

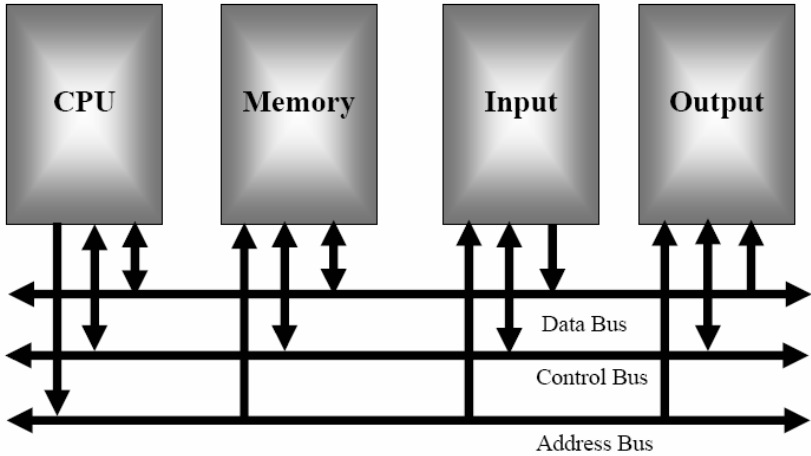
Computer Bus Architecture

Janaka Harambearachchi
(Engineer/Systems Development)

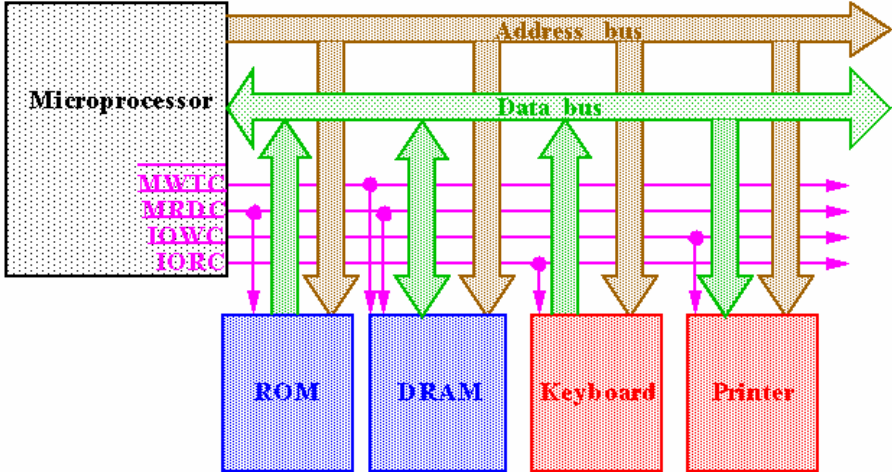
Von Neumann computer model

- The major parts of this model are the **central processing unit (CPU)**, **memory**, and the **Input and output circuitry** or I/O.
- Connecting these parts are three sets of parallel lines called buses.
- The three buses are the **address bus**, the **data bus**, and the **control bus**.

Von Neumann computer model.



Address & Data Buses



Data Bus

- The data bus consists of 8, 16, or 32 parallel signal lines. The data bus lines are bidirectional.
- Many devices in a system will have their outputs connected to the data bus, but only one device at a time will have its outputs enabled.
- Any device connected on the data bus must have three-state outputs so that its outputs can be disabled when it is not being used to put data on the bus.

Address Bus

- The address bus consists of 16, 20, 24, or 32 parallel signal lines. On these lines the CPU sends out the address of the memory location that is to be written to or read from.
- The number of memory locations that the CPU can address is determined by the number of address lines. If the CPU has N address lines, then it can directly address 2^N memory locations. CPU with 16 address lines can address 65,536 memory CPU with 20 address lines can address 1,048,576 locations
- When the CPU reads data from or writes data to a port, it sends the port address out on the address bus.

