X86 BASED PERSONAL COMPUTER

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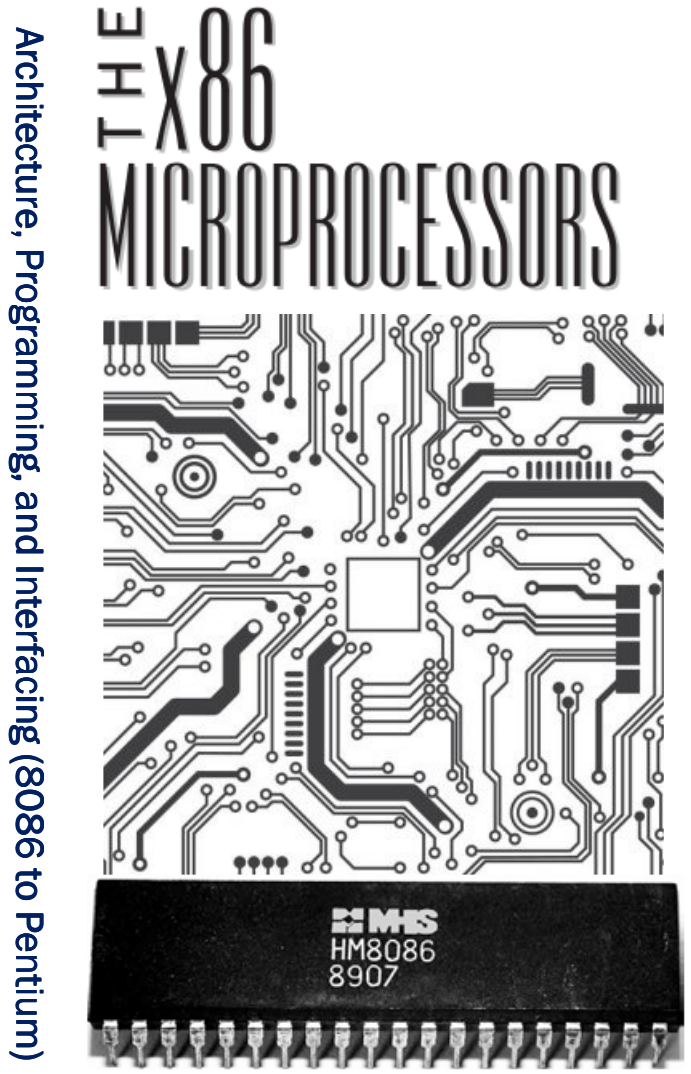
