



**Open Modular
Computing Specifications**

CompactPCI – a technology in evolution

CompactPCI (PICMG 2.0) is a well-established parallel bus standard for building cost-effective modular industrial computers. It is supported by a large group of suppliers covering a wide range of products: from components to complete systems. CompactPCI is based on the Eurocard form factors 3U and 6U, and supports 19" mechanics. It is reliable, robust and maintenance-friendly. A passive backplane with PCI up to 64Bit/66MHz connects a system slot (CPU) to up to 7 peripheral slots (devices) – or more with bridges. The original architecture is based on a parallel bus which connects the system slot to the peripheral slots. Nowadays this technology is more and more complemented by fast serial point-to-point connections. Depending on the peripheral boards and the functions, different interface standards like SATA/SAS, USB, Ethernet and PCI Express are used.

These interfaces coexist in a modern computer. However, they are not operated via a single controller chip, and as such not by a single, interconnected bus. These serial interfaces are available directly at the chipset, changing the structure of a computer from a bus-based system to one with a star topology with serial communication. This is similar to the topology used in the office automation to interconnect of the many PCs and intelligent units (like printers). With CompactPCI this solution is within one system – the cables are in the backplane, supporting the different serial networks and topologies. With this, the CompactPCI architecture adapts these modern chipsets also. As such it evolves with CompactPCI PlusIO and CompactPCI Serial. The proven mechanics of the IEC 1101 are adopted. Existing boards can stay in use.

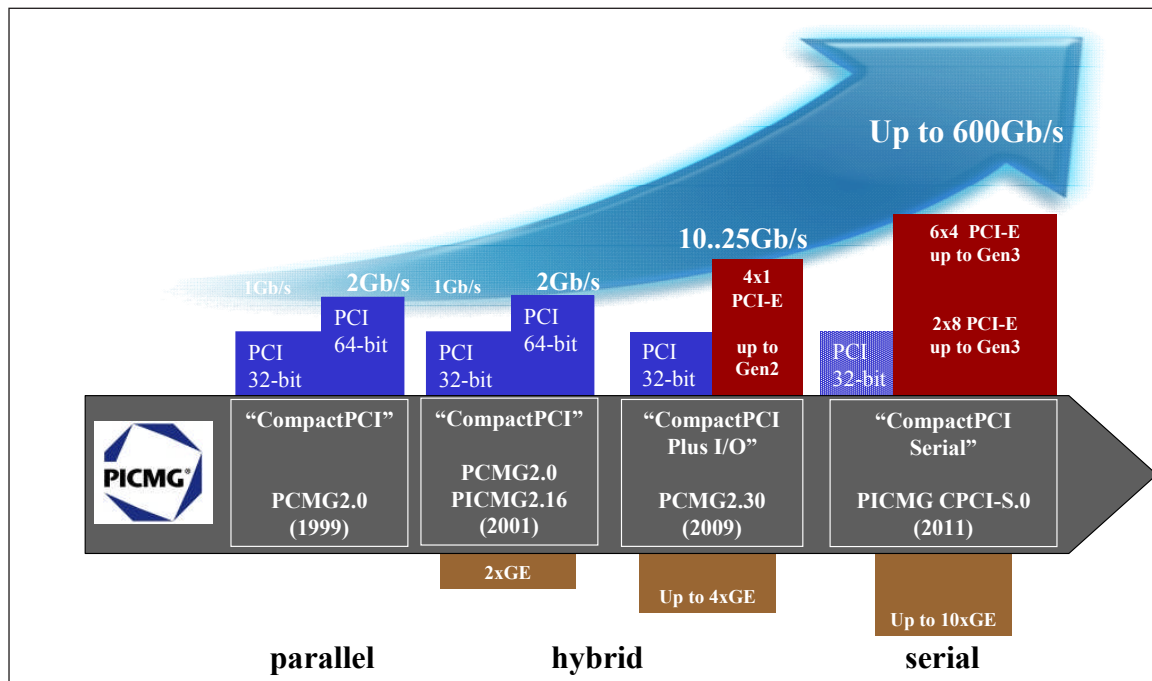


Figure 1: History, status and future of the CompactPCI technology

CompactPCI

CompactPCI originated in 1999, with an update in 2001, creating the basis CompactPCI 2.0 Core Specification. This defines the form factors, the parallel bus, the connectors and pin lay-out for this, power consumption, cooling, topologies, etc. Additions to the core

specification guarantee that the more demanding industrial requirements like hot swap, multi-computing, rear I/O of mezzanine cards or conduction cooling can also be solved in a standard way. Within a CompactPCI system the serial point-to-point connections are realized in a proprietary way via user-defined pins on the J2 connector. Unfortunately,

this leads to a growing incompatibility of assemblies from different manufacturers. Therefore, two new PICMG standards – CompactPCI PlusIO (PICMG 2.30)

and CompactPCI Serial (PICMG CPCI-5.0) – define the common integration of serial high-speed signals into a modular 19" environment.

