Expansion connectors (slots)

- **The buses constitute a common path, integrated into all recent motherboards.**
- **The bus is used by data as a movement medium to circulate inside a computer, thus making it possible to establish communications between the different components of a computer.**

Expansion connectors (slots)

- **Most computers have at least three different buses organized hierarchically according to transfer speed.**
- **Each bus is connected to a faster bus located above it in the hierarchy and in this way each component of the computer is connected to one of these buses, however, some act as bridges between the different buses such as the chipset.**

Expansion connectors (slots)

- **The input/output bus connectors, or expansion connectors (slots), are the elements which ensure communications between the processor and the peripherals.**
- **The slots are receptacles in which it is possible to insert expansion cards which provide new features or better performance to the computer.**

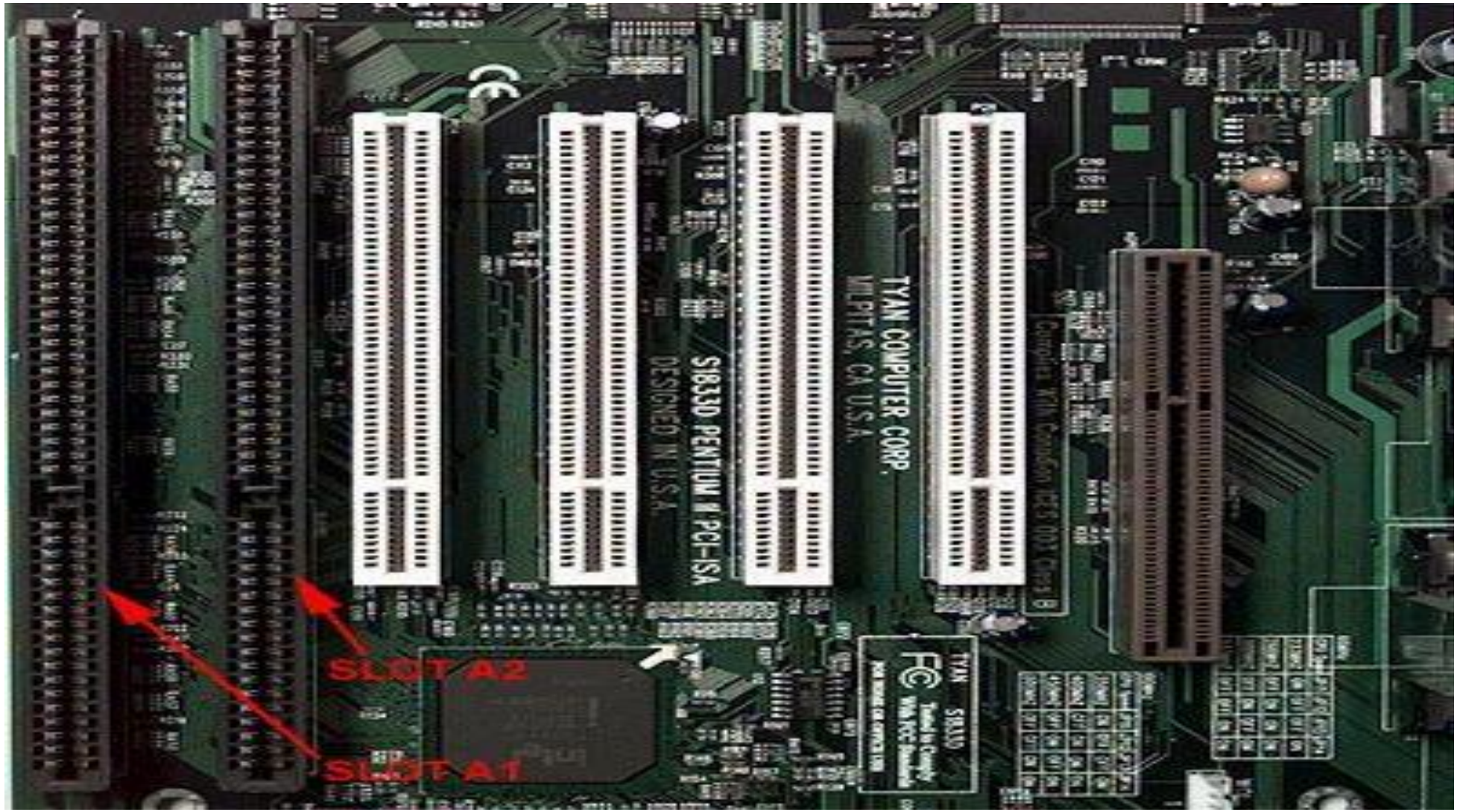
ISA (*Industry Standard Architecture)*

- The outdated data bus format, which is still in use due to cost and compatibility considerations, was first introduced in 1981.
- Initially, it operated on an 8-bit system with a clock speed of 4.77 MHz.
- Later, in 1984, it was upgraded to a 16-bit system with frequencies varying from 6.8 MHz to 8.33 MHz.

ISA (*Industry Standard Architecture)*

- ISA is a very slow bus, but it was perfect for some slow devices.
- It is only suitable for devices that do not require large information transfers such as modems or sound cards.