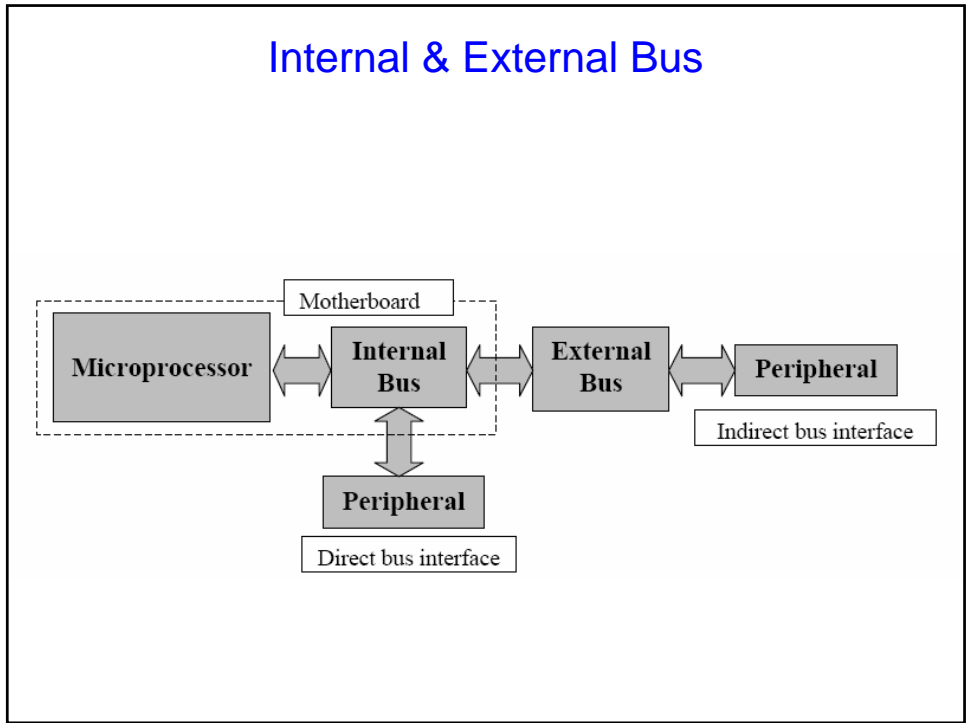
Control Bus

- The control bus consists of 4 to 10 parallel signal lines.
- The CPU sends out signals on the control bus to enable the outputs of addressed memory devices or port devices.
- Typical control bus signals are Memory Read, Memory Write, I/O Read, and I/O Write.
- *To read a byte of data from a memory location, the CPU sends out the memory address of the desired byte on the address bus and then sends out a Memory Read signal on the control bus. The Memory Read signal enables the addressed memory device to output a data word onto the data bus. The data word from memory travels along the data bus to the CPU.*

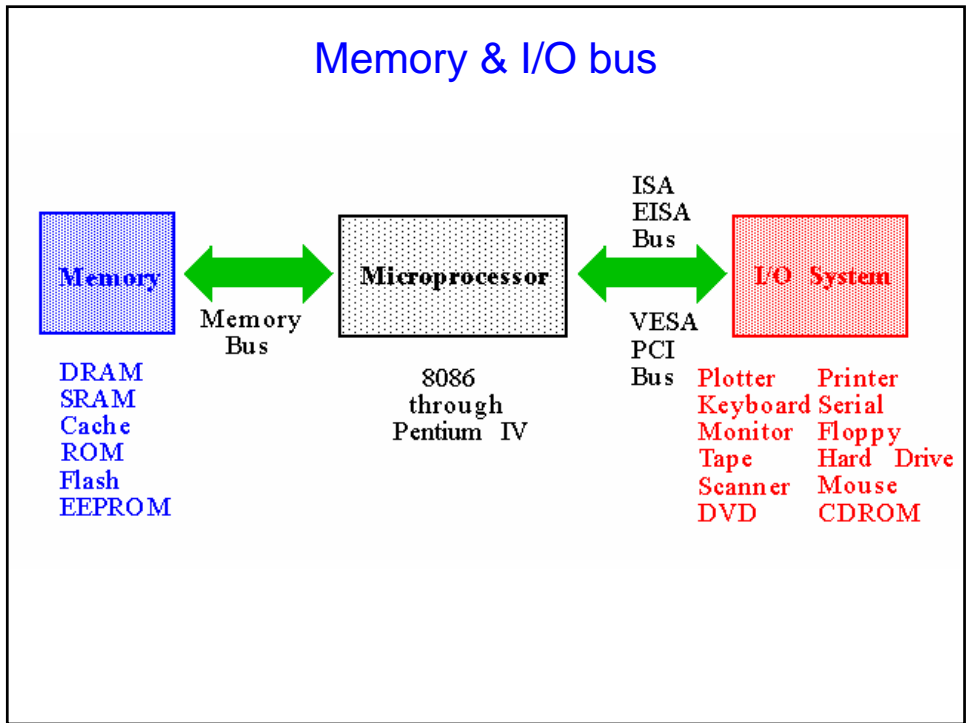
Buses

- Today all computers utilize two types of buses, an internal or local bus and an external bus.
- An internal bus enables a communication between internal components such as a computer video card and memory (e.g. ISA, EISA, PCI, AGP, etc.) and an external bus is capable of communicating with external components such as a SCSI bus, GPIB, etc.
- A computer or devices bus speed or throughput is always measured in bits per second or megabytes per second.
- *The bus is not only cable connection but also hardware (bus architecture), protocol, software, and bus controller*

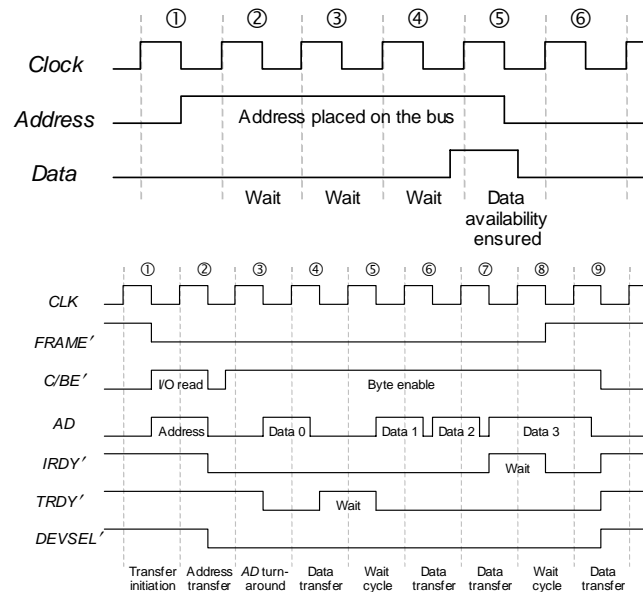
Internal & External Bus



Memory & I/O bus



Bus Communication Protocols- I/O read operation

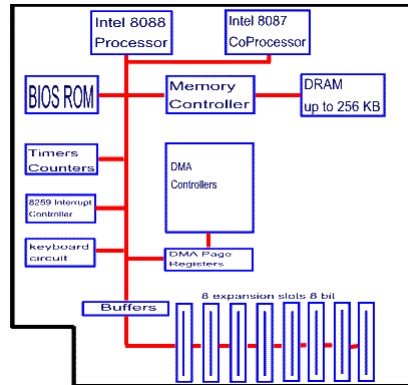


ISA BUS

- Introduced by IBM, ISA or **Industry Standard Architecture** was originally an 8-bit bus that was later expanded to a 16-bit bus in 1984.
- In 1993, Intel and Microsoft introduced a PnP ISA bus that allowed the computer to automatically detect and setup computer ISA peripherals such as a modem or sound card.
- Using the PnP technology an end-user would have the capability of connecting a device and not having to configure the device using jumpers or dipswitches.
- Many manufacturers are trying to eliminate the usage of the ISA slots however for backwards compatibility you may find 1 or 2 ISA slots with additional PCI slots.

