COMPACTPCI: AN OVERVIEW
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ABSTRACT

CompactPCI has become an important bus structure for commercial and industrial applications which need to run on a Windows9x* or WindowsNT platform. A CompactPCI implementation is far more suited to industrial or enterprise wide applications than desktop or tower PCs. This is because the CompactPCI architecture offers more slots, more I/O, better cooling and easier access for service as well as features to support live insertion of new daughter cards. A 2mm hard metric (H.M.) was chosen to replace PCI's edge card connector. The high density 2mm H.M. connector allows for rear panel I/O. The Euro-card mechanical structure allows easy serviceability and provides excellent cooling.

CompactPCI brings the performance of the desktop Wintel architecture, which has one of the richest software development environments into the rugged and dependable Euro-card 19" rack mount backplane subrack system. This combination makes CompactPCI a perfect platform for telecom and computer-telephony integration that is intended to support the office LAN environment.

BACKGROUND

CompactPCI is growing faster than anyone originally imagined. What was first planned as a replacement bus for the modest STD bus market has taken on a life of its own. The number of new applications is staggering and its future looks brighter than ever.

When CompactPCI (cPCI) was conceived in late 1994, it was seen as a migration path for industrial control applications that had been wedded to the Intel architecture but needed a mechanical structure that was more rugged than the desktop PC. In fact, its early developers were companies that had developed extensive product lines utilizing the Intel oriented STD bus. By 1994 it was clear that the STD architecture needed a faster bus. The PCI bus seemed to be the natural next step. However, because the STD market was quite small (under $ 100 million), market expectations were that CompactPCI would represent a similarly small segment of the equipment market.

Proposing a bus architecture based on the desktop PC was not an unusual choice. Ever since the Intel PC became the most popular small computer for industry, developers of industrial and commercial systems have been attracted to the PC as an inexpensive platform. It turned out that developing a rugged, serviceable implementation for PCI had a tremendous appeal that extended far beyond the small cadre of STD manufacturers. Apparently, this mechanical transformation to an industrial rack mount design was just what many developers were primed to accept.

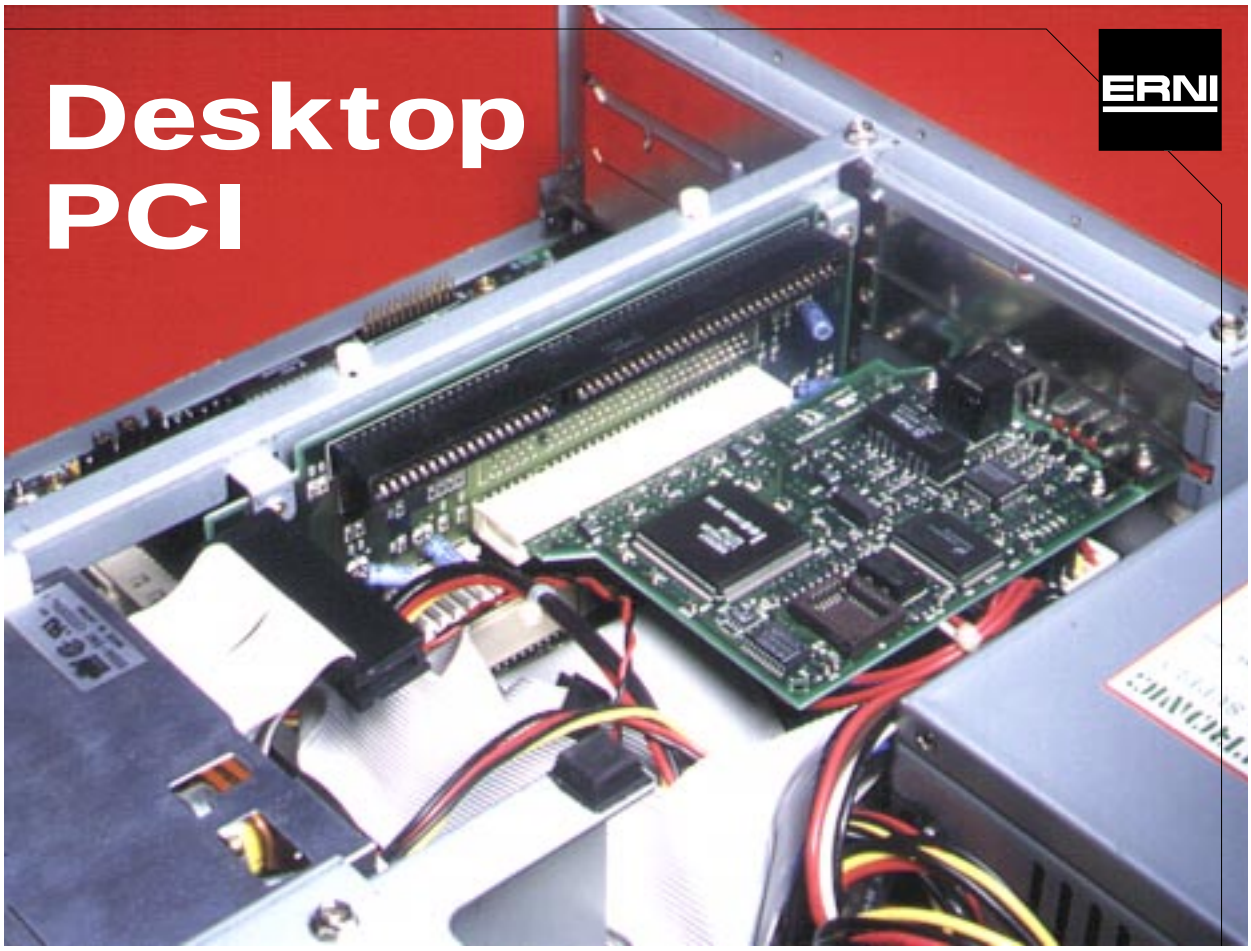
There's no doubt that the rapid rise of the CompactPCI market has taken many people by surprise. Jerry Gipper, Director of Marketing for the Motorola's Computer Group, best characterized the movement. "The industry is moving toward CompactPCI. So you can either stand on the sidelines and watch it go by or get in the parade."