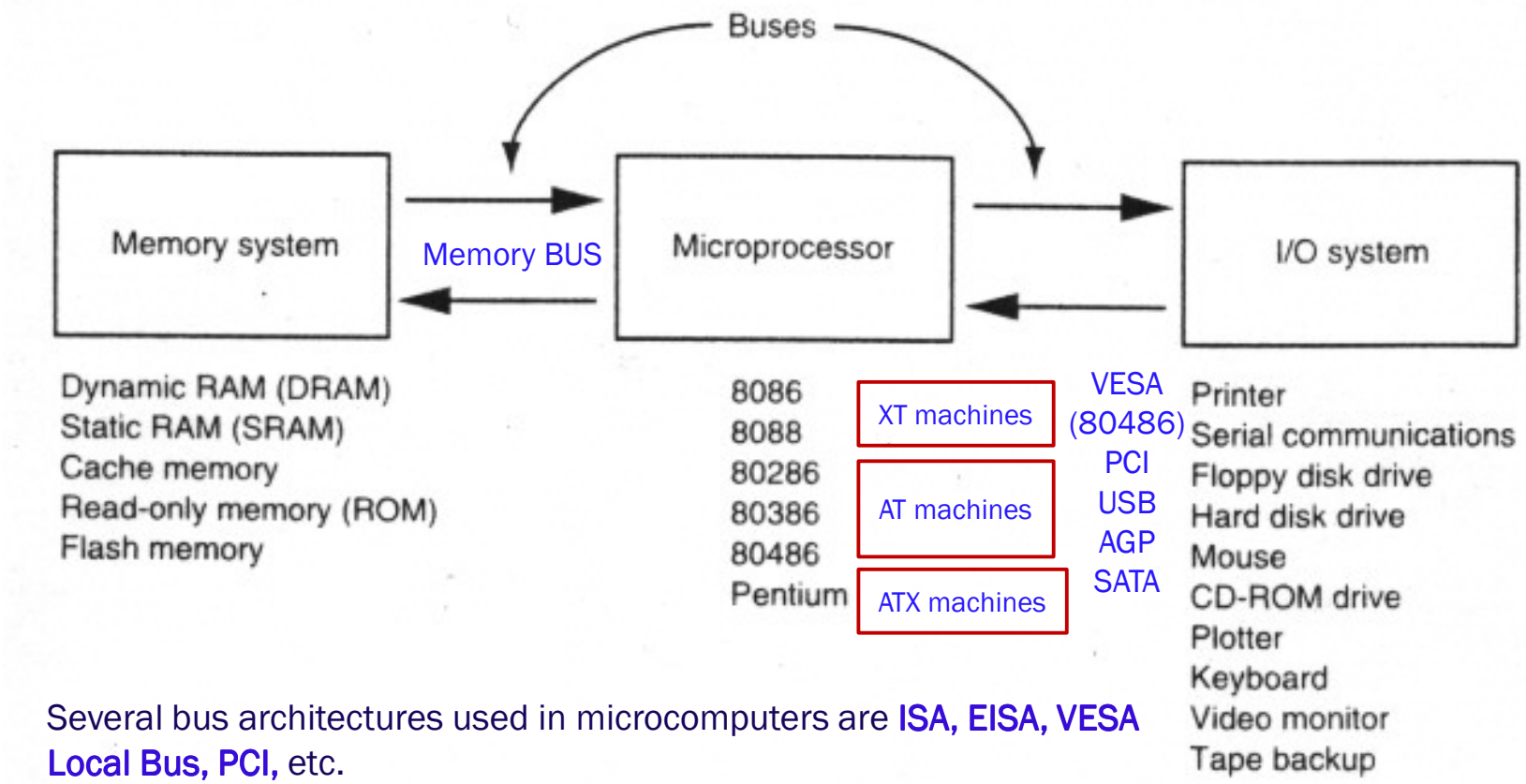
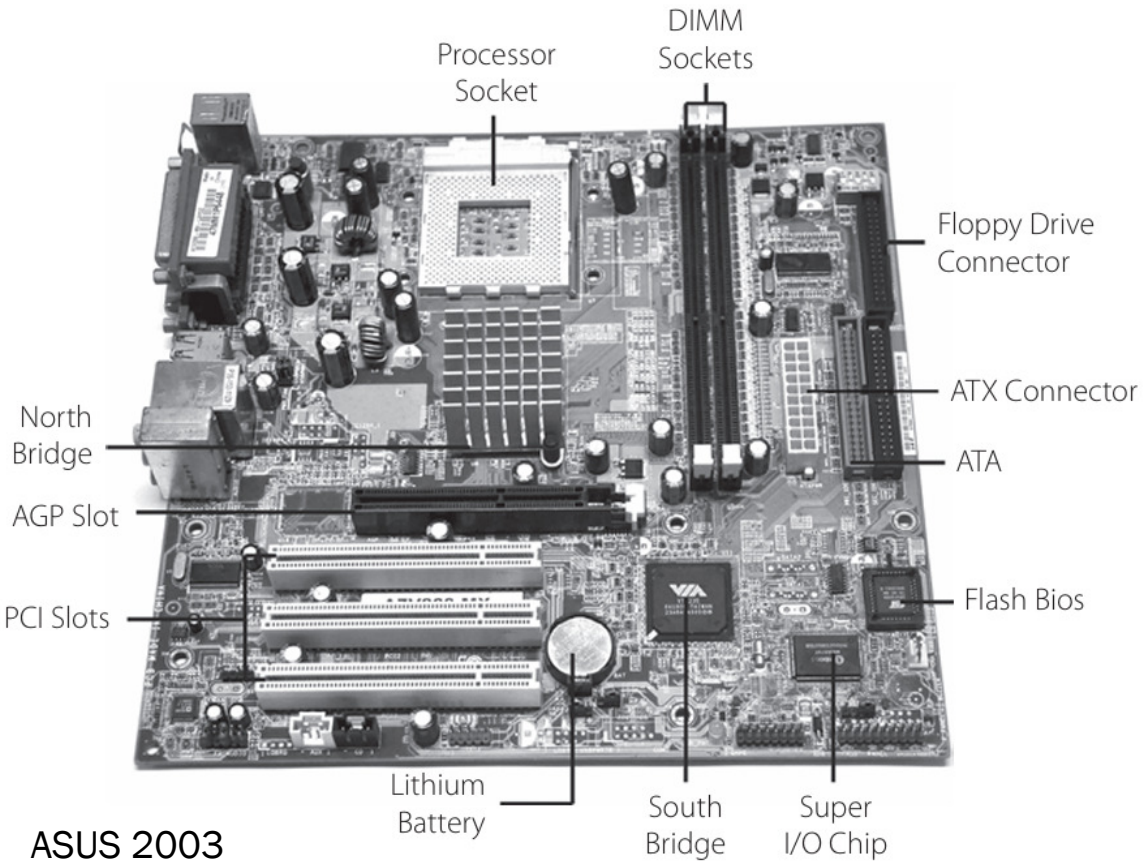


