Next Generation IPCs

Industrial PCs based on CompactPCI technology are the next generation platform for industrial automation and other related applications.

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Automation specialists have known for some time that the hardware platform of choice for many industries is an industrial PC or IPC. Designers choose IPCs to integrate control, sensing, and I/O requirements because they can access the latest PC technologies, but in a package far more suitable for challenging environments and severe duty. The alternatives are to use costly custom-developed hardware, to compromise on capabilities, or to cobble together assorted components into a less than ideal solution.

While custom solutions have their place and can be tailor-made for an application, IPCs represent a far more powerful and cost effective solution. Yet even “traditional” IPCs may not offer all the peripherals needed for a particular applications. The question becomes, how can the next generation of IPCs be enhanced to better meet industry’s needs? What technologies will propel IPCs to the next level of effectiveness?

Manufacturers are responding to the challenge by incorporating CompactPCI technology into IPC platforms. CompactPCI is a well-established industrial computer parallel bus interconnect standard that has been in existence for over 10 years, and has progressively evolved while maintaining backwards/downward compatibility.

Standardization is specified by the PCI Industrial Computer Manufacturers Group (PICMG, www.picmg.org) which is a consortium of over 200 companies. It’s not unusual for suppliers to abbreviate CompactPCI as “CPCI” or “cPCI”, but these abbreviations are not officially endorsed by PICMG. However, for convenience this paper will use the abbreviation “cPCI”.

cPCI technology incorporates a passive connectorized backplane, with PCI signaling and protocols. The combination of tough hardware components with a well-known PC-world protocol results in a very effective product well-suited to the most demanding automation applications.

However, there is a price to access the benefits of cPCI. In past years it was not unusual for cPCI products to cost up to 400% more than similarly equipped standard IPCs. However, developments in the market mean that today it is possible to find cPCI IPCs at only a 20% price premium over traditional IPCs. At this small price adder, the benefits or cPCI far outweigh the additional costs (Table 1); making IPCs based on cPCI a compelling choice.

The next generation of IPCs is available today. This White Paper will examine the technology powering these new IPCs and why cPCI IPCs have arrived as the best option for many of the most demanding automation applications.

CompactPCI Sets the Pace

When engineers select an automation platform for the toughest jobs, perhaps the most fundamental requirement is reliability. Of course overall capabilities and interconnectivity need to be there, and the performance must be adequate. But at the end of the day, the system needs to start up reliably and keep running indefinitely. If there is ever a failure

then production suffers, delays are imposed and repair expenses are incurred—all of which must be avoided to achieve high productivity.

For these reasons, improved reliability must be approached from all avenues in order to achieve overall robustness. A cPCI-based system achieves this goal first through the use of a precision metal cage designed not only to be rugged, but also featuring easy assembly. This structure forms the foundation of an IPC built using cPCI technology.

Table 1: CompactPCI For IPC, Features and Benefits

1. Reliability through improved overall robustness
2. Precision cage design, rugged and durable with easy assembly
3. Anti-vibration and anti-oxidation built in
4. Maintainability through modular front access
5. Hot swappable components for increased uptime
6. Compliant with open standards
7. Flexibility, can accept both PCI and cPCI peripherals
8. Vendor neutral, users can choose from among many compatible components

Building upon this foundation, the next area of interest is the connector system. cPCI configurations feature a passive backplane utilizing 2.0mm Euro card hard metric connectors. The assembly is provided with alignment guides for seating the cards, while connectors are engineered to exhibit anti-vibration and anti-oxidation characteristics. The cPCI standard also incorporates high resistance to electrical noise and the ability to operate in extended temperature ranges, both extremely important in a wide range of demanding automation applications.