There are two reasons for the rapid growth of the CompactPCI architecture. First, PCI dominates the office environment because it is jointly supported by the Intel PC and Microsoft software. WindowsNT and Windows9x

*Windows95, 98, or 2000

are the driving applications for ninety percent of every CompactPCI application. Because almost every desktop PC accepts PCI devices and runs the Windows operating system, CompactPCI maintains that same compatibility. This compatibility provides all the necessary software support for printers, hard drives, other standard peripheral devices and common I/O protocols. For developers, the availability of drivers represents a significant cost avoidance.

Secondly, developers are comfortable with the PCI architecture. The Windows operating system has the richest software development environment available today. This means that developers find it easy to develop software on a PC and then run the same software in a commercial CompactPCI system for applications such as voice mail, fax back or document imaging systems. This is due to the fact that the development platform for the application software is the ubiquitous and inexpensive PC. Additionally, developers experienced in this environment are readily available.



PCI boards buried within a desktop PC chassis

One of the first attempts to utilize the desktop PCI architecture in industrial applications involved changing the motherboard to a passive backplane. A trade organization was formed to define and promote a passive edge card backplane that would accept the standard desktop PCI cards. This group was the PCI Industrial Computer Manufacturer's Group (PICMG).

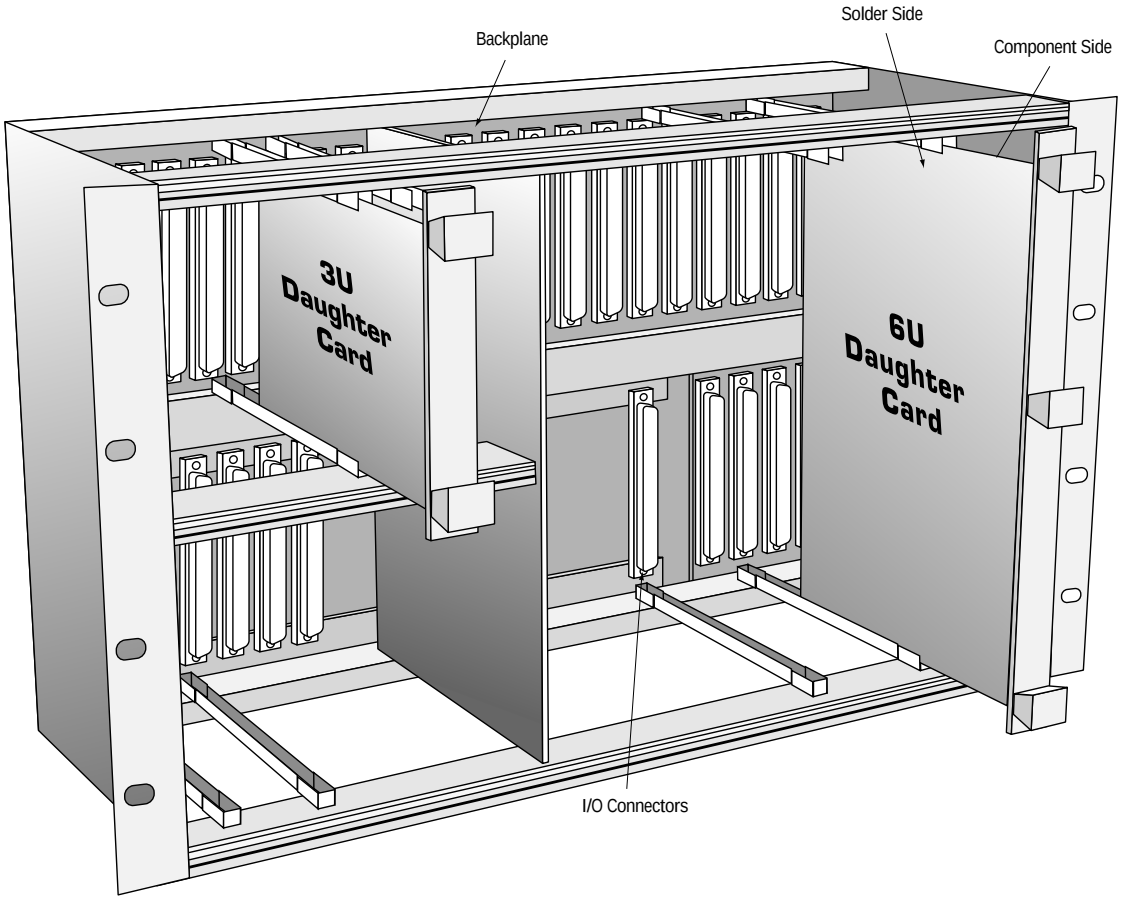
This effort resulted in a passive backplane architecture for PCI. Now the backplane was no longer an active motherboard and all the functions including CPU and memory were now removable boards. This made it easier to service and repair systems. Problems still remained, however. To get at the removable boards for service, the chassis cover still had to be removed as in the original desktop PC. Additionally, cooling was still a problem and a system could only consist of at most four separate daughter boards.

COMPACTPCI TO THE RESCUE

In 1994 a subcommittee was formed within the PICMG to solve the problem of creating a new industrial implementation of PCI that would solve the problems outlined above. They named this new version of PCI, CompactPCI.

Adapting the desktop PCI to a more versatile physical and electrical architecture presented three major challenges to integrators who wanted to use this bus structure in industrial applications. These challenges were: serviceability, cooling, and slot count.

Serviceability and cooling had a logical solution: The Eurocard chassis system. This well accepted 19" subrack system offered several advantages: front removable cards and unobstructed cooling across the entire set of daughter cards. This Eurocard packaging hardware was developed in the early 1970's. Today, there are a multitude of vendors who can provide different subrack configurations with any level of customization.