µP BASED PERSONAL COMPUTER SYSTEM



Several bus architectures used in microcomputers are **ISA, EISA, VESA Local Bus, PCI,** etc.

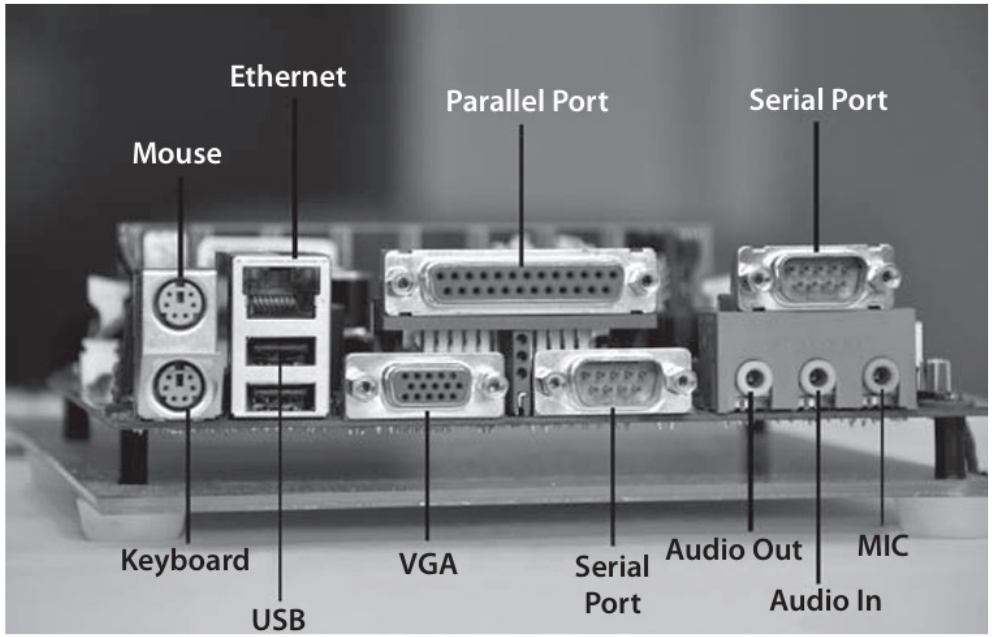
THE MOTHERBOARD



ASUS 2003

- The most important part of the PC – the motherboard, the system board, or simply called the 'board'.
- The first and foremost item on this board is the CPU i.e., the processor. Besides holding the CPU, it houses the RAM, ROM, other hardware, and all the peripherals are plugged into it. It also contains all the control circuitry essential for the working of the system.
- The motherboard has slots or sockets for connecting various peripherals or support systems/ hardware.
- There is an **Accelerated Graphics Port**, which is used exclusively for video cards; **an ATA adapter** which provides the interfaces for the hard disk drives; slots for RAM cards; and Peripheral Component Interconnect (PCI) connectors, which provide electronic connections for **sound cards, network cards and so on**.

THE MOTHERBOARD



- In addition to these **sockets, connectors, and ports**, the motherboard contains several other contacts.
- These include:
  - **Jumpers**, which are used on some motherboards to configure voltage and various operating speeds.
  - Some **pins are used to connect the reset button, like the LED for hard disk activity, and the built-in speaker**.

pins 1-2 jumped for Normal mode, 2-3 for config mode, and when open (no jumper), the computer is in recovery mode.

Jumpers allow the computer to close an electrical circuit, allowing the electricity to flow on a circuit board and perform a function.

Before plug and play(PnP), jumpers were used to adjust device resources, such as changing what IRQ (Interrupt ReQuest) the device uses.

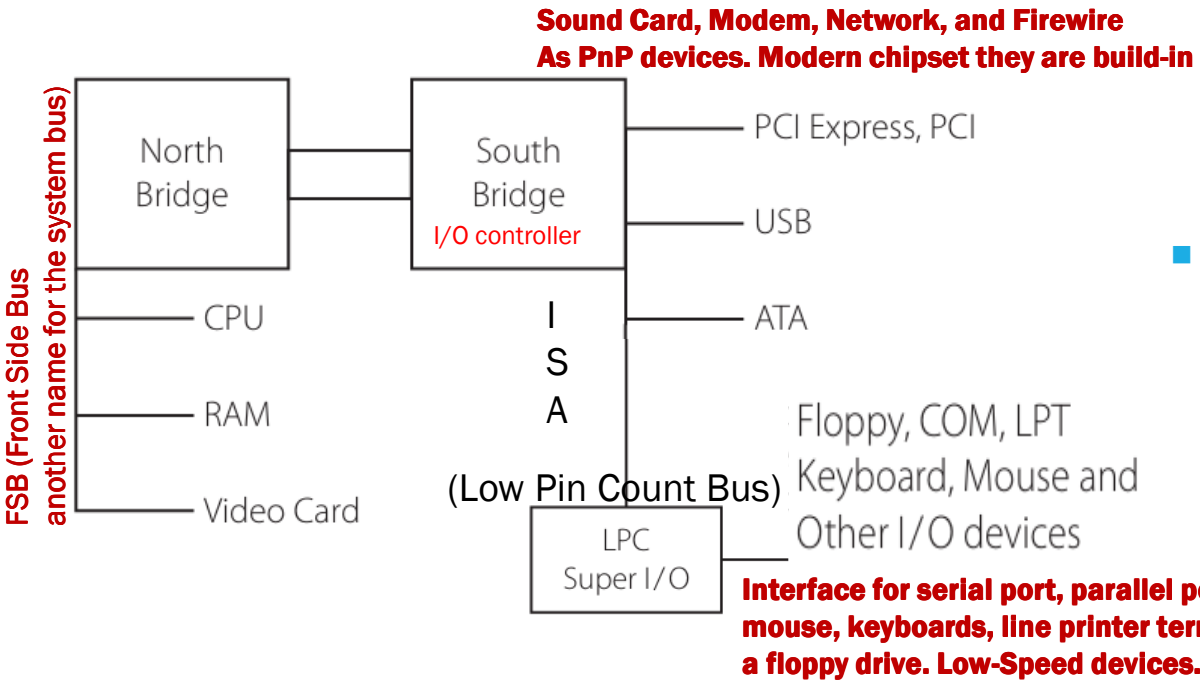
CHIPSET

- A chipset is a group of ICs (controllers) working together to control the flow of data from/to and within the motherboard.

- The processor needs various chips for buffering, de-multiplexing, generating control signals, interfacing and handling parallel data, serial data, the bus controller, clock generator, system timer, interrupt controllers, DMA controllers memory controller, and so on.

A chipset consists of two major microchips.