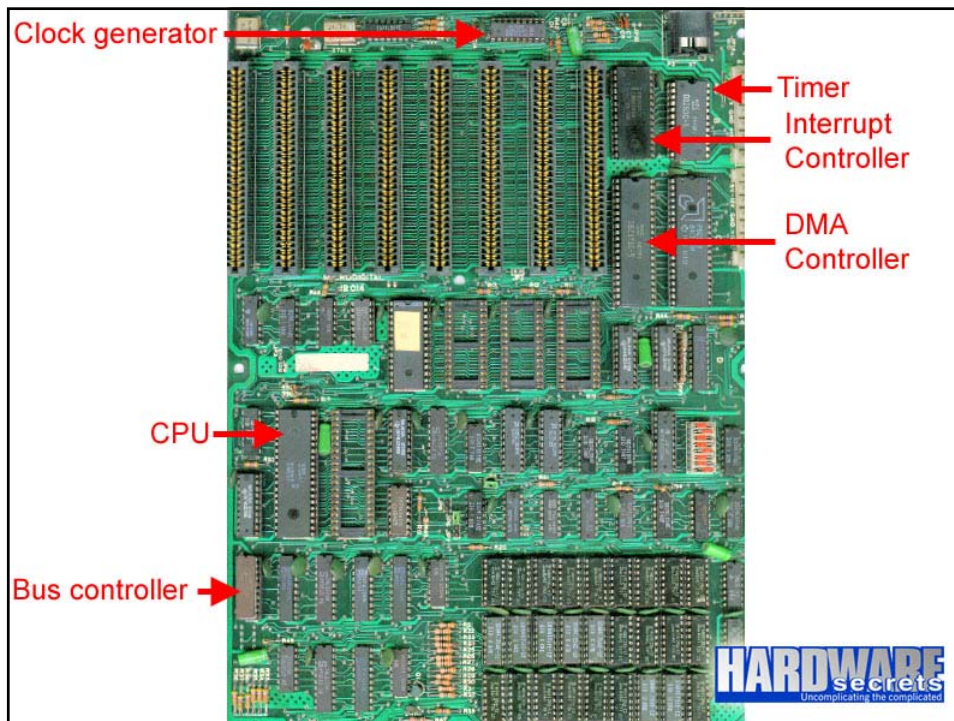


The PC and PC XT block diagram



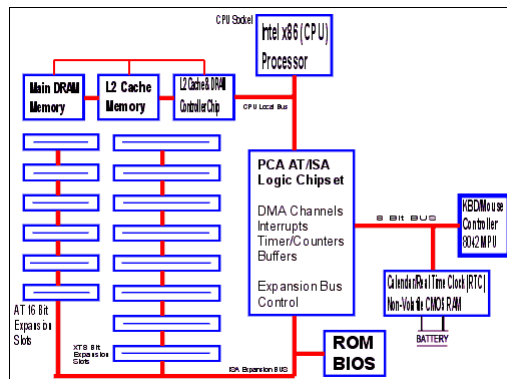
A typical system used four expansion slots

1. Floppy Disk Controller
2. Hard Disk Drive controller
3. The Display adapter
4. Combined Serial and Parallel Port Adapter



The PC AT ISA block diagram

- 8 slots with two usually used
 1. EGA or VGA display controller adapter
 2. Multi I/O Port adapter with
 - 2 serial ports
 - a parallel port
 - floppy disk drive interface
 - IDE interface for hard disk drives
 - a Game Port



MCA BUS & EISA BUS

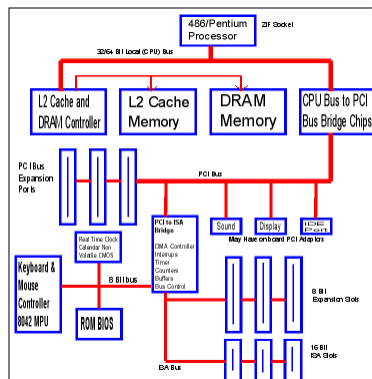
- Short for **Micro Channel Architecture**, MCA was introduced by IBM in 1987, The MCA bus offered several additional features over the ISA such as a 32-bit bus.
- *The MCA BUS never became widely used and has since been faded out of the desktop computers.*
- Short for **Extended Industry Standard Architecture**, EISA was announced September of 1988. EISA is a computer bus designed by 9 competitors to compete with IBM's MCA BUS.
- The EISA Bus provided 32-bit slots at an 8.33 MHz cycle rate for the use with 386DX, or higher processors.
- *EISA bus never became widely used and is no longer found in computers today.*

