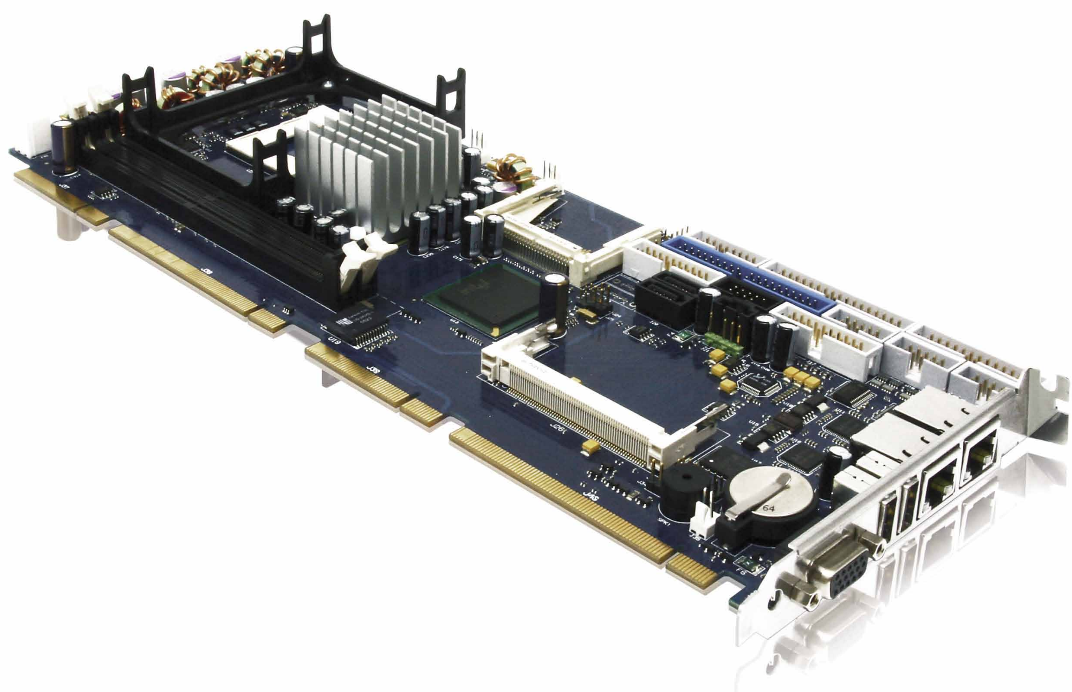
» Whitepaper «



PICMG 1.3:

The answer to growing bandwidth requirements?

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In all applications, bandwidth requirements for data transmission and processing are constantly rising. Existing PCI infrastructure should continue to be used here as much as possible. At least in the cases where it technically makes sense, since this amortizes investment costs and reduces costs for recertification. In the current chipsets, the manufacturers take these requirements into account by integrating more and more PCI Express interfaces while retaining the PCI bus. This encouraged the PICMG 1.3 subcommittee to define two form factors that serves the current requirements. Due to the high flexibility of the interfaces, nearly all requirements as to type and number of plug-in cards used can be implemented on the basis of the backplane.

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Market requirements

In some sectors such as image processing and data communication, the available processor performance no longer limits the number of channels. The bandwidth of the available busses is often the limiting factor. The 10-gigabit Ethernet cards currently used in data communications are at present offered in PCI-X or PCI Express. But for the required data rate of ca. 1 Gbyte, there is only one slot available per PCI-X bus. To speak of a BUS is thus rather questionable. Current server chipsets offer at least four of the alternatively usable PCI Express X4 interfaces. The constantly rising camera resolutions, both with regard to space and time, place ever higher requirements on the bandwidth to be mastered. Thus a doubling of the spatial resolution already leads to four times the data volume. But it is not just the bandwidth in the productive environment that is constantly rising. Parallel to this, the data volumes to be moved and archived are also getting larger and larger. For instance, if the design documents of a complete CPU component (Orcad, Intel® Pentium®) used only 17 megabytes at the end of 2001, a current PICMG 1.3 card (Mentor, Intel® Core™2 Duo) requires 255 megabytes. Thus, to get the same sort of work speed, the throughput between server hard drive and work station would have to increase by a factor of 15. For the "passive" backplane systems used successfully for years, a rework is therefore urgently needed to meet these requirements.

PICMG 1.3: The answer to growing bandwidth requirements?