NORTH BRIDGE AND SOUTH BRIDGE

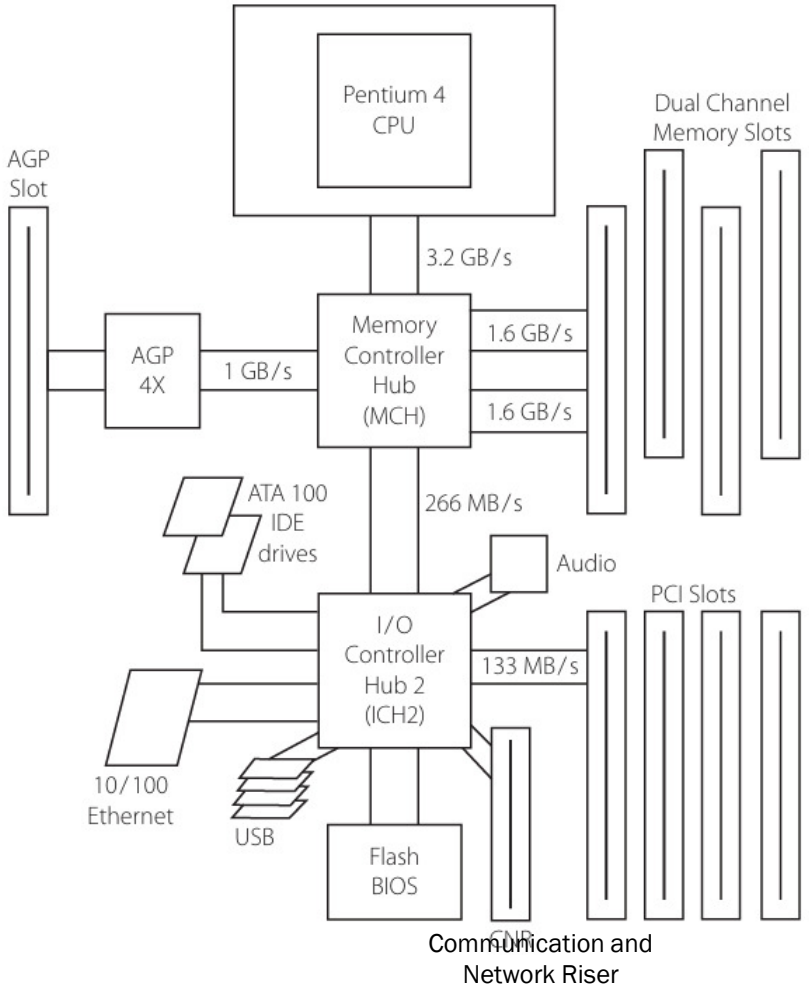


- On the motherboard, the North Bridge is situated close to the processor and is covered by a heat sink to take care of the large amount of heat it generates.
- North Bridge handles most of the very important tasks such as the connection between the CPU and main memory. It also handles data for the AGP (Accelerated Graphics Port)

- The South Bridge handles data from the PCI, USB, ATA, and ISA (now obsolete) buses.
- The South Bridge is a controller for I/O which can afford to be slower than the main system bus. In this setup, some ports connect the I/O to the motherboard by adapters which are plugged into the slots (sockets) on the motherboard.

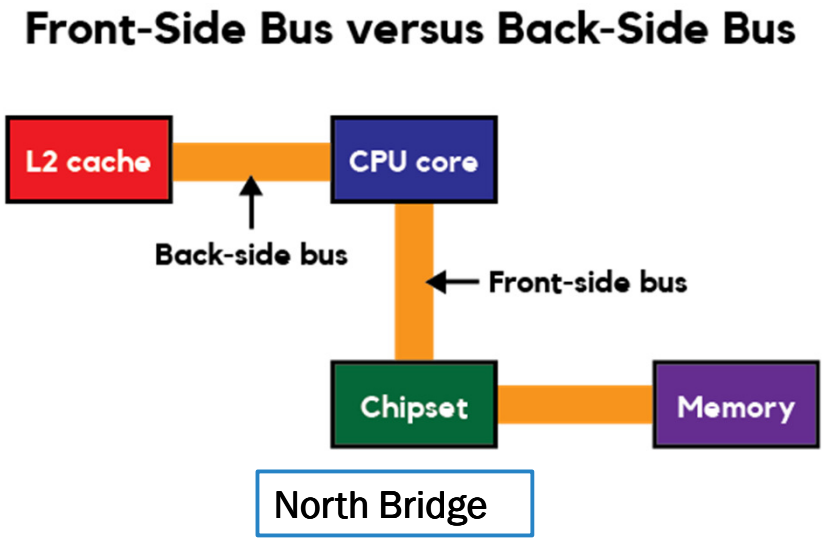
INTEL HUB ARCHITECTURE INTEL'S 800 SERIES CHIPSETS,

- The Intel Hub Architecture (IHA) has replaced the Northbridge/Southbridge chipset.
- The IHA chipset also has two parts, the Graphics and Memory Controller Hub (GMCH) and the I/O Controller Hub (ICH).
- The GMCH interfaces between the high-speed processor bus and the hub interface and AGP bus, whereas the ICH interfaces between the hub interface and the ATA (IDE) ports, the SATA ports, and the PCI bus. The ICH also includes a new low-pin-count (LPC) bus, consisting basically of a version of PCI designed primarily to support the motherboard ROM BIOS and Super I/O chips.