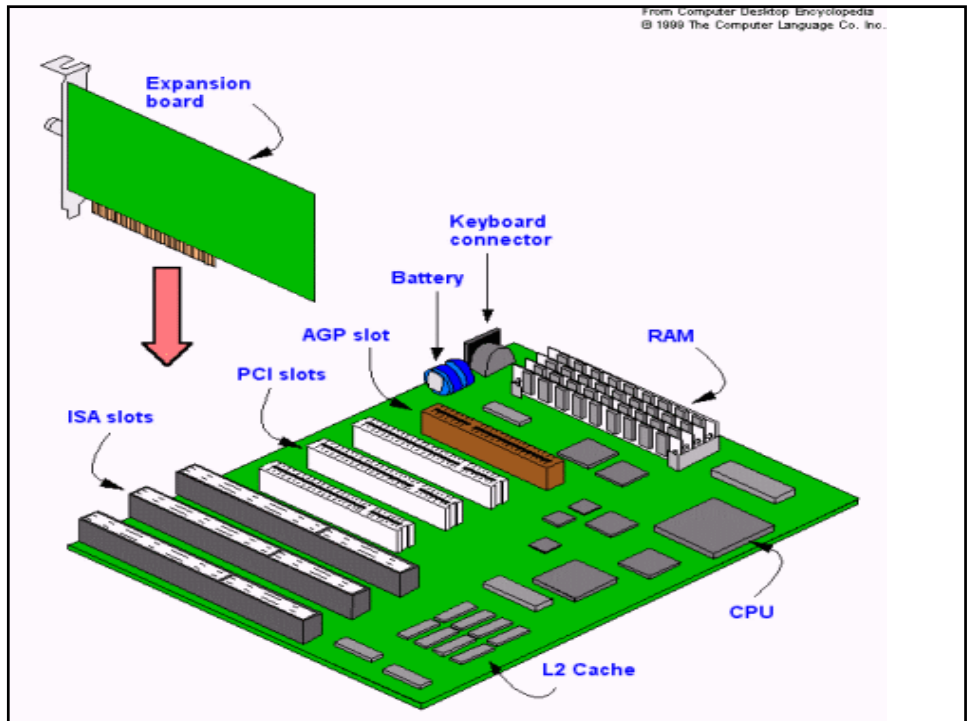
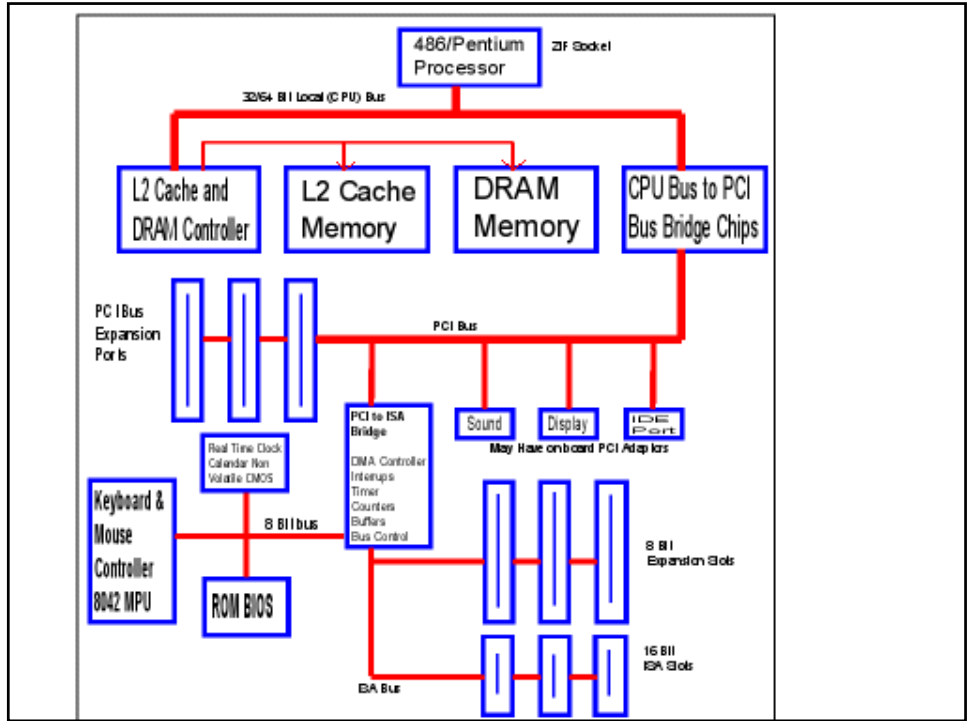
PCI BUS

- Introduced by Intel in 1992, PCI is short for **Peripheral Component Interconnect** and is a 32-bit computer bus that is also available as a 64-bit bus today. The PCI bus is the most commonly used and found bus in computers today.
- **Mini PCI** is a new standard developed by leading notebook manufacturers. This technology could allow manufacturers to lower their price as the motherboards would be simpler to design.
- **PCI-X** is a high performance bus that is designed to meet the increased I/O demands of technologies such as Fiber Channel, Gigabit Ethernet and Ultra3 SCSI. PCI-X capabilities include:
 - Up to 133 MHz bus speed
 - 64-Bit bandwidth
 - 1GB/sec throughput