CompactPCI PlusIO

CompactPCI PlusIO (PICMG 2.30) is downward-compatible to CompactPCI (PICMG 2.0). It offers the modularity, robustness and economic efficiency of CompactPCI, adding fast serial data transfer inside the same 19" standard environment.

PICMG 2.30 solely fixes the pin assignment and the function of the free user pins of PICMG 2.0 on the J2 connector for 32-bit system slots. The pin number is sufficient for leading 4 PCI Express x1 links, 4 SATA, 4 USB 2.0 as well as 2 Ethernet 1000BaseT interfaces to the backplane.

To achieve these additional functions CompactPCI PlusIO uses a different 2-mm-connector from 3M with

5 Gb/s to support the new high frequency signals. Though the single pins are shielded individually and independent of the other pins, the connector is 100% mechanically compatible to CompactPCI – meaning that a PICMG 2.30 CPU board can also be operated in a PICMG 2.0 system.

The new serial interfaces can either be wired via a rear I/O adapter or up to 4 new peripheral slots are added to the system backplane. These slots have identical assignment for PCI Express, SATA and USB. The first 2 peripheral slots support Ethernet in addition. CompactPCI PlusIO can be combined with existing CompactPCI boards in hybrid systems thus offering an ideal migration path to CompactPCI Serial.

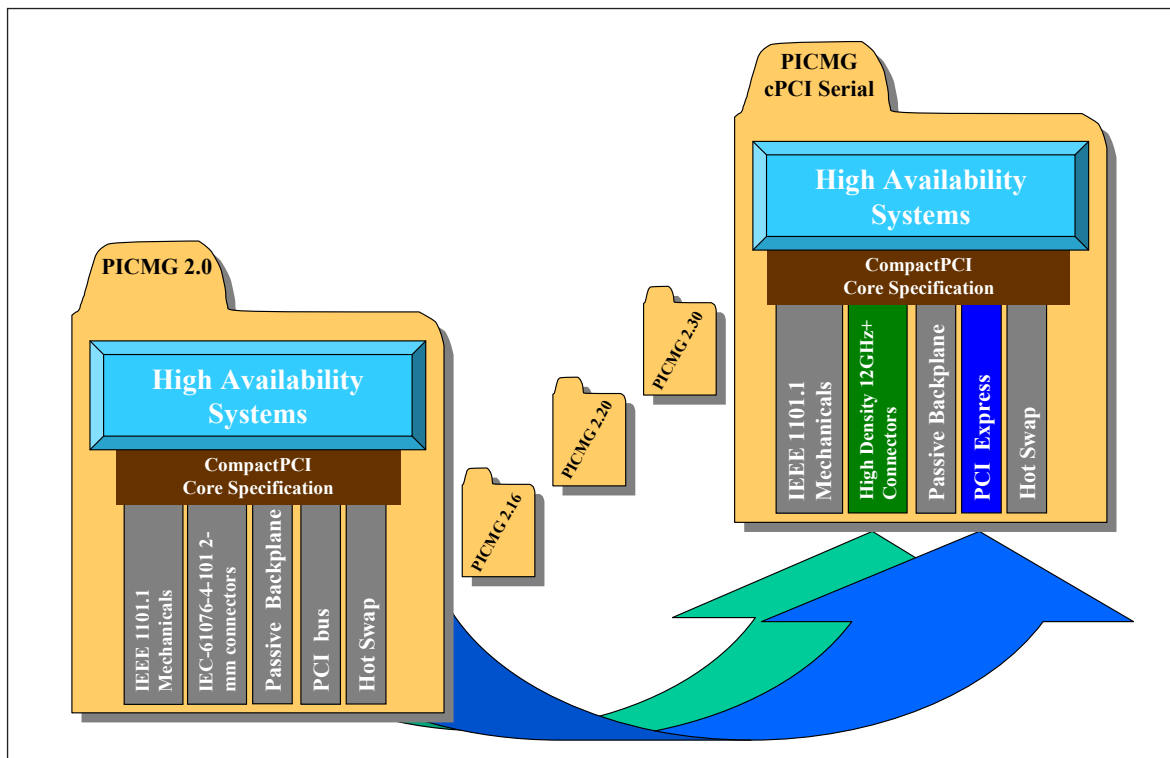


Figure 2: The move to serial in a compatible way

CompactPCI Serial

With CompactPCI Serial (PICMG CPCI-5.0) the CompactPCI architecture moves to serial high-speed interconnects. A configuration of one system slot and up to eight peripheral slots does not need switches and bridges. Keeping the proven 19" mechanics of the IEC 1101 as well as hot-plug, the standard introduces a new rugged connector with a signal density of up to 184 pin pairs (on 3U) and transmission frequencies of 12 Gb/s.