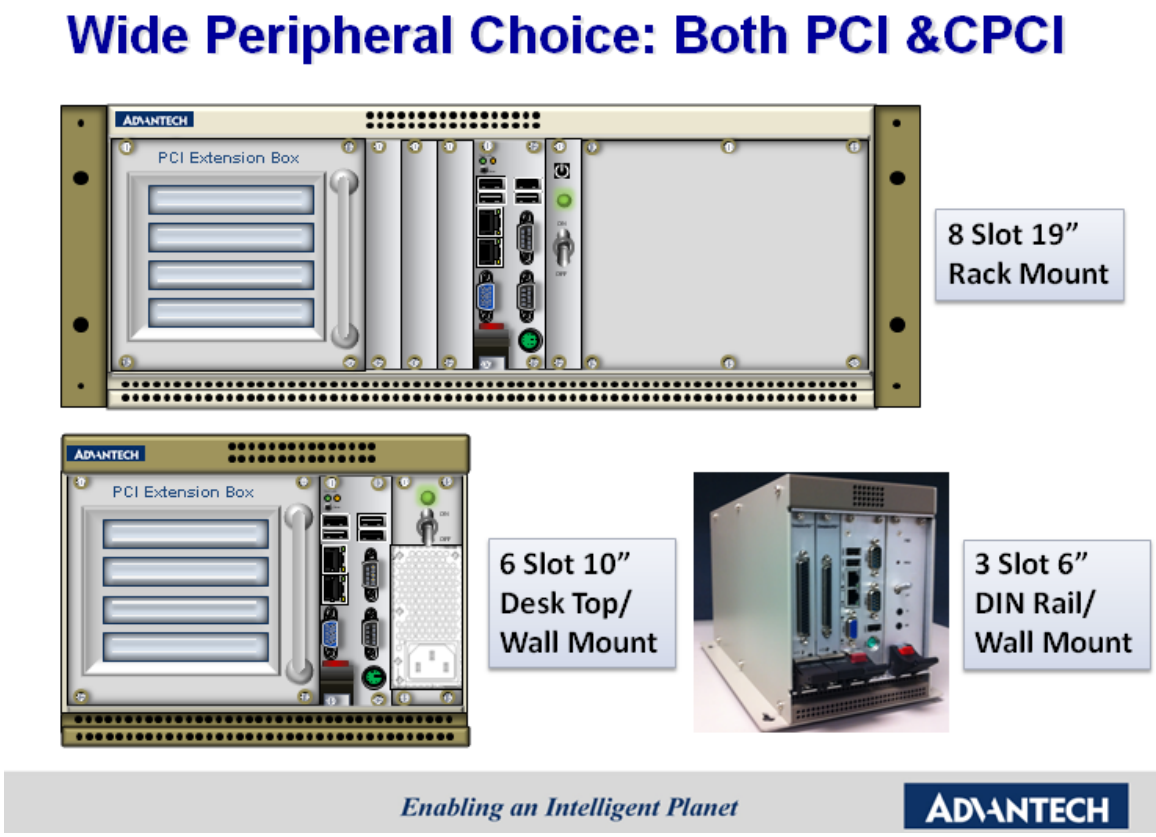
Both the card size and the connector size are common standardized form factors. In fact, the entire cage architecture is part of a larger standardized system of 19” and 23” racks as well as common “1U” 1.75” spacing. Boards are typically available in 3U and 6U sizes, with selected sizing striking a balance between accessibility and compactness. According to *COTS Journal*, “The 3U flavor of cPCI is particularly attractive to space/weight-constrained applications[1].”

The cage is an open-front design to facilitate modular access from the front. This mechanical configuration works in conjunction with the hot-pluggable features of the cPCI specification to make cards hot-swappable during system operation. Both of these features combine to offer the ultimate in maintainability.

Open Design Increases Flexibility

Beyond the hardware, it is important to note that the signaling and protocols are based upon the PCI protocol that is common to the PC computing industry. “PCI” stands for Peripheral Component Interconnect, and represents a technology for device communication on a bus. Therefore, cPCI is effectively a marriage of hardware and software standards, combining the best of both worlds to produce a truly open platform.