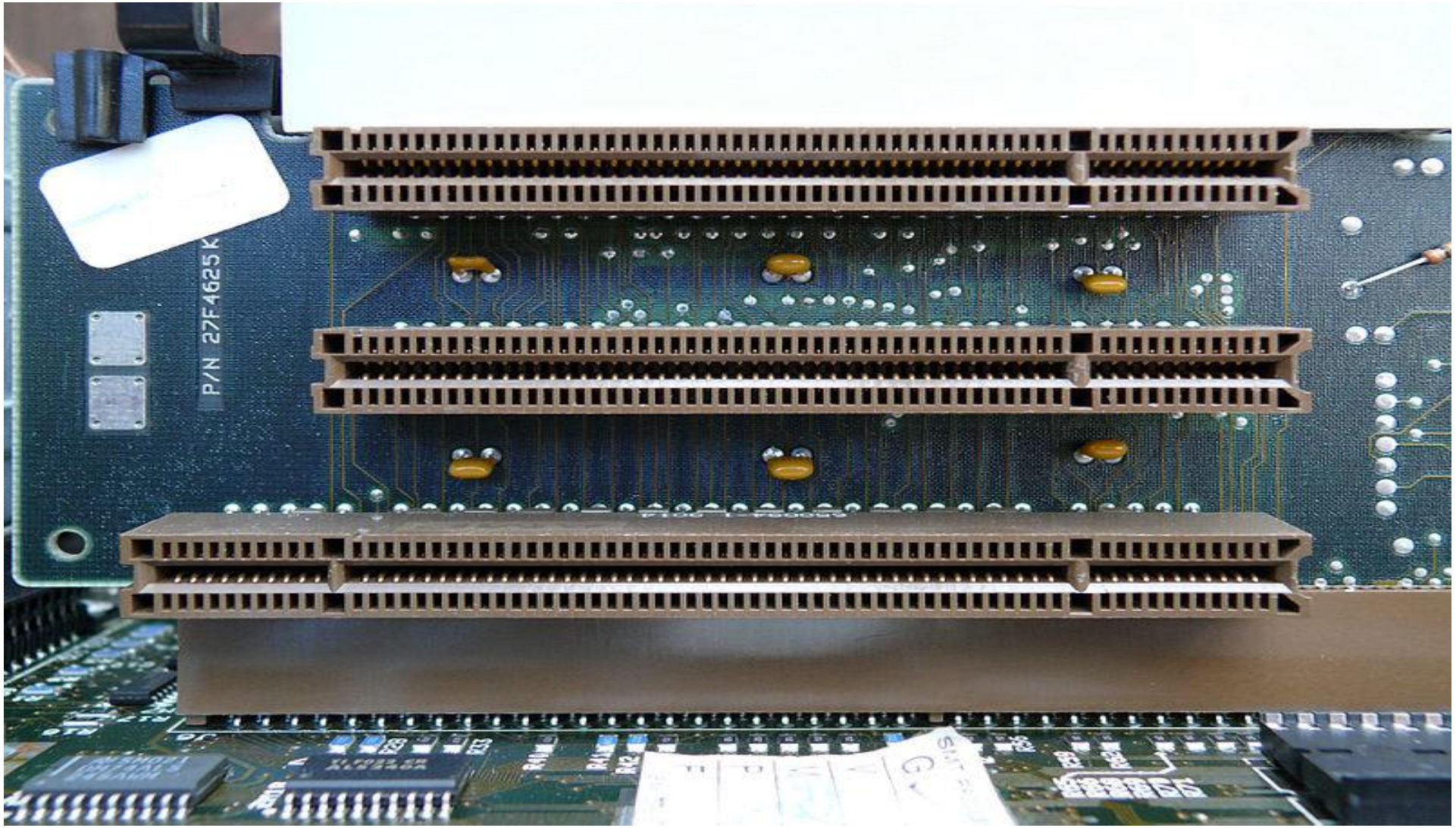
ISA (*Industry Standard Architecture)*



MCA (*Micro Channel Architecture)*

- The MCA bus is an improved proprietary bus designed by IBM in 1987 to equip their PS/2 line of computers.
- This bus, with a width of 16 and 32 bits, was incompatible with the ISA bus and made it possible to obtain a transfer rate of 20 MB/s.

MCA (*Micro Channel Architecture)*



EISA (*Extended Industry Standard Architecture)*

- In 1988, several companies came together to build a new expansion port capable of competing with the proprietary MCA bus launched by IBM in 1987.
- The EISA bus used connectors of the same size as the ISA connector, but with four rows of contacts instead of two, thus allowing 32-bit addressing.

EISA

- EISA is completely compatible with ISA cards since the EISA connectors were deeper and the additional contact rows were placed below the ISA contact rows.

VLB (*VESA Local Bus)*

- The VLB is an expansion bus developed by the VESA association (Video Electronics Standard Association) in 1992.
- The objective was to offer a local bus dedicated to graphics systems by offering higher performance than the ISA bus.
- The VLB bus is designed to complement the operation of an ISA bus.