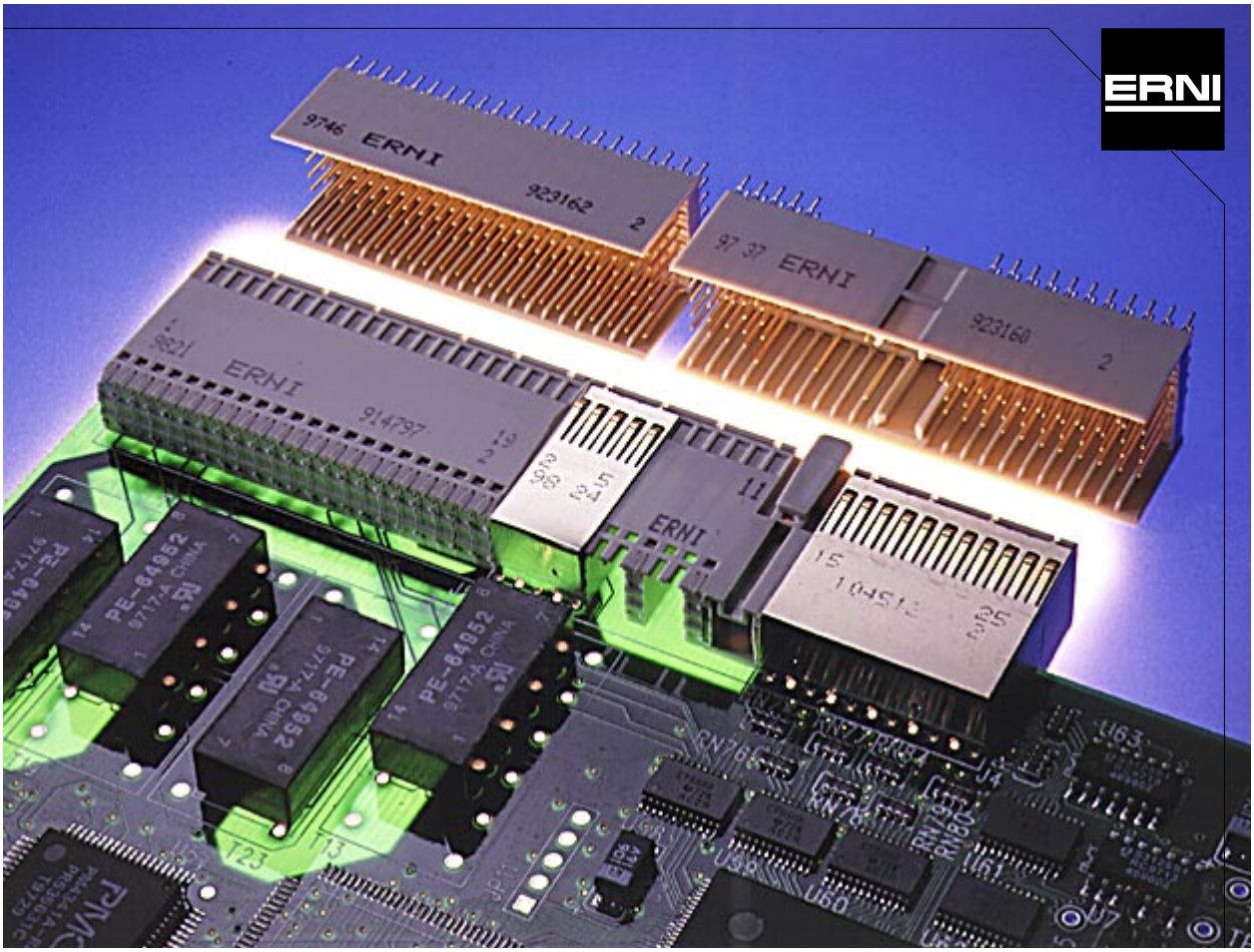


Euro-card Subrack For 19" Rack Mounting

A solution to achieve additional slots did not have an obvious solution. This problem was ultimately solved with a carefully engineered backplane design that was superior to the previous edgecard and PC motherboard combination.

The key to achieving an improved interconnect path was the connector and backplane design. Electrical characteristics, density and installed cost were the three issues that drove the connector selection.

Choosing the connector was an important decision. The original developers of the CompactPCI specification wanted a small circuit board size to keep costs to a minimum. The goal was to provide for all the 32 bit signals as well as providing extra user pins for rear I/O all within the constraints of the 3U-160 Eurocard board size. This lead to the examination of various types of 2.0 mm pin and socket connectors. These connectors offered the required pin density. However, detailed simulation was required to determine which connector could meet the special electrical requirements of this extended PCI bus. The 2mm IEC 61076-4-101 family of connectors was found to meet all three goals: cost, density and electrical performance.



Product courtesy of NATURAL MicroSystems

The split shield is one of the special features of a CompactPCI J4 telecom connector.

CompactPCI provides a rugged platform that utilizes the accepted Eurocard mechanical packaging in a conventional 19” vertical rack mount enclosures, with improved cooling and front removable daughter cards. In addition, the CompactPCI backplane design achieved four additional card slots for a total of eight possible slots. This was a big improvement over desktop PCI which only allowed four slots. This meant more cards could be used for more complex systems.