The cPCI technology is developed entirely upon open and established standards, and no custom or proprietary characteristics limit the ability of multiple suppliers to provide interchangeable products. This provides a significant advantage to end users, and is direct contrast to proprietary automation products that limit flexibility and tie uses to one supplier. As an example of flexibility offered by the cPCI architecture, it is even possible for the system to accept both PCI and cPCI peripherals.



Because the technology is inherently vendor neutral, system designers can select from a wide variety of components available on the market, mixing and matching to create an optimal yet standardized solution for each application. On the other side of the fence, such an open and available standard encourages suppliers to design components for this style of system, since they know the potential market is large and growing.

As *NASA Tech Briefs* puts it, "It's no wonder CompactPCI systems have proliferated during the last few decades. They can be built using standard components and can run practically any operating system as well as thousands of application software packages without modification. Because of this, CompactPCI is a widely accepted — and utilized — technology platform in countless markets from telecommunications and computer telephony to industrial automation, real-time data acquisition and military systems[2]."

IPCs based on cPCI technology combine to provide an automation platform offering a competitive advantage because they provide bulletproof reliability at a reasonable cost such as Advantech's MIC-3042.

cPCI technology delivers unquestionable reliability for IPCs by addressing many forms of potential failure modes and mechanisms. The combination of tough hardware components with a well-established PC-world PCI protocol results in a very effective product for the most difficult applications.

cPCI technology is here today and being used across in a wide array of automation applications, and the future holds promise for further improvements and increased use.

Trends For Next Gen IPCs

Engineers and designers looking to specify industrial PCs will quickly find that all of the benefits and features of cPCI technology are a direct and natural fit for IPCs. While there are IPCs based on other technology platforms, those incorporating cPCI technology deserve a more detailed look as the standard provides much more in the way of reliability, maintainability and flexibility.

Identifying trends for next gen IPCs is challenging, but improvements are expected to follow the path identified in Table 2 and discussed below.

Table 2: Trends For Next Gen IPCs

1. Build upon established standards
2. Reduced learning curve
3. Maintain or improve overall robustness
4. Incorporate CompactPCI (cPCI)
5. cPCI benefits at an IPC price
6. Provide triple the value of traditional box PC with only limited extra cost
7. Multiple chassis configurations available
8. Enable a wide choice of peripherals

It is important to point out that successful next gen IPCs must build upon established standards, as opposed to introducing many revolutionary developments. This helps ensure a stable platform and is far more appropriate to the intended market. As an example, cPCI is a mature technology that has been available on the market for many years, and is therefore an ideal candidate for incorporating into IPC designs. This is

particularly important for automation applications, many of which demand very long lifecycles spanning decades.

A secondary reason for progressive technological development is to reduce the developer's need to learn new technologies. This improves product acceptance with designers and lets them bring products to market faster, while cutting training and maintenance costs.

Of course any technologies, whether hardware or software, must maintain or improve the overall robustness of an IPC design. The market will rarely accept a downgrade in this regard because IPCs are used in the most demanding applications. the cPCI standard fits the bill in this area, and any change to the standard will undoubtedly improve reliability and/or increase performance.

Three Times the Value

One downside to combining all best-of-breed technologies into one package is the increased cost that can result if care is not taken in design. That is why successful IPC candidates must aggressively control costs even as they are adding better technology. The overall goal is for IPCs to achieve as much as three times the value of using traditional PCs, while limiting the additional actual cost.

This threefold increase in value is delivered through better reliability, less required design work and easier maintainability. Better reliability is the cornerstone on an IPC, particularly one built upon a cPCI foundation. Traditional PCs suffer in this area, particularly when faced with environmentally challenging applications.

Traditional PCs aren't available in form factors convenient for industrial and other related applications, and they also are quite large. This makes it hard for designers to use these products in their designs, while IPCs are much more amenable to panel, DIN-rail and rack mounting.