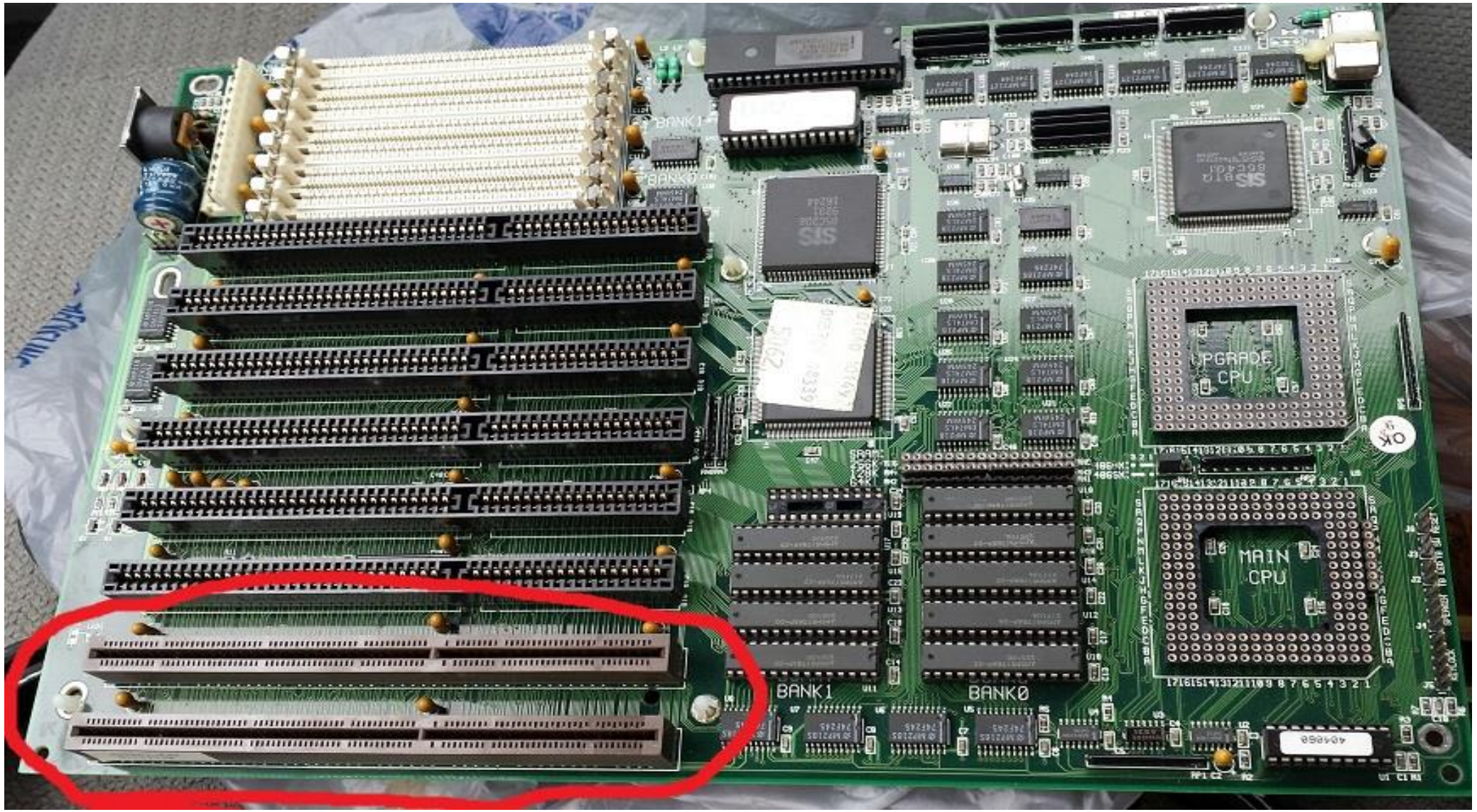
VLB (*VESA Local Bus)*

- This is a 16-bit ISA connector combined with an additional 16-bit connector.
- Expansion cards used the ISA bus for low-bandwidth operations while the VLB bus is used for high-bandwidth exchanges.

VLB (*VESA Local Bus)*

- The VLB bus is a 32-bit bus initially clocked to operate at a frequency of 33 MHz.
- Speed can vary from 25 to 50 MHz depending on the model installed.
- On the motherboard, a VLB slot can accommodate either a VLB card or an 8- or 16-bit wide ISA card.

VLB (*VESA Local Bus)*



PCI (*Peripheral Component Interconnect)*

- In order to overcome the weaknesses of the ISA and EISA buses, Intel proposed a new type of computer bus.
- In June 1992, Intel released the first version of the PCI specification.
- The latter has been updated several times in order to improve its performance.

PCI (*Peripheral Component Interconnect)*

- In April 1993, version 2.0 appeared with a new definition of connectors and expansion cards.
- In June 1995 the frequency increased from 32 to 66 MHz with the arrival of PCI 2.1.
- Version 2.2 which was released in January 1999 aimed to reduce energy consumption.

PCI (*Peripheral Component Interconnect)*

- The PCI standard has succeeded in modifying the traditional bus design by adding another bus between the processor and the native I/O bus using bridges.
- The construction of the bridges required the development of a new set of controllers to extend the bus.

PCI (*Peripheral Component Interconnect)*

- This technique made it possible to avoid a direct connection to the processor bus.
- The standard version of the PCI bus was 32 bits wide clocked at 33 MHz.
- It equips most computers since the Intel Pentium 4 processor.
- Currently there are 64-bit versions with 66, 100 and 133 MHz.

PCI (*Peripheral Component Interconnect)*

- This increase in performance is due to the fact that the PCI bus can operate in parallel with the processor bus.
- The processor can handle data in external cache while the PCI bus takes care of transferring data between other system components.