The original CompactPCI specification as conceived in 1994 is remarkably unchanged today. Additions have been made to support features required for Hot Swap and special connector pin outs have been defined for the upper J4/P4 and J5/P5 connectors in Telecom applications. However, 3U boards designed to the original specification still work in the newest systems built to the recently approved release 3.0 of the PICMG 2.0 core specification.

PICMG has now attracted 115 executive members and over three hundred and thirty associate members. Major telecom manufacturers such as Alcatel, Lucent, Mitel, Motorola, Nokia Telecommunications, and Nortel Networks have joined the organization. There are other reasons to judge that CompactPCI is off to a healthy start:

- There are currently more than 6 vendors of the interface chip sets and the chips are already being built in volume to support PCI
- There are a wide variety of available bridge chips.
- There are hundreds of PCI boards on the market and re-laying them out for the CompactPCI form factor is routine and presents no significant technical challenges.
- Software is already available for PCI applications that can be used for CompactPCI applications.
- Software development for CompactPCI can be done on the ubiquitous desktop PC.
- Intel has abandoned Multibus II and MultibusI. The Multibus systems as well as STD and STD32 need a new venue. Remember that as late as 1991, Multibus I had larger sales volumes than VME due to a huge installed base.
- Pentium II, Power PC, Alpha, and SPARC based CPU boards are readily available for the most challenging designs.