Technical background

Over the years, the available performance of computer technology has constantly risen. As can be seen from Table 1, this applies not only to processor performance, as is often assumed, but also to mass storage performance and the networking throughput, which has greatly increased. Since these functional units are addressed via the bus systems used in the system, there is high pressure for innovation. Thus, today a hard drive with 300 Mbyte connection is still fast. But it is already foreseeable that with VDSL2 a solution is ready for the market that offers comparable data rates for Internet connections.

Time	Internal Bus system		Mass storage		Local area network		Wide area network	
1981	ISA 8bit	<1MB/s	FDD	250 kBit/s	-(RS485)	-	-(TELEX)	-
1984	ISA 16bit	<2MByte/s	MFM HDD	200 kByte/s	Arcnet	1MBit/s	Akustikkoppler	300baud
1991	PCI	132 MByte/s	IDE	33 MByte/s	TP Ethernet	1 MByte/s	ISDN	16kByte/s
2007	PCIexpress	> 250 MByte/s	SATA	300 MByte/s	Gigabit Ethernet	100 MByte/s	ADSL	2 MByte/s
Next gen	PCIexpress 2.0	> 500 MByte/s	?	?	10 Gigabit Ethernet	1000 MByte/s	VDSL	200 MByte/s

Table 1

Commercial background

For the success of a new platform, various factors are decisive. The solutions available so far are only replaced with new ones if there is a technical necessity or if the costs of the solution used so far turn out to be too high. If this happens with products, the attainable price drops, for one thing, and the danger of losing projects to competitors grows. In our current customer market, there has for some time now been more than one supplier for every product. The price is thus determined by competitive pressure. In this environment, if the solution available from the one provider does not have all the features required on the market, this product comes under strong pricing pressure. In the automobile industry, we are presently familiar with the case of the diesel soot filters in Germany.
In this situation, it is necessary to push the existing products with minimal expense up to the current level without great costs and long development times. An advantage over the competitors should quickly be achieved here if at all possible, since all costs incurred with a change of generations can in this way be amortized much more quickly.

Approach to a solution

Design

From the customer's perspective, retaining the appearance of products that were launched years ago is of decisive importance. For one thing, this saves costs in marketing, since it does not have to be conveyed to the customer that the new design is much better without making the old product seem bad; for another, the customer incurs costs with a conversion. This will motivate the customer to purchase a solution that still has the same mechanical and visual characteristics. A current customer example shows how one can be led in the wrong direction by department here. For a router application, a reduction of installation size was possible with current technology. The old solution consisted of a 19" rack PC with 2 U installation height. The new one could only be integrated into existing cabinets with a mounting plate. This solution looked like an extreme waste of space to the end customer and for that reason was only grudgingly accepted. At the next opportunity, the end customer changed to a comparable 2U system from an alternative provider.
From this, it is clear that a new solution absolutely has to offer the possibility of continuing to use the proven mechanical system and technology as seamlessly as possible.
Currently, the most successful form factor is, despite its age, still PICMG 1.0. Consequently, a new form factor ought to be designed to be as similarly as possible in its mechanical system and – very important – also its cooling. Since only then does the expense in the case of an update remain manageable.

Interfaces

As PICMG 1.0 was defined years ago, other than the simple interfaces going to the backplane, there were no other functions on a customary slot board. Thus, the number of cables needed was limited. As a consequence of the continuously increasing integration of functions in the chipsets, the number of connections needed continued to increase parallel to this. A current PICMG1.0 board (PCI-955) can require more than 10 cables for connection of all the integrated functions. In order to reduce this again to a manageable quantity, as many interfaces as possible have to be lead to the backplane in a design similar to the "Rear IO."

	PICMG 1.0	PICMG 1.3	CPCI
Wide base of chassis	3	3	-
PCIexpress available on BPL	-	3	-
PCI available on BPL	3	3	3
PCI-X available	-	3 (Bridge on BPL)	3
SATA available on BPL	-	3	Rear IO
USB available on BPL	-	3	Rear IO
ATX Control	-	3	3
Hotswap	-	-	3
Front Interface	-	-	3
Telecom-Bus (H110)	-	-	3

Table 2

Bandwidth

For a first selection of the available possibilities, the distinction between server and desktop chipsets (Table 1, Source). Due to the current tendency to integrate more and more CPU cores (e.g., Intel® Core™2 Quad), the possibility of using more independent processors plays a subordinate role due to available memory bandwith, at least for slot CPUs. Thus, the decisive question is mainly whether one needs an ECC memory or not. If the answer here is no, then only the higher flexibility with the PCI Express connections speaks for an approach based on a server chipset. For this, another solution is presented later (see PCI Express switches, page 11). Since nearly all applications require a graphic output even if it is only for debugging (98% of all PCI-946 have VGA), such a chipset always means extra costs for a graphics solution and issues with availability.