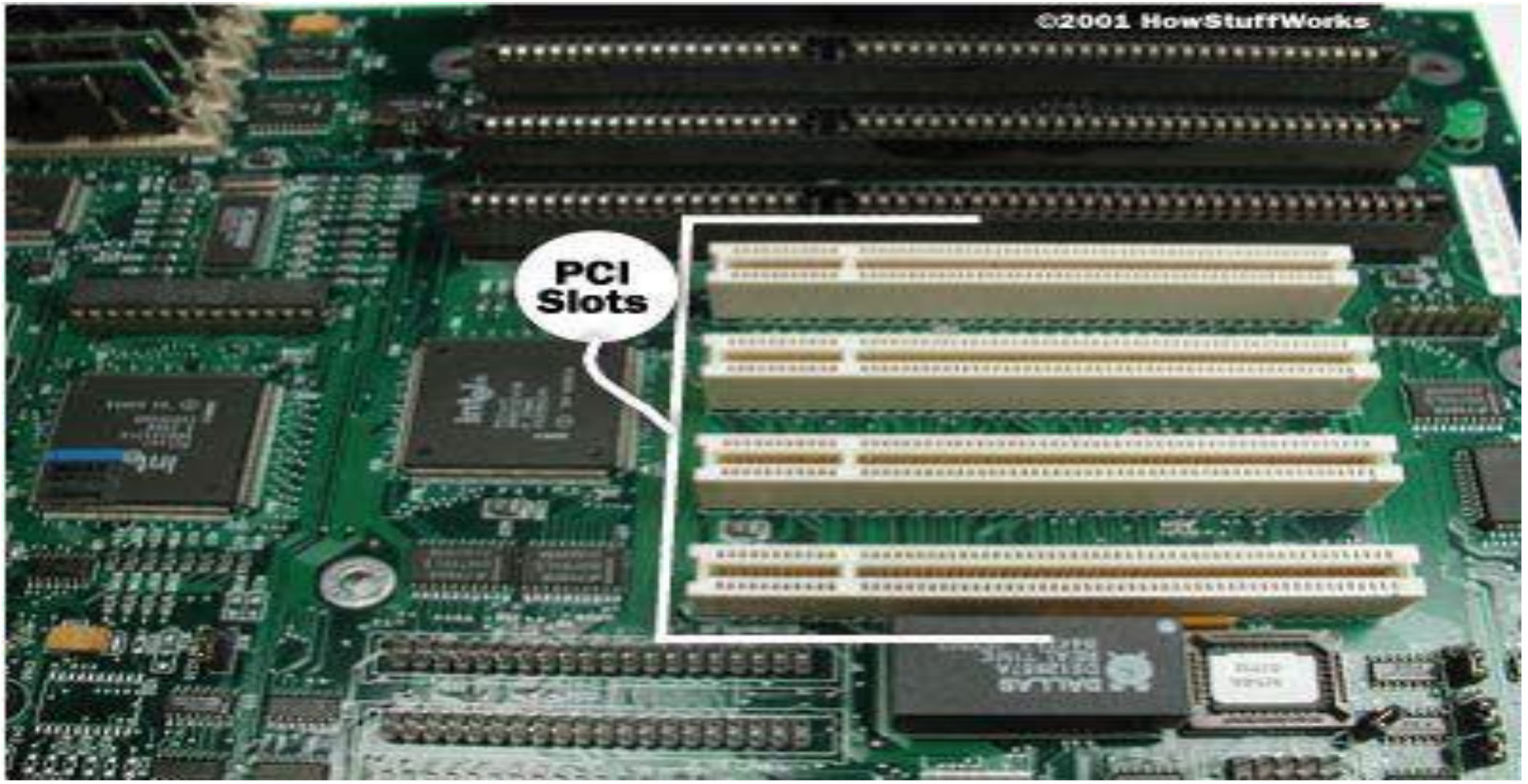
PCI (*Peripheral Component Interconnect)*

- There are also two levels of signaling:
  - 3.3V, intended for laptops (PCI 2.3);
  - 5V, intended for desktop computers (PCI 2.2).
- The signaling voltage does not correspond to the card supply voltage, but to the voltage threshold for digital coding of information.

PCI (*Peripheral Component Interconnect)*

- 64-bit PCI connectors offer additional pins, but can still accommodate 32-bit PCI cards.
- Another major characteristic of the PCI standard is that it served as a model for the Plug and Play (PnP) specification defined by Intel.

PCI (*Peripheral Component Interconnect)*



AGP (*Accelerated Graphics Port)*

- The AGP bus was a proposal from Intel in the 1990s to help manage graphics data flows that were becoming too large for the PCI bus.
- We had to wait until July 1996 to be able to benefit from this technology on chipsets based on “Slot One”, then on supports based on Super 7.