The system slot supports 8 PCI Express links (6 by 4 lanes, 2 by 8 lanes), 8 SATA/SAS, 8 USB 2.0/3.0 and 8 Ethernet interfaces plus signals for general system management (reset, IPMB, hot plug, geographical addressing etc). It is supplied with 12V (60W per 3U, 120W per 6U slot).

Each peripheral slot offers 1 PCI Express link, 1 SATA/SAS and 1 USB 2.0/3.0 interface. Each slot can support up to 8 Ethernet interfaces to build a full mesh. All interfaces are accessible at the same time. It is supplied with 12V (60W per 3U, 120W per 6U slot). The pin assignment of the system and the peripheral slot is congruent. This way it is possible to plug a system slot board into each peripheral slot to support symmetrical multiprocessing. The star topology is equal for PCI Express, SATA/SAS and USB. All peripheral slots are identical except two that are connected via PCI Express links by 8 lanes. Ethernet is wired as a full mesh. Transmission is based on the proven standards for copper connections up to 10GbaseT to allow configuration of redundant, safety-critical systems.

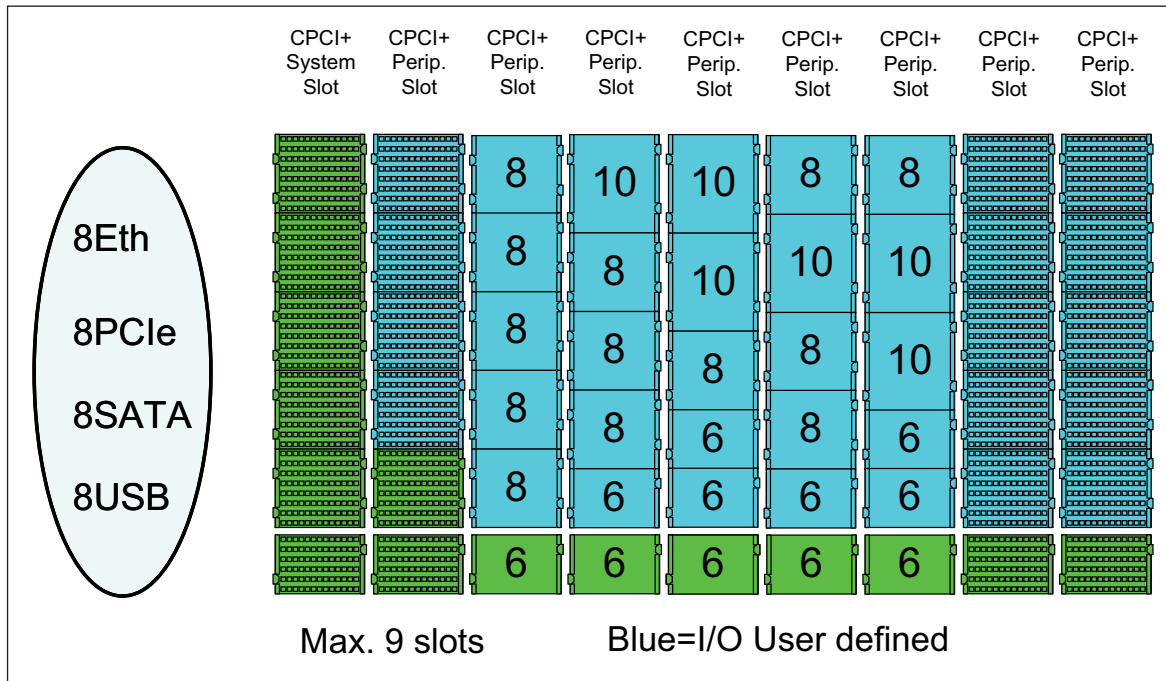


Figure 3: Example of a CompactPCI Serial backplane incl. User I/O

Hybrid Systems & Migration

As an extension of the parallel CompactPCI standard PICMG 2.0, a CPU board which is developed according to the serial CompactPCI PlusIO standard PICMG 2.30 can also be used as a system slot in a hybrid system. Such a hybrid system can offer CompactPCI slots as well as CompactPCI Express and CompactPCI Serial slots. (It can even be combined with other bus-based slots like VME).