BUS-SIGNAL TRANSFER CARRIER

- Processor Bus: Front-Side Bus (FSB)/Back-Side Bus(BSB),
  - The highest-speed bus in the system and is at the core of the chipset and motherboard.
  - This bus is used primarily by the processor to pass information to and from the cache (BSB) or main memory (FSB) and the North Bridge of the chipset (FSB).
  - The processor bus in a modern system runs at 800MHz or higher and is normally 64 bits wide.



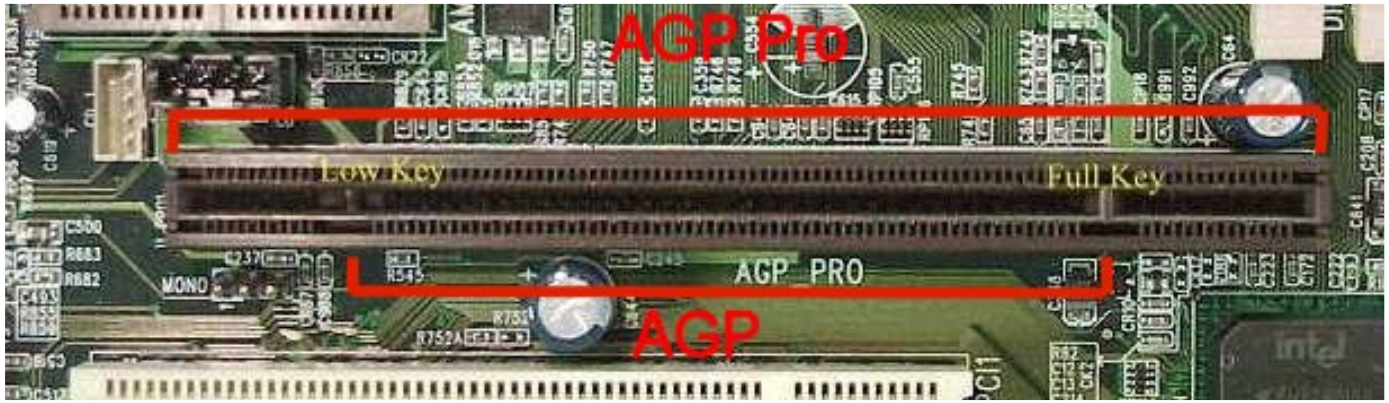
AGP- ACCELERATED (ADVANCED) GRAPHICS PORT

- Special video cards have been designed with extra onboard RAM, a specialized graphics processor, and other features.
  - However, these cards will be useless unless they have high-speed CPU and system RAM access.
  - This need made Intel design a special port for it, placed close to the processor connected to the chipset's North Bridge or Memory Controller Hub, manifested as a single AGP slot in systems that support it.

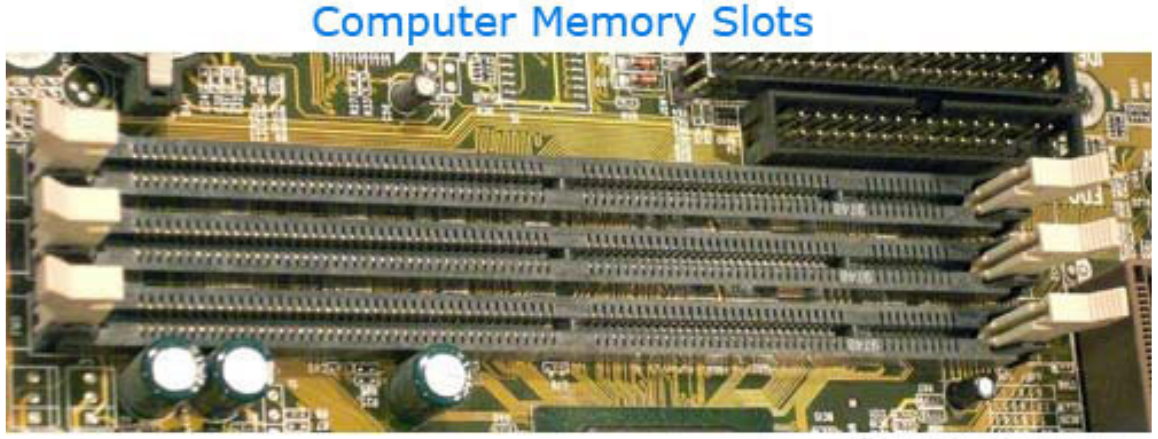
AGP is a high-speed bus with a clock frequency of 66.66 MHz. In the basic mode, called AGP 1x, there is only one channel of transfer of 32 bits (4 bytes) making its bandwidth to be 66.66 × 4 = 266 MBps.

There are AGP cards numbered 2x, 4x, and 8x - 2, 4, and 8 are the number of data transfer channels possible, where the data rate for 8x should be 266 × 8 MBps. In Intel Hub Architecture (IHA), an AGP slot is seen which supports an x4 transfer rate. Note that, in motherboards made after 2006 the newer and faster PCI Express (PCIe) graphics interface has more or less replaced AGP.

AGP SLOT



MEMORY SLOT



EXPANSION BUSES

The word 'expansion bus' means the I/O buses through which I/O devices are connected to the South Bridge or ICH.