PCI ISA Bus Block diagram

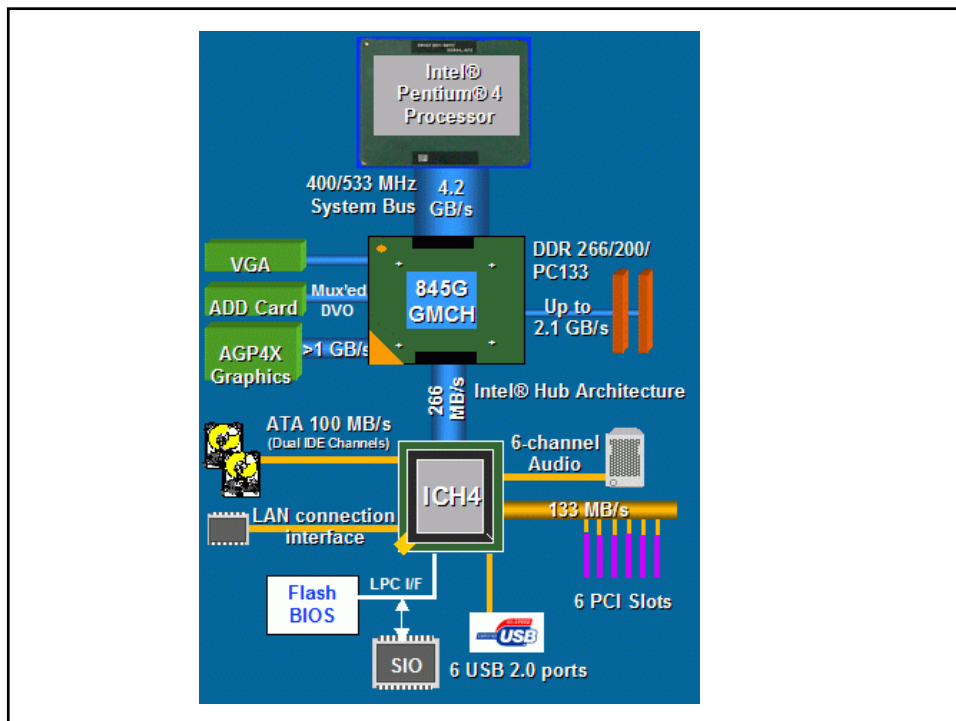
- One of the PCI slots is placed close to one ISA slot and share the (but not at the same time) a back-plate. Some motherboards only offer two ISA slots and as many as five PCI slots.

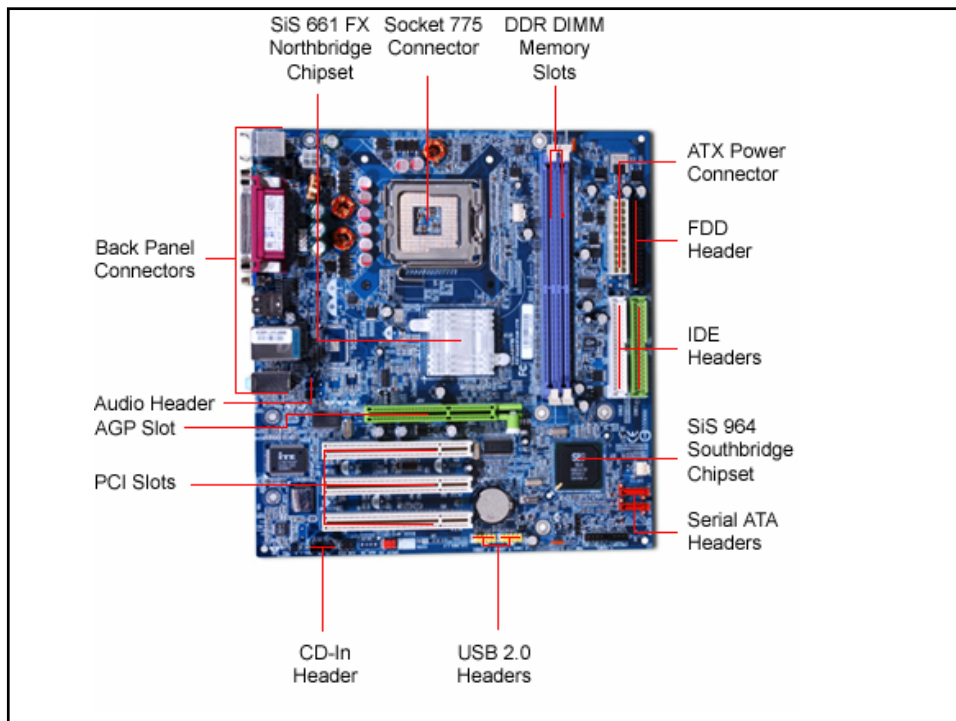
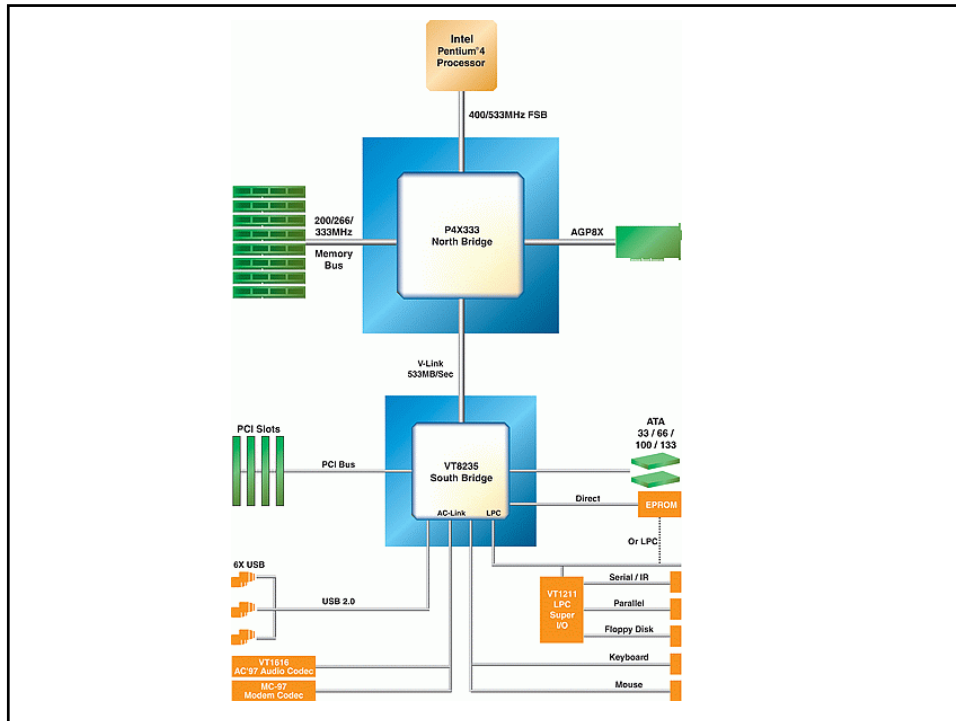