AGP (*Accelerated Graphics Port)*

- The AGP bus is directly connected to the processor bus and benefits from high bandwidth.
- The AGP port is physically, electrically, and logically independent of PCI.
- There are three types of connectors:
  - AGP 1.5 volts, AGP 3.3 volts and universal AGP

AGP (*Accelerated Graphics Port)*

- The AGP interface was designed specifically to connect graphics cards by opening a direct memory access channel (DMA), without going through the input-output controller.
- This property has reduced the manufacturing cost of graphics cards since they theoretically need less onboard memory.

AGP (*Accelerated Graphics Port)*

- The AGP 1.0 specification was released in July 1996, and defines a clock frequency of 66 MHz and a 1X or 2X signaling mode operating at 3.3 V.
- 1X mode allows 8 bytes to be sent every two cycles while 2X mode allows 8 bytes to be transferred per cycle.

AGP (*Accelerated Graphics Port)*

- In 1998, version 2.0 of the AGP bus brought an AGP 4X mode allowing the sending of 16 bytes per cycle.
- Version 2.0 of the AGP bus being powered at a voltage of 1.5 V, so-called “universal” connectors (AGP 2.0 Universal) appeared, supporting both voltages.

AGP (*Accelerated Graphics Port)*

- Version 3.0 of the AGP bus, which appeared in 2002, doubled the throughput of AGP 2.0 by offering an AGP 8X mode which defines a transfer speed of 2.133 GB/s, double that of AGP 4X.
- Most latest generation AGP video cards conform to the AGP 4X or AGP 8X specifications, which are based on a voltage of 1.5 V.

AGP (*Accelerated Graphics Port)*

- There is also a low-reputation specification called AGP Pro 1.0, defined in August 1998 and revised in April 1999 as AGP Pro 1.1a.

- AGP Pro cards are primarily intended for high-end graphics workstations

AGP (*Accelerated Graphics Port)*

PCI-ExpresS

- In August 2001, the PCI Special Interest Group (PCI-SIG) agreed to support, manage, and promote the 3GIO architecture specification as the next generation of PCI.

- In April 2002, the 3GIO project version 1.0 was completed, transferred to PCI-SIG and renamed PCI-Express.

PCI-ExpresS

- In June 2002, the PCI-Express 1.0 specifications were finally approved.
- They went to version 1.1 in April 2005 and to version 2.0 in January 2007.
- The PCI-Express bus is compatible with PCI enumeration and software device drivers.

PCI-ExpresS

- PCI-E ports have:
  - maximum bandwidth per pin,
  - resulting in reduced form factors,
  - lower costs,
  - simplified card designs,
  - fewer signal integrity issues.

PCI-ExpresS

- The PCI-Express bus makes it possible to increase the transfer rate with the frequency as well as the number of lines.
- They can be hot plugged in without restarting.
- The PCI-Express bus differs from the AGP bus by the transition from parallel interfaces to serial interfaces.

PCI-ExpresS

- The serial bus design is much simpler.
- It sends a bit through a single cable, but at much higher speeds than the parallel bus allows.
- By combining multiple serial channels, much higher transfer rates can be achieved.

PCI-ExpresS

- The PCI-Express bus allows data to be sent using two pairs of wires.
- Each wire allows a bandwidth of 250 to 500 MB/s.
- Acceleration is possible by adding additional wires (1x, 2x, 4x, 8x, 16x and 32x).