- ISA (Industry Standards Architecture) First Generation I/O bus specifications

ISA standard Peripheral Interface Bus 80286	16-bit devices 8MHz-16MB/s	Function at 8MHz reduces the performance of disk and video peripherals.
EISA (Extended ISA) 80386-80486 (compatible with earlier/Microchannel Architecture-MCA)	32 bit devices 8MHz-33MB/s	Intel created the MCA (Microchannel Architecture) which was a 32-bit bus compatible for 16-bit applications.
VESA (Video Electronics Standards Association) also called VL-Bus interfaces disk and video to µp	32 bit µp(latest 64bits) competes with PCI	

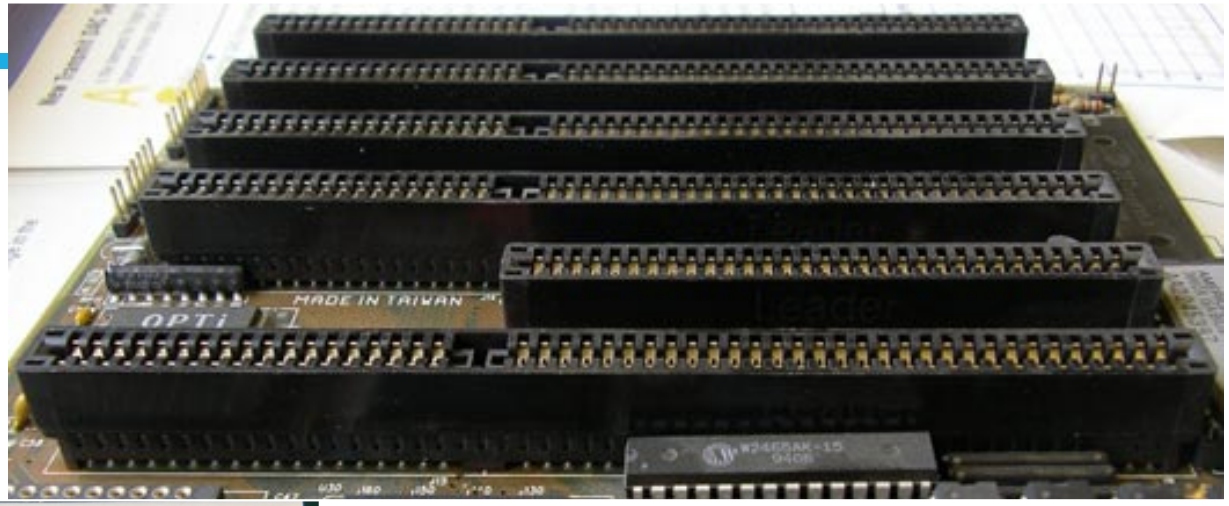
EXPANSION BUSES

Second Generation I/O bus specifications

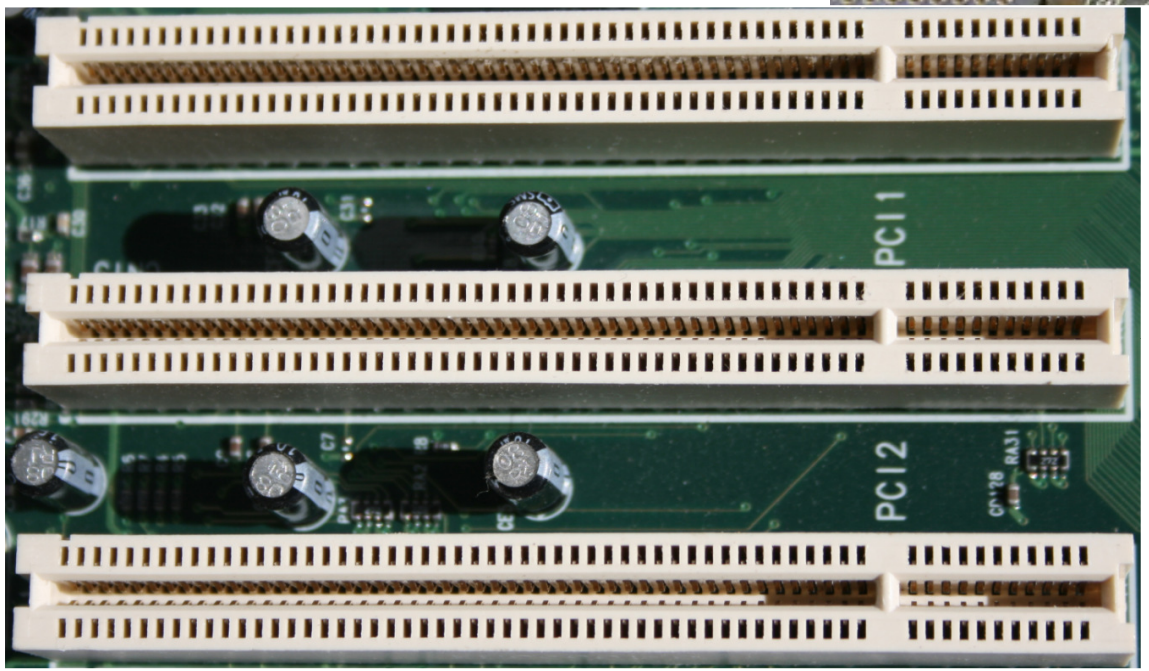
- PCI (Peripheral Component Interconnect)