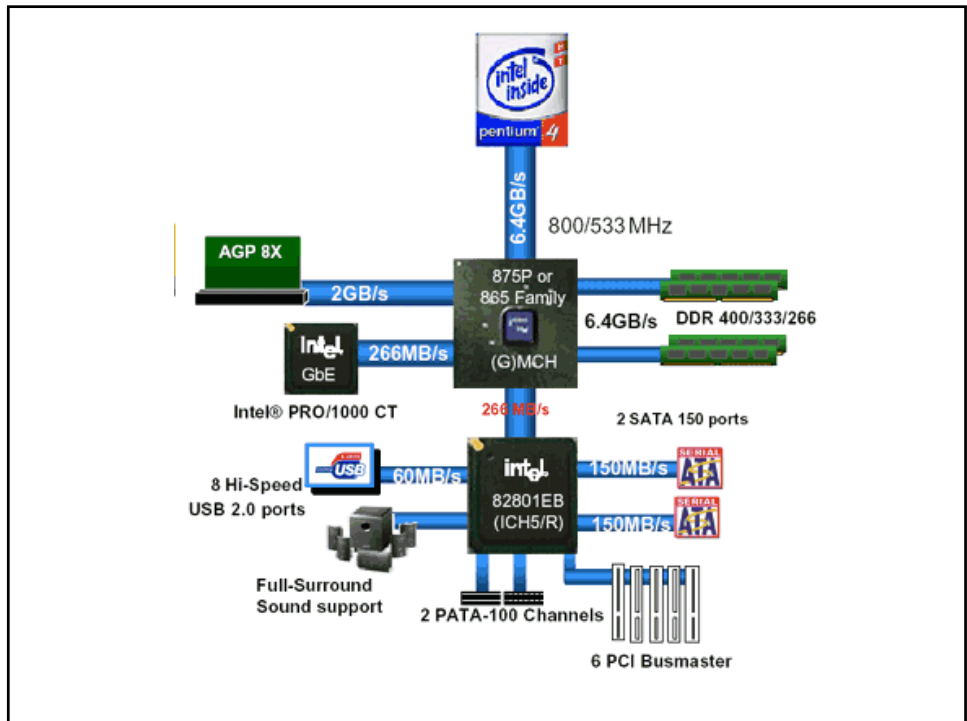
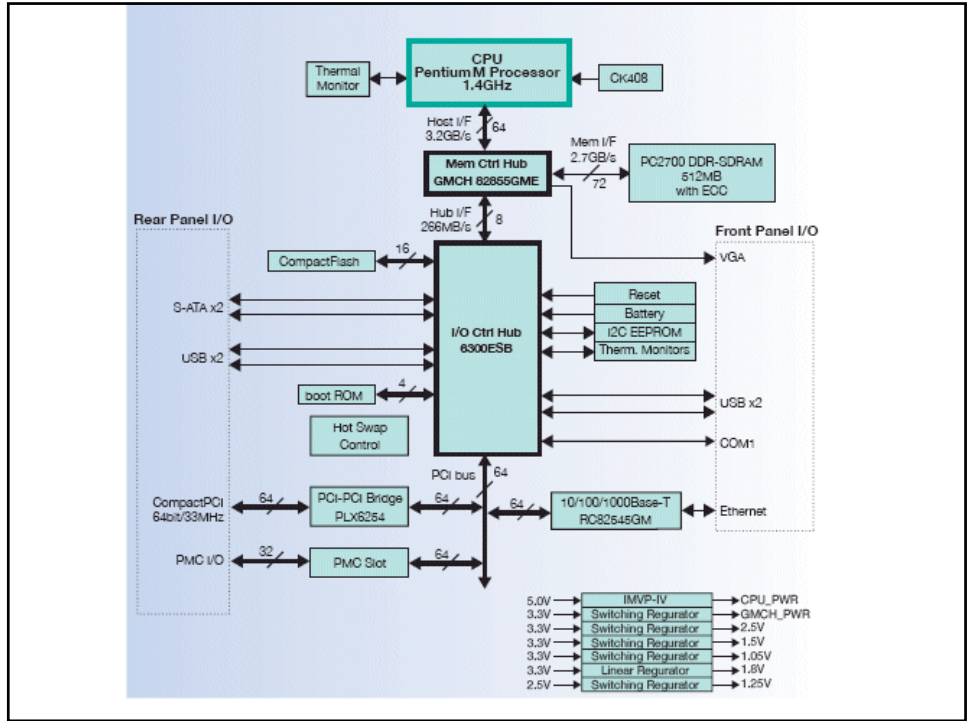