	Intel Desktop Chipset	Intel Server Chipset
Internal Graphics	3	-
ECC Memory	-	3
Multi CPU	-	3
PCIExpress x16	3	-
PCIExpress x8	-	3
PCIExpress x4	3	3
PCIExpress x1	3	3
SATA	3	3
PCI-32	3	3
PCI-X	-	-[1]

Table 3

SHB outline

In order to be able to carry out the existing PICMG 1.0 solutions as seamlessly as possible, the new PICMG 1.3 standard places particular emphasis on mechanical compatibility.
This is reflected in, among other things, the outline (see Illustration 1). This corresponds as closely as possible to the size already established by PICMG.

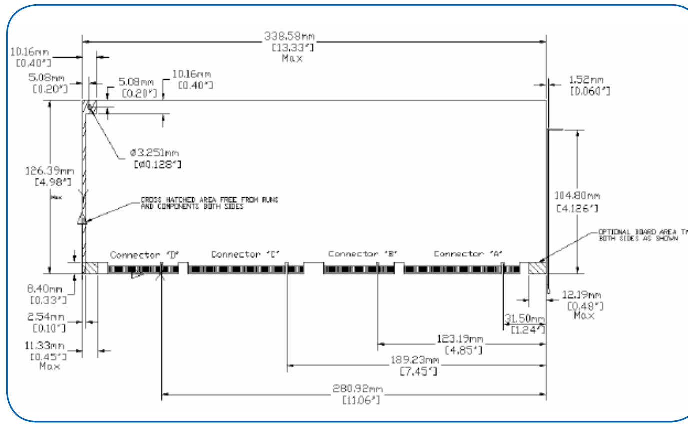


Illustration 1

SHB features and cooling

In addition, PICMG 1.3 again uses the same component side, in contrast to PICM 1.2. This has the decisive advantage of the CPU cooling element being integrated on the same side as previously (see Illustration 2). This reduces the expense of a conversion even further, since the existing slot configuration can also be retained.

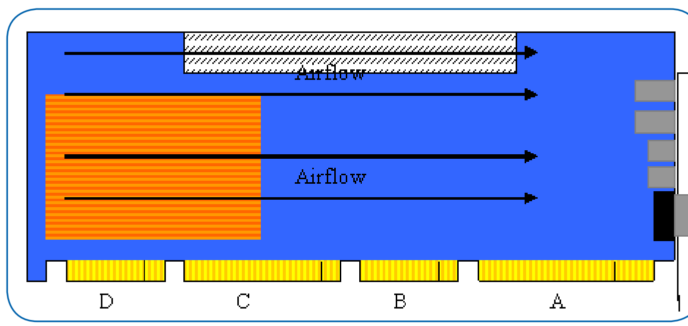


Illustration 2

SHB interfaces

The direct connectors (see Illustration 3) to a component according to PICMG 1.3 are logically divided into functional groups.

A. PCI Express 16 lanes, can be grouped (flexibility depending on chipset)
   1x PCI Express X16
   2x PCI Express X8
   1x PCI Express X8 and 2x PCI Express X4
   4x PCI Express X4
   1x PCI Express X1
B. PCI Express 1 lane, can be grouped
   1x PCI Express X4
   4x PCI Express X1
C. Standard interfaces (optional)
   2x SATA (necessary for SATA-II driver on BLP)
   4x USB 2.0
   2x LAN

D. PCI bus (optional)
In addition, signals for controlling an ATX power supply are provided as well as an I²C bus.
Depending on execution, the number of functions can differ, since not all are optional. In general, one can differentiate between server chipset and desktop chipset.
I. Server chipset
Flexible configuration for connector A but no PCI Express X16
II. Desktop chipset
Only PCI Express X16 and PCI Express X1 for connector A