PICMG 2.30 is downwards-compatible to PICMG 2.0 without any limitations because it just fixes the J2 pin assignment for:

- 4 x PCI Express (one lane each)
- 2 x Ethernet 1000BaseT
- 4 x USB 2.0
- 4 x SATA/SAS

At the same time it introduces a new 100% compatible 2-mm-connector, which is also suited for transmission of high frequencies. The parallel PCI bus is not changed but is limited to a data bus width of 32 bit. PICMG 2.30 can be used for both single and double Eurocard formats.

Hybrid systems offer the possibility to integrate boards with serial interconnects beside the parallel bus-based boards – an easy and cost-saving way to migrate to modern technologies.

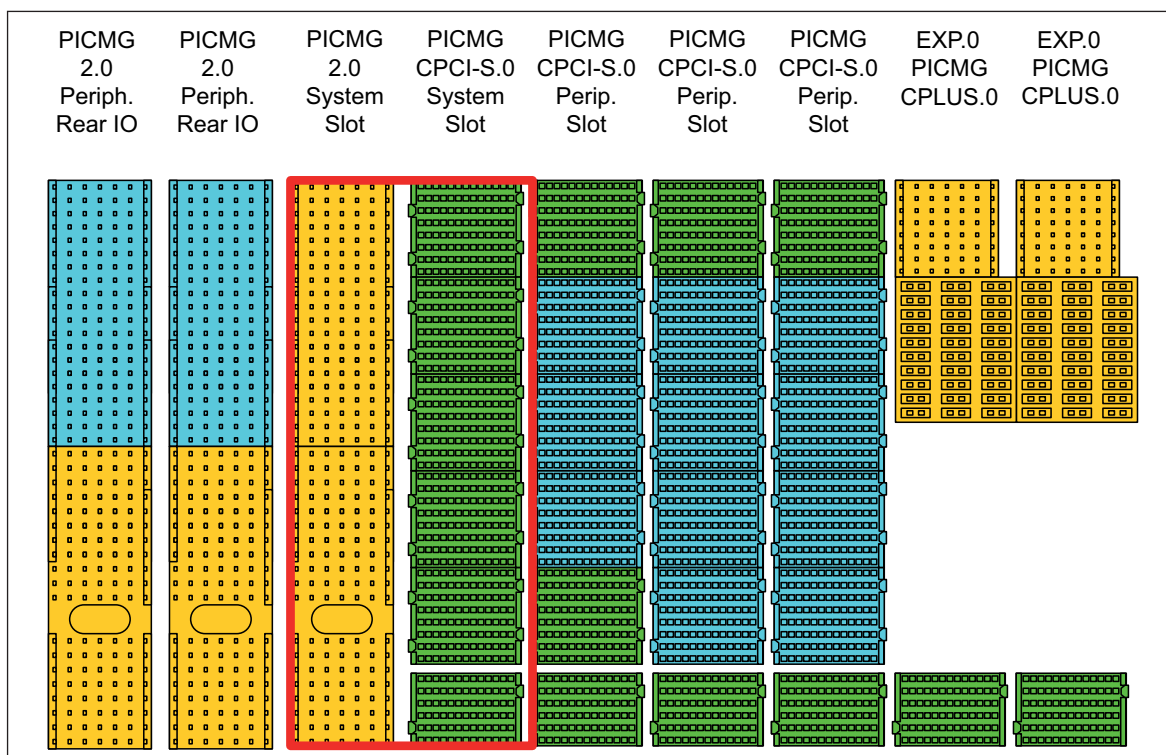


Figure 4: Example of a hybrid backplane with CompactPCI, CompactPCI PlusIO, and CompactPCI Serial

IN-BETWEEN EVOLUTIONARY STEPS: Packet Switching Backplane

A Packet Switching Backplane is composed of node slots, fabric slots, and the links that interconnect them. The topology is a star, with each line interconnecting a node board and fabric board. This way each board communicates with the other assemblies over two Ethernet links via a special switch card. The specification leverages IEEE 802.3-2000 1000BASE-T in providing the physical and data link layers. Protocol stacks such as TCP/IP can be added at the network and transport layers to provide a reliable connection-oriented environment. As an extension to the CompactPCI core specification

PICMG 2.16 introduced a 10/100/1000 full-duplex Ethernet network on the backplane as a high-speed serial transmission medium beside the parallel PCI bus to create an Embedded System Area Network (ESAN). PICMG 2.16 supplements the robust, reliable and hot-swap capable CompactPCI architecture with the easily integrated, low-cost, high-performance, and extensible Ethernet. This creates a platform well suited to the integration of components for the most demanding systems and empowers system integration and design to ascend to higher layers of the Open Systems Interconnection (OSI) protocol stack, thus reducing system integration time. The Ethernet signals are led to the J3 connector making PICMG 2.16 only applicable for 6U boards.