AGP

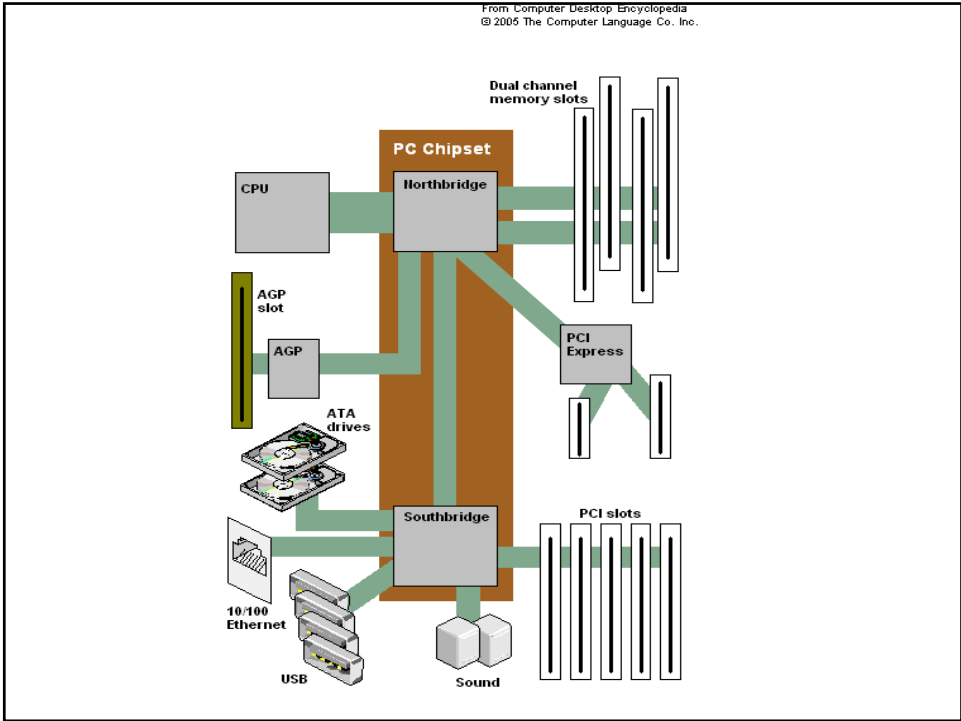
- Introduced by Intel in 1997, AGP or **Advanced Graphic Port** is a 32-bit bus designed for the high demands of 3-D graphics.
- AGP has a direct line to the computers memory which allows 3-D elements to be stored in the system memory instead of the video memory.
- For AGP to work in a computer must have the AGP slot which comes with most Pentium II and Pentium III machines.
- The computer also needs to be running Windows 95 OSR2.1, Windows 98, Windows 98 SE, Windows 2000, Windows ME or higher.





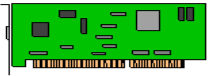
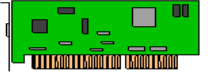
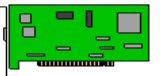
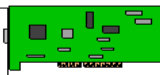
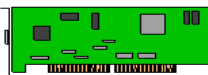
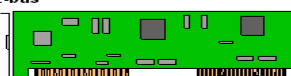


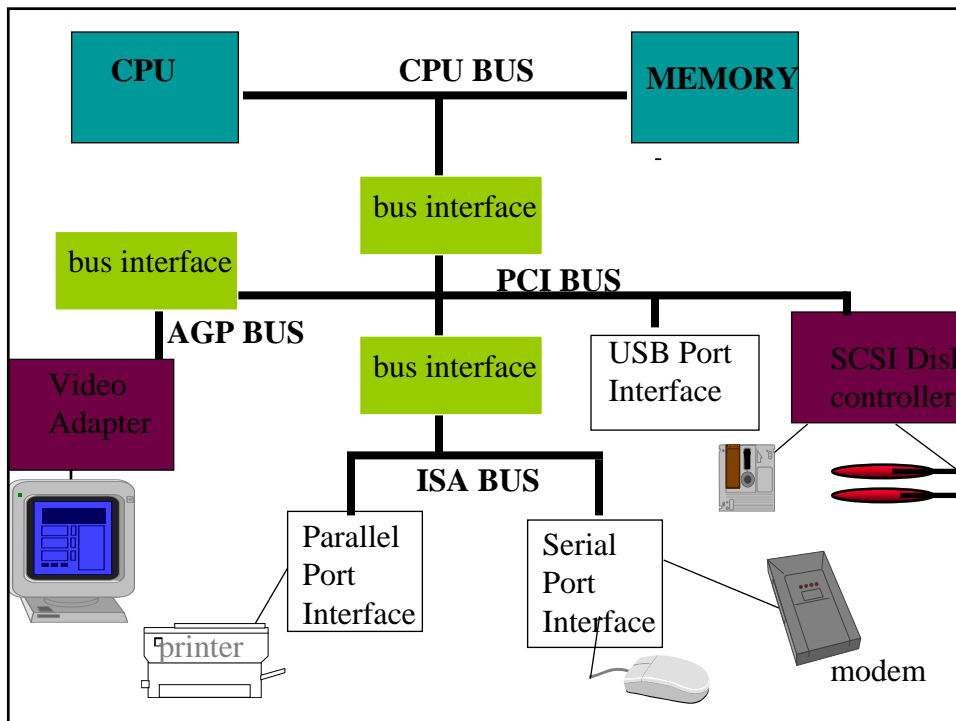
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Various Buses