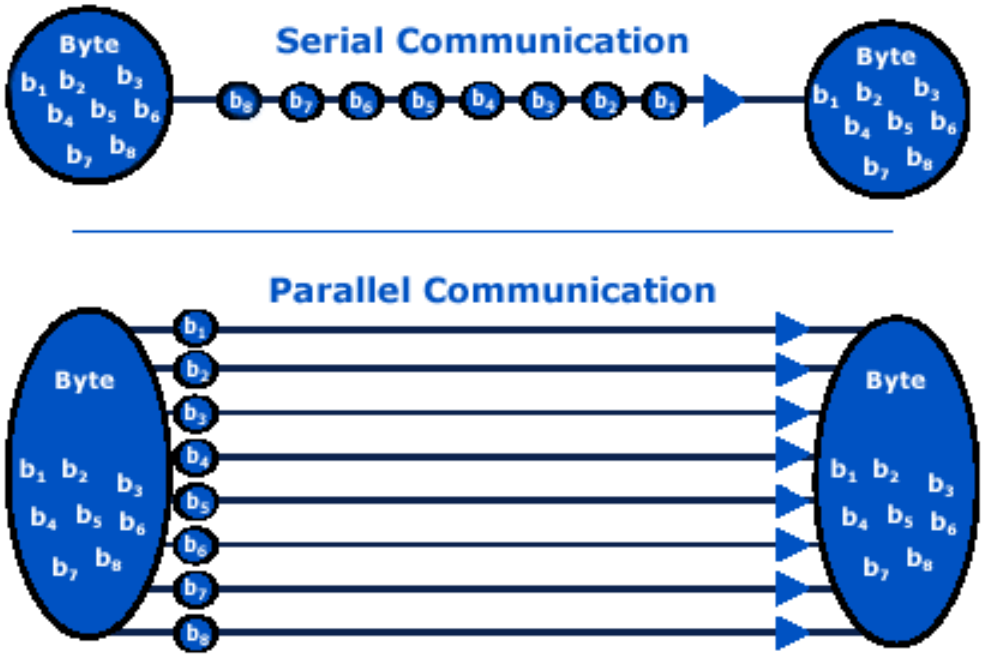
PCI-Peripheral Component Interconnect BUS	32/64 bits Bus Speed 33MHz
Information typically is transferred through the PCI bus at 33MHz and 32 bits at a time. The bandwidth is 133MBps, as the following formula shows: 33.33 MHz × 4 bytes (32 bits) = 133 MBps	
Important and distinct features of the PCI bus: a) Supports 3.3 V and 5 V signaling. b) Processor-independent. c) Plug and Play. d) Allows 'bus mastering', any peripheral to take charge of the bus – this is most relevant for DMA between peripherals and main memory.	

ISA SLOTS



PCI SLOTS





Skew and electromagnetic interference.

- All buses we have talked about **were parallel buses** – data of 8 bits, 16 bits, 32 bits, or 64 bits moved in parallel, that made **large # of bus connector pins**.
- Over the years, the **trend of data transfer has moved from parallel to serial** because of the **problems associated with parallel data transfer, the most significant being what is called 'skew'-** when all the bit information **does not arrive at the destination at the same time.**
- Moreover, with more data lines, **the problem of cross-talk and electromagnetic interference**.

EXPANSION BUSES

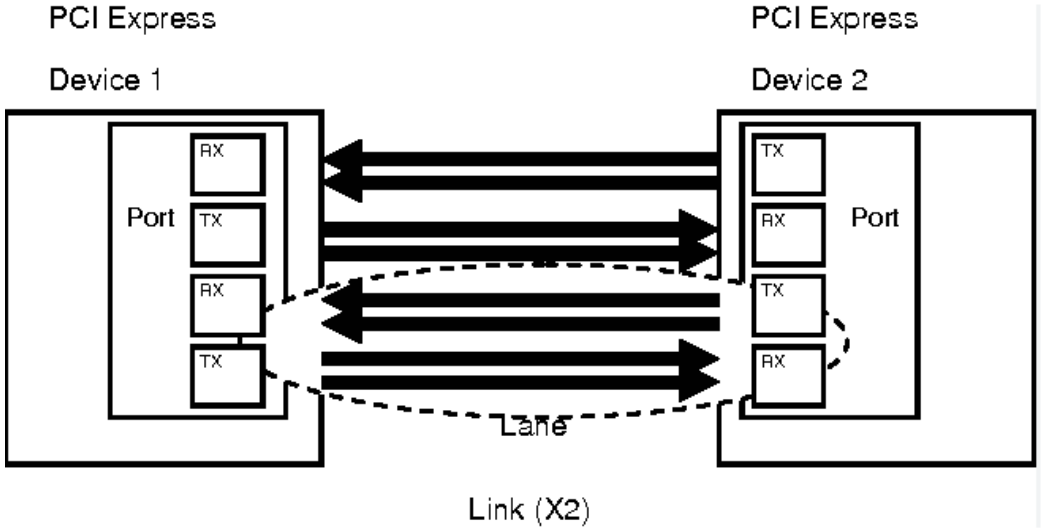
Third Generation I/O bus specifications

- PCIe (PCI-Express)

In PCI-Express, data is sent full duplex (two separate one-way paths) over two pairs of differentially signaled wires called a lane.

A multiplication factor of 1 to 2, 4, 8, 16, or 32 is possible, where these numbers mean the number of such lanes (channels). With 8 channels, the bandwidth is 250 × 8 = 2000 MBps one way.

PCIe 16x has a data rate of 4000 MBps. Compare this with PCI which has a bandwidth of 133 MBps (one way) and needs many more pins by being a parallel port.