		CompactPCI 2.0		CompactPCI 2.16	CompactPCI PlusO		CompactPCI Serial	
		3U	6U	6U	3U	6U	3U	6U
PCI (parallel)	Databus width	32/64bit	32/64bit	32/64bit	32bit	32bit	-	-
	Frequency	33/66MHz	33/66MHz	33/66MHz	33/66MHz	33/66MHz	-	-
	Overall max data rate	0.533GB/s	0.533GB/s	0.533GB/s	0.266GB/s	0.266GB/s	-	-
PCI Express	No of links	-	-	-	4	4	8	8
	No of lanes per link	-	-	-	1	1	4/8	4/8
	Generation	-	-	-	1 / 2	1 / 2	1 / 2 / 3	1 / 2 / 3
	Overall max data rate	-	-	-	2GB/s	2GB/s	400GB/s	400GB/s
Ethernet	No. of interfaces	-	-	2	2	2	8	10
	Speed	-	-	100Mb/s	0.1/1/10Gb/s	0.1/1/10Gb/s	0.1/1/10Gb/s	0.1/1/10Gb/s
	Overall max data rate	-	-	0.025MB/s	2.5GB/s	2.5GB/s	10GB/s	12.5GB/s
SATA	No. of interfaces	-	-	-	2	2	8	8
	Generation	-	-	-	1 / 2	1 / 2	1 / 2 / 3	1 / 2 / 3
	Speed	-	-	-	1.5/3Gb/s	1.5/3Gb/s	1.5/3/6Gb/s	1.5/3/6Gb/s
	Overall max data rate	-	-	-	0.75GB/s	0.75GB/s	6GB/s	6GB/s
USB	No. of interfaces	-	-	-	2	2	8	8
	Generation	-	-	-	2.0	2.0	2.0/3.0	2.0/3.0
	Speed	-	-	-	480 Mbit/s	480 Mbit/s	4.8 Gbit/s	4.8 Gbit/s
	Overall max data rate	-	-	-	0.12 GB/s	0.12 GB/s	4.92GB/s	4.92GB/s
Rear I/O free pins	System slot	none with PCI64 75 with PCI32	95 + 220	65 + 220	n.a.	95 + 220	11	528 (w. AirMax)
	Peripheral slots	none with PCI64 75 with PCI32	95 + 220	65 + 220	n.a.	n.a.	192 with PCIe4 240 with PCIe1	768 (w. AirMax)
PICMG 2.0	Peripheral slots	4 with 66MHz	4 with 66MHz	4 with 66MHz	4 with 66MHz	4 with 66MHz	-	-
PICMG CPCI-S.0	Peripheral slots	7 with 33MHz	7 with 33MHz	7 with 33MHz	7 with 33MHz	7 with 33MHz	-	-
PICMG CPCI-S.0	Peripheral slots	-	-	-	4 / (2 Ethernet)	4 / (2 Ethernet)	8	8

CompactPCI Technology Feature Matrix

What is PICMG Europe?

PICMG Europe is the neutral promoter of the PICMG technologies in Europe. The definition of the technical specifications is managed by the parent organization in the United States. The European branch office, PICMG Europe, was established in 1997. The writing of the specifications is one aspect. Marketing of the technology and products is the necessary next step. PICMG Europe is a dedicated, independent association for supporting this goal. By marketing these technical specifications as a group, we are stronger than a number of individually operating companies. Moreover, users expect from open environments that products from different manufacturers are compatible on the same back panel.

PICMG Europe is supported by its members, as well as it supports its members. For instance, every member receives all specifications, updates and changes, free of charge. With this they are sure they are using the latest versions only. Membership levels include suppliers, users and system integrators. As such, PICMG Europe is an organization to join if you are active in these markets.

For more information please check www.picmgeu.org

For more information on the CompactPCI technology, check www.CompactPCI.org

Other PICMG Offices are:

For USA www.picmg.org

For Japan www.picmg-japan.com

For China www.picmg.com.cn

This is a publication of PICMG Europe, The Netherlands