Aside from the compelling mechanical and electrical issues mentioned above there is one other important factor that that stands above all the rest. This factor is agreed by most developers to be the primary driving issue that causes CompactPCI to be selected for new applications. That driving issue is software compatibility. The key to software compatibility is the natural support for Windows9x and WindowsNT .

WHAT REALLY HAPPENED – SOFTWARE

What was not anticipated by early CompactPCI manufacturers was that this bus structure would find wide-spread interest among telecom equipment providers. This was an unexpected turn of events and opened up a far larger potential market than the slower growing industrial controls market.

There are two principal reasons why Window9X* and WindowsNT seems to be so important to the success of the CompactPCI architecture.

First and most important is the fact that PCI is everywhere in the office because it is jointly supported by the Intel PC hardware and Microsoft software. Being a part of every desktop PC means that all office software supports PCI devices. PCI was designed by Intel to enhance their PC designs. Thus, a bus structure based on PCI running WindowsNT or Windows9x has all the necessary software support for printers, hard drives, monitors, modems, sound cards that can be desired. And this comes at no effort or cost to the developer.

Second, developers are comfortable because the development platform for the application software is the PC - inexpensive and everywhere. This means you can start developing your software on a PC even before you have built your prototype hardware. Also, developers experienced in such an environment are readily available.

As one new telecom application after another adopted CompactPCI, early advocates tried to understand what was the special appeal to this unexpected class of applications.

Telecom applications can be broken up into two broad categories: The Central office and customer premise equipment (also know as Enterprise systems). Central office equipment can be further subdivided into two groups of hardware. There is the central office switch itself which is the heart of the public telephone network. This switch is what actually routes a call when the number is dialed on the telephone itself. The other type of Central Office hardware is often referred to as “off switch” hardware. This equipment is supplied by many different vendors and provides many special features such as call forwarding, billing, interactive voice messaging, and caller ID.

These “off switch” applications are part of what is now referred to as the Advanced Intelligent Network (AIN). This network is becoming dominated by the Intel architecture. For new installations, WindowsNT is becoming the most common network server architecture and Windows9x is the most common office client architecture. This is significant because new applications such as fax back, voice mail and PBXs, that integrate voice and data, must interface with the office local area network (LAN). CompactPCI is a perfect fit. In addition, several carrier-end cable modems based on CompactPCI are being proposed. All the applications mentioned above are in markets that will grow more quickly than any application in the manufacturing sector.

Perceived as both high performance as well as Intel and Microsoft compatible, CompactPCI has become a natural platform for new applications. Virtually every large hardware company has developed a variety of PCI applications from companies that test cellular base station components and those building data acquisition cards to those supporting voice mail and fax on demand. For these companies, to re-layout circuits from the original desktop PCI form factor to the CompactPCI form factor is easy, cheap and has virtually no technical risk. But by doing so, they have ported their product to an implementation that is acceptable in a more rugged industrial environment.

CompactPCI has already attracted the interest of the cellular divisions of such hardware suppliers as Motorola and Lucent Technologies as well as important programs at Alcatel, Cisco, and Nortel Networks. CompactPCI is developing as a natural framework to merge the telephone network and the internet at the enterprise level. At the central office, CompactPCI seems to be a natural solution for the growing demand for Voice over Internet Protocol (VoIP).

In the beginning, CompactPCI seemed relegated to being a little sister to VME which would have limited its total market size to some fraction of 1.1 billion dollars* Now it seems that the market could grow to many billions of dollars. Furthermore the publicity associated with these applications will continue to bring the 2mm “hard metric” connector to an ever wider audience of engineers. The rack mount Eurocard architecture of CompactPCI and the Wintel software support will capture all the desktop applications which need a more rugged and serviceable platform for larger scale applications.

Michael Munroe is the Strategic Product Marketing Manager at ERNI Components. With 14 years of experience in the packaging and interconnect industry, Mr. Munroe has contributed many industry articles published in such magazines as I&CS, VITA Journal, OEM Magazine, Futurebus+ Design, Connector Specifier, Electronic Products and Electronic Design.

Mr. Munroe is a former vice-chair of the VITA Standards Organization. He continues to play an active role in the PICMG, VITA, Standards Working Groups and is a professional member of the IEEE.

Mr. Munroe lives in Chesterfield, Virginia with his wife Julie and their three sons.

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*The 1996 VME market size according to Venture Development Corporation, Natick, MA.