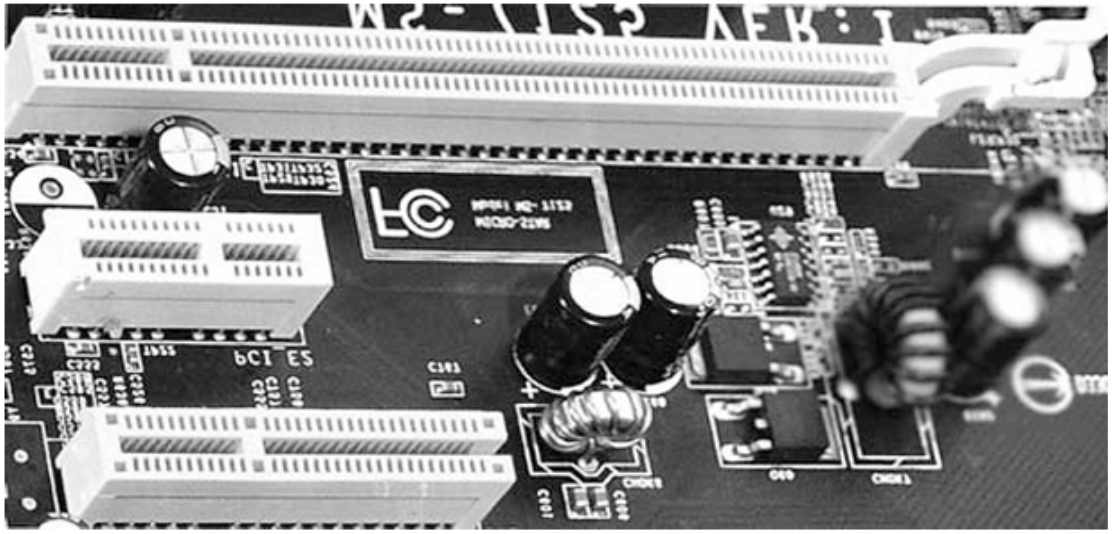
Each lane caters to 250 MBps throughput in each direction.

- PCIe (PCI-Express)

Why are they of different lengths?

Obviously, because of creating a different number of lanes.

16x connector for an advanced graphics card requiring high-speed transfer and thus more lanes.



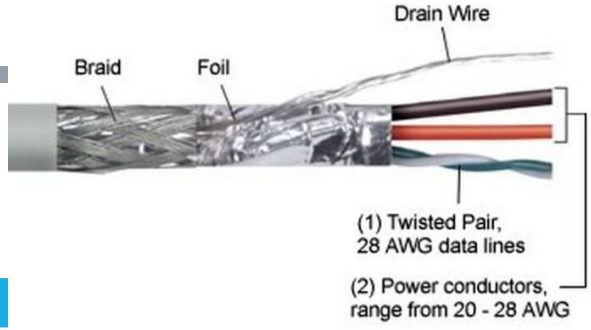
Important features:

Hot-pluggable and Hot-swappable.

- Hot-swapping describes changing components without significant interruption to the system, while hot-plugging describes changing or adding components that interact with the operating system.
- One does not need to switch off the computer while doing this – this is similar to the USB port, for example.

EXPANSION BUSES

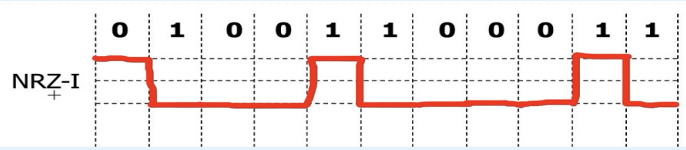
Third Generation I/O bus specifications



USB (Universal Serial Bus)

USB-Universal Serial Bus –connects keyboard, mouse, modem and sound cards with µp	USB1-10Mbps, USB2-480Mbps USB3-4.8Gbps (fiber optics)

- A USB system consists of a host controller and multiple devices connected in a tree-like fashion using special hub devices. Hubs may be cascaded, up to 5 levels. Up to 127 devices may be connected to a single host controller.
- It uses 4 shielded wires of which two are power (+ 5 V and GND). The remaining two are twisted pair differential data signals.
- It uses an NRZI (Non-Return to Zero Invert) encoding scheme synchronize the host and receiver clocks.

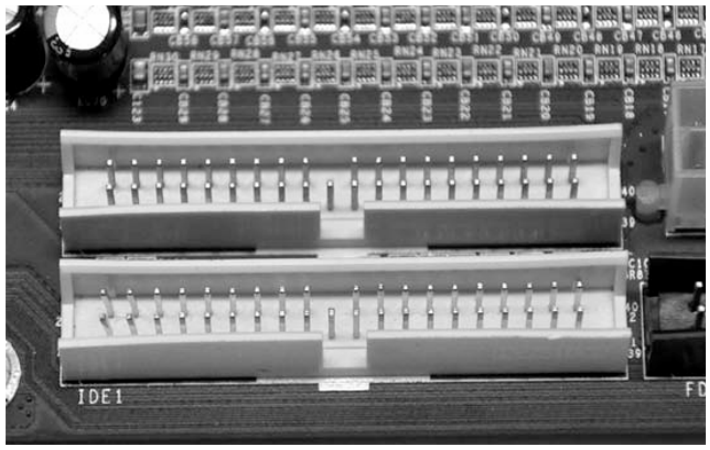


