master enable easy connection for fieldbus networks such as DEVICENET, PROFIBUS or INTERBUS
- Multiple integrated Ethernet ports that enable fast and easy production data transfer to central servers and as an additional benefit offer the option to connect to Ethernet-based I/O via protocols such as MODBUS/TCP and future options for ETHERNET/IP or PROFINET.
- Large application program and user data storage in a removable CF Flash cards (32MB to 512MB)
- Non-volatile memory (NVRAM) that stores critical data in the event of a power loss

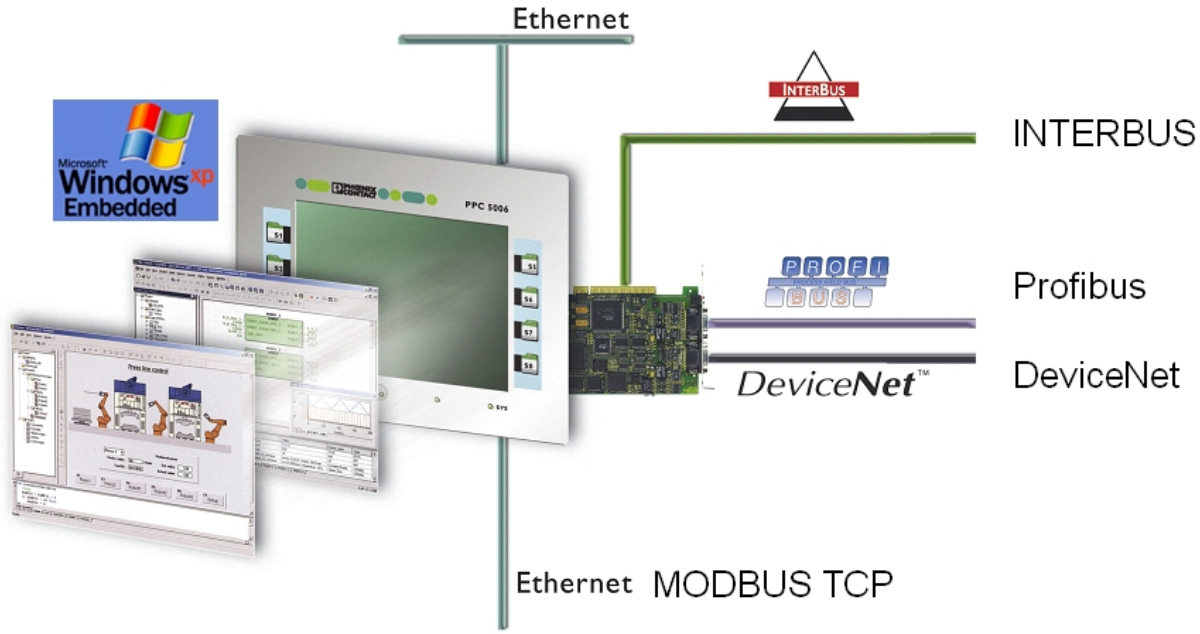


Figure #4, Control Panel Options

## IV. INDUSTRIAL PC DEVELOPMENTS

For demanding applications where higher processing power or more memory is needed industrial PCs even more control and connectivity options. Features such as dual hard drives, that are also known as **R**edundant **A**rrays of **I**ndependent **D**isks or short RAID, ensure increased system uptime. The integrated RAID controller in the PC automatically mirrors the data of both hard drives. In case of a failure of one hard drive the PC automatically switches over to the healthy one and keeps running without an interruption. The defective hard drive then can be simply ejected thanks to a removable frame and a new one can be inserted without shutting down the PC. (see figure #5)

Figure #5, Industrial PC with dual RAID hard drives

Other options include non-rotating solid-state hard drives. Those however are fairly expensive and often have much slower read/write times, thus increase start-up and data access times.

Sophisticated control software that protects the user from operating system crashes are available in the market for some time already. Their special real-time operating systems run independently from the main O/S are thus immune against O/S crashes. When combined with retentive plug-in memory cards an industrial PC offers all the advantages of a traditional PLC at a lower cost and with higher performance & features.

Even with the additional safety net from the features listed above it is recommended to build a PC based control solution on a high quality, rugged industrial PC (vs. a consumer-grade home PC) that is designed for industrial applications.

As with every PC the trend goes to higher CPU speeds even in the industrial PCs. Even if the need for high-end CPUs in an industrial environment is often questionable, customers are requesting ever faster CPUs. Here again not every CPU is the same. Especially Pentium 4 CPUs are known to generate a lot of heat sometimes in excess of 66 watts. This typically requires a CPU fan to move enough air for cooling. The radiated heat plus the heat that all other devices generate in the control enclosure can add up requiring additional cooling measures. One solution here is to go to the latest CPU families that have reduced power consumption such as the new Pentium M family with power consumptions of about 22 watts. These modern CPUs actually have such low power consumption that a CPU fan is no longer required.

## V. CONCLUSION

The small size combined with fast processing power makes the new control panels well suited for today's automations tasks and offer a solid alternative to more traditional control solutions. By eliminating the need for separate operating and monitoring devices, a reduction in cost, machine size and design time is realized.

Industrial PLCs are a viable control solution for applications requiring high processing power and large amounts of data exchange.

Automation solutions based on a common operating system such as Microsoft Windows allow for scalable control systems that allow for easy porting of software over multiple control platforms.