Backplane approaches

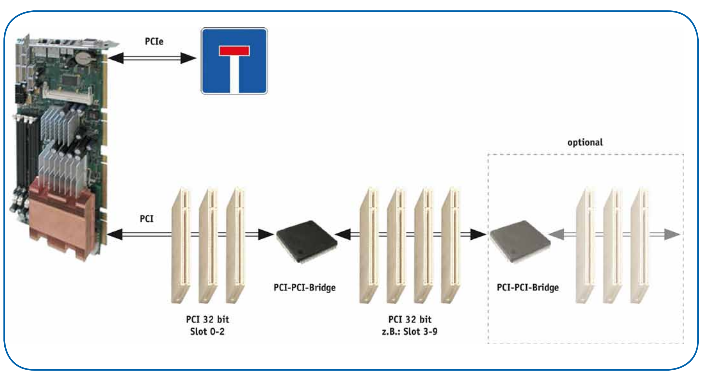
So that customers can test the concept quickly and easily, all providers offer a selection of standard backplanes. Using these, the functional blocks that may be necessary for a required dedicated solution can be tested by the customer.

PCI bridging

For some applications, the increased bandwidth has so far not been required. In such cases, a conversion presents itself with PICMG 1.0, as has been customary for years. The maximum number of possible slots is increased by PCI to PCI bridging [Illustration 3].

Advantages
- » Technically simple design
- » Software transparent
- » Proven components

Disadvantages
- » Total bandwidth of PCI slots limited to 132 MB
- » PCI Express is idle

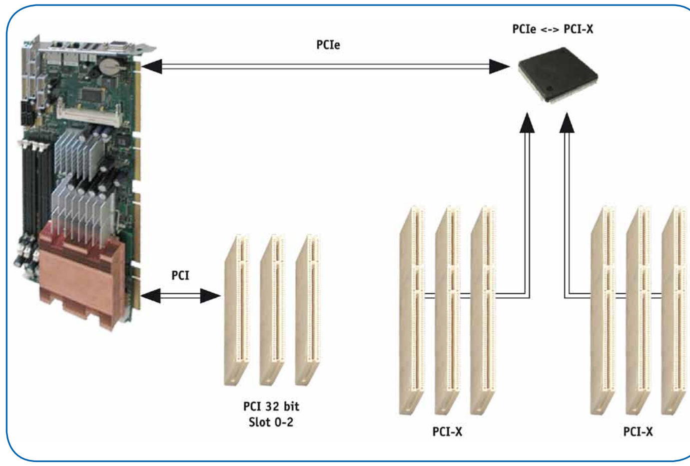


PCI Express bridging

Currently, there are bridges from PCI Express both to PCI and also to PCI-X. Use of them offers the advantage of higher bandwidth.

Advantages
- » High bandwidth ready
- » Independent fast and slow segments

Disadvantages
- » BIOS adaptation may be necessary
- » More complex backplane (e.g., BGA)

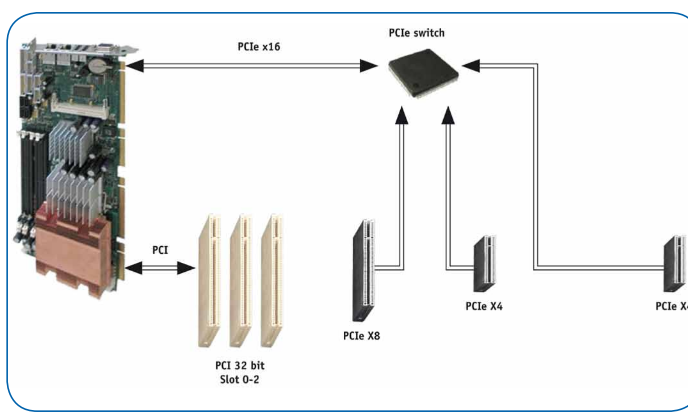


PCI Express switches

At first glance, the decision for desktop chipsets appears to greatly reduce the flexibility of possible solutions. In the meantime, various manufacturers are offering so-called “PCI Express switches.” They correspond in function roughly to the modules for PCI known previously as “bridges.” Thus, for example, it is possible to segment PCI Express x16. It is advantageous here that flexibility is implemented on the backplane, not by means of cost-intensive server chipset solutions. Because of this, the costs are incurred only in applications in which the flexibility is actually needed.