PCI-ExpresS

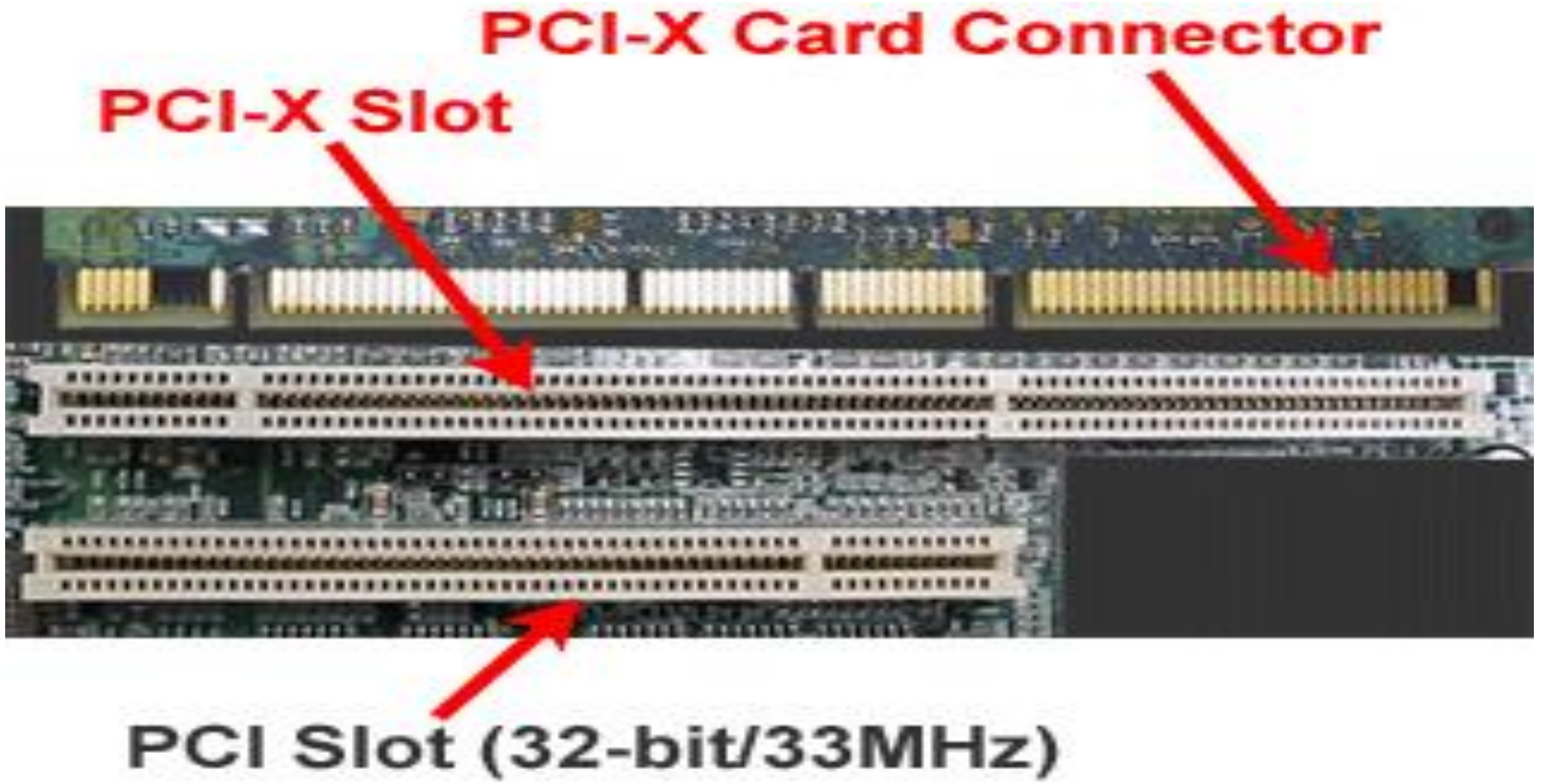
PCI-X

- The PCI-X bus is the second generation of the PCI bus.
- It offers greater bandwidth than PCI, but remains compatible with this bus.
- The PCI-X bus supports 64-bit connectors that are compatible with 32- or 64-bit PCI cards.

PCI-X

- PCI-X version 1.0 runs at 133 MHz, while PCI-X 2.0 can go up to 533 MHz.
- PCI-X 2.0 bandwidth is split between multiple PCI-X and PCI slots.
- Although a few motherboard can handle the PCI-X bus.

PCI-X



AMR /CNR

- Some motherboards include a special connector called AMR(Audio Modem Riser) CNR (Communication Network Riser).
- This is a small slot present recent generation motherboards (a bit like a PCI or AGP port but shorter).

AMR /CNR

- This slot allows you to connect a small additional card which is low cost and which allows you to have a sound card or a modem at very low cost.
- They are not designed to be universal bus interfaces, but to provide a communication option without having to reserve a special place for optional chips.

AMR /CNR

- A good number of the components are replaced in this case by a program (this is emulation).
- This inexpensive solution is therefore intended to lower the price of computers, but the great difficulty we have in finding AMR cards as well as the fact that emulation inevitably slows down the machine make this solution unattractive.

AMR /CNR