A traditional PC isn't designed for easy maintenance, as replacement of failed components requires a shutdown and some disassembly and reassembly. With an IPC, this task is greatly eased; particularly the front access and the ability to hot swap inherent to the cPCI standard.

Value is also realized when using next gen IPCs due to their flexibility. Multiple chassis configurations ensure they can be utilized in any application, letting designers standardize on a platform. More importantly, a wide choice of peripherals empowers cPCI-based IPCs for use in varied applications including industrial automation, aerospace, transportation, medical and others.

Even the Internet of Things (IOT) is driving adoption as intelligence moves farther out to the network's edge, finds *RTC Magazine*. "Small form factor systems have a growing role in the connected world. Massive amounts of sensor data is being collected and shared by

an exploding group of small but powerful systems, enabling a range of new applications and deployments fueled by the Internet of Things (IoT)[3]."

The next generation of IPCs will offer a compelling choice as the automation platform for all types of critical applications. They will be built upon proven technologies to offer the highest reliability and flexibility, but at a reasonable cost.

Application Examples

Next generation IPCs will serve duty in applications ranging from factory assembly systems to machine automation. They will be used in test and measurement systems, and in vehicle service for aerospace and intelligent transportation services. Each of these implementations will be in demanding environments, subjecting the automation platform to vibration, contamination electrical noise, and wide ranges of temperature.

For example, an assembly machine with on-board controls undergoes a certain amount of shaking and operates in a less than pristine environment. Electrical noise will be present to some degree, as well as elevated temperatures in many cases. A cPCI-based IPC would be designed from the ground up to operate reliably in such an environment, with little or no extra effort required by the designer to match the PC to the demands of the surroundings.

Such a machine may be shut down intermittently between production runs. It is not uncommon for electrical hardware in this type of service to occasionally fail to boot up upon activation. Sometimes small amounts of corrosion on card contacts cause this.

The construction of a cPCI-based IPC would inherently make it more resistant to this type of failure. However, even if there was such a problem, the front-accessible card cage structure would make it quick and easy for a technician to re-seat the modules as a first line of troubleshooting.

Skid-mounted equipment and automated guided vehicles are often shipped to end user destinations. After a period of transportation and storage, the equipment becomes available on-site, and then must undergo checkout, commissioning, and startup. When such equipment is automated by an IPC, the form factor facilitates these activities. Technicians can readily remove and re-insert components for inspection, and if any components were damaged during transport or storage, they can be quickly replaced.

Referring specifically to vehicle automation systems, *RTC Magazine* had this to say. "The modularity and low footprint of 3U CompactPCI commercial off-the-shelf (COTS) boards have proven to be effective in keeping computing costs within reason, while offering advanced technologies that can handle the growing requirements of modern transportation systems[4]."

IPCs based on cPCI technology not only increase uptime, but can dramatically reduce downtime in the event of a problem. Greatly improved performance during normal

operation and the chance for speedy repairs if there is trouble combine to bring value to any application.

Conclusion

It is clear that CompactPCI is a mature and high-performance technology positioned to provide optimum reliability and complete flexibility in the most demanding applications. The format incorporates many features to promote maximum operational uptime, and is configured to allow quick and easy maintenance when required.

Traditionally, this level of performance could only be obtained at a substantially increased price, but now there are reasonably priced next generation industrial PCs available that take advantage of cPCI technology, representing a trend of building upon established standards.

All of the characteristics that make cPCI reliable and flexible are directly leveraged by IPCs. This makes next gen IPCs the best choice for the most challenging automation applications across a wide variety of industries.

Figures:
Figure 1, MIC-3042. This CompactPCI-based IPC provides a rugged industry-standard platform that can accept a wide variety of peripherals.

Figure 2, Slide 29 from the “Ind. I/O @ Y2014” PPT. The cPCI architecture allows for a wide variety of configurations and can accept both PCI and cPCI peripherals.

References:
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