Advantages
- » Flexible PCI Express slot configuration
- » Cost advantage in comparison to server solution
- » Independent of special SHBs

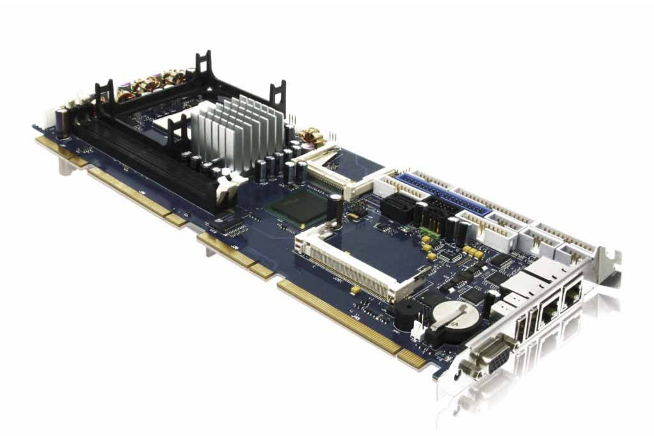
Disadvantages
- » BIOS adaptation may be necessary
- » Not supported by all chipsets (with internal graphics)



Conclusion

Based on the prepared approaches to a solution, implementation of every conceivable slot configuration is possible. Through sticking with proven and thus tested designs, design costs and risks are reduced.

Implementation examples



Slot-CPU PICMG 1.3: PCI-760

With up to 1333 MHz front-side bus, up to 8 Gbytes fast DDR2 SDRAM and numerous interfaces, the Kontron PCI-760 offers a comprehensive range of functions: 1 x PEG, 4 x PCI Express x1 and 1 x PCI to the backplane, 6 x 300 Mbps SATA II (2 via backplane) and RAID 0, 1, 5 and 10 functionality, 3 x 10/100/1000 Base-T Ethernet (1 via backplane), 12 x USB 2.0 (4 via backplane), one parallel and two serial interfaces (16550 UART-compatible) and 7.1+2 channel HD audio codecs (including digital I/O). Applications profit from the large bandwidth of possible interfaces via the backplane through reduced wiring expense and high flexibility. Additional interfaces are adaptable via a mini-PCI connector (type IIA). Kontron's own components are available for LAN, WLAN and SCSI. If no high-end PEG graphics are required, the integrated Intel® GMA 3100 Graphics Media Adapter DirectX 9.0c full Windows Vista Aero support and resolutions up to QXGA (2048 x 1536) with 75 Hz via the VGA connection. In addition, a robust optional USB flash module with up to 8 Gbytes and a MTBF of 5 million hours allows a maintenance-free system design without rotating storage media.

KISS 1U

Despite its slight installation height of merely 44 mm, the KISS-1U server has space for a PICMG 1.3 system host board and two customized PCI expansion cards. Future expansion options include PCI Express interfaces (PEG and PCI Express x 4). Additional PICMG 1.x variants are also available on request. In addition to the shock- and vibration-protected internal 3.5″ HDD, the Kontron KISS-1U offers enough space for an additional 3.5″ hard drive or two 2.5″ hard drives. For improved data security, the optional KISS Stor-Slim RAID 1 subsystem with two hotswap-capable 2.5″ HDDs sees to it that addressing only has to be done via SATA and has integrated RAID logic. The four temperature-controlled, extremely quiet fans KISS 1U are hotswap-capable and provide for reduced down time and higher availability. Together with shock and vibration protection for hard drives and PCI slots, they contribute to the impressive MTFB of 50,000 hours (~ 5.7 years of continuous operation) of the Kontron KISS 1-U.The first configuration of the KISS-1U with Intel® Core™2 Duo T7400 processor offers GB LAN and 4 * USB 2.0 on the front. On the back there are 2 x gigabit LAN, 2 x USB 2.0, 1 x VGA and 2 * RS232 available. Further customized interfaces capable of being integrated can be added as needed. Windows XP, Vista and Linux are supported. This high flexibility in an extremely compact enclosure makes the KISS-1U the ideal solution for customized, space-saving industrial computers, for example, in industrial automation, process control technology, high-performance image processing medical technology, security technology and building control technology.

Sources

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About Kontron

Kontron designs and manufactures standard-based and custom embedded and communications solutions for OEMs, systems integrators, and application providers in a variety of markets. Kontron engineering and manufacturing facilities, located throughout Europe, North America, and Asia-Pacific, work together with streamlined global sales and support services to help customers reduce their time-to-market and gain a competitive advantage. Kontron's diverse product portfolio includes: boards and mezzanines, Computer-on-Modules, HMIs and displays, systems, and custom capabilities.

Kontron is a Premier member of the Intel® Embedded and Communications Alliance.

The company is a recent three-time VDC Platinum vendor for Embedded Computer Boards. Kontron is listed on the German TecDAX stock exchange under the symbol „KBC".

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