BUS	Width (bits)	Bus Speed (MHz)	Bus Bandwidth (MBytes/sec)
8-bit ISA	8	8.3	7.9
16-bit ISA	16	8.3	15.9
EISA	32	8.3	31.8
VLB	32	33	127.2
PCI	32	33	127.2
64-bit PCI 2.1	64	66	508.6
AGP	32	66	254.3
AGP (x2 mode)	32	66x2	508.6
AGP (x4 mode)	32	66x4	1,017.3

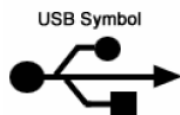
PC BUSES	Bandwidth	
	Bits	Speed
ISA 	8 16	8-10 MHz
EISA 	32	8-10 MHz
PCI 	32 64	33MHz
AGP 	32	66-533 MHz
Micro Channel 	32	5-20 MHz
VL-bus 	32	40MHz



Universal Serial Bus (USB)

- **Universal Serial Bus** is a new external bus developed by Intel, Compaq, DEC, IBM, Microsoft, NEC and Northern Telecom and released to the public in 1996 with the Intel 430HX Triton II Mother Board.
- USB has the capability of transferring 12 Mbps, supporting up to 127 devices and only utilizing one IRQ.
- For PC computers to take advantage of USB the user must be running Windows 95 OSR2, Windows 98 or Windows 2000. Linux users also have the capability of running USB with the proper support drivers installed.

Universal Serial Bus (USB)



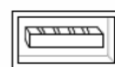
Type A USB connector



Type B USB connector



Type A Slot



Type B Slot



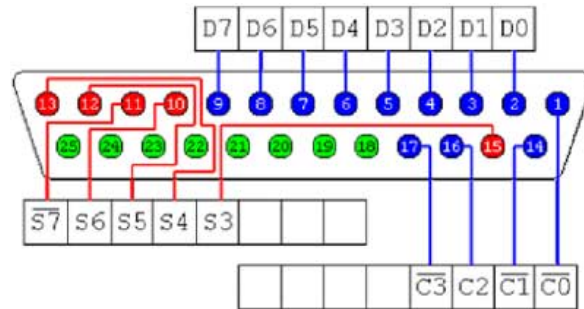
USB VERSIONS

- **USB 1.0** - The original release of USB supports 127 devices transferring 12 Mbps.
- **USB 1.1** - Also known as full-speed USB, USB 1.1 is similar to the original release of USB however minor modifications for the hardware and the specifications. This version of USB still only supports a rate of 12 Mbps.
- **USB 2.0** - USB 2.0 also known as hi-speed USB was developed by Compaq, Hewlett Packard, Intel, Lucent, Microsoft, NEC and Philips and was introduced in 2001. Hi-speed USB is capable of supporting a transfer rate of up to 480 Mbps and is backwards compatible meaning it is capable of supporting USB 1.0 and 1.1 devices and cables.

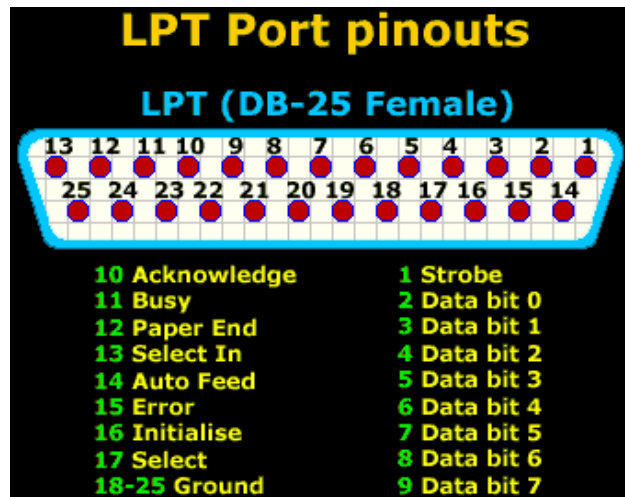
PARALLEL PORT

- DB25 connector with an 8 bit data bus (Pin 2-7) which is more popularly used for computer printers while is still used for other devices.
- **TYPES OF PARALLEL PORTS**
 - **Unidirectional** - 4-bit standard port which by factory default did not have the capability of transferring data both ways.
 - **Bi-directional** - 8-bit standard port which was released with the introduction of the PS/2 port in 1987 by IBM and are still found in computers today. The Bi-directional port is cable of sending 8-bits input and output. Today, on multifunction printers, this port can be referred to as a bi-directional, Centronics, PS/2 type or standard port.
 - **EPP** - The Enhanced Parallel Port (EPP) was developed in 1991 by Intel, Xircom and Zenith Data Systems and operates close to ISA bus speed and can achieve transfer rates up to 1 to

PARALLEL PORT



PARALLEL PORT

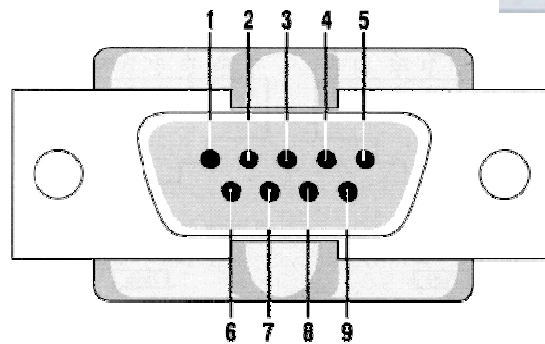


Serial Port



- The serial port is an Asynchronous port which transmits one bit of data at a time, usually connecting to the UART Chip.
- Serial Ports are commonly found on the majority of PC Compatible computers.
- Usually referred to as a DB9 or DB25 connection, both of which adhere to the RS-232c interface standard

Serial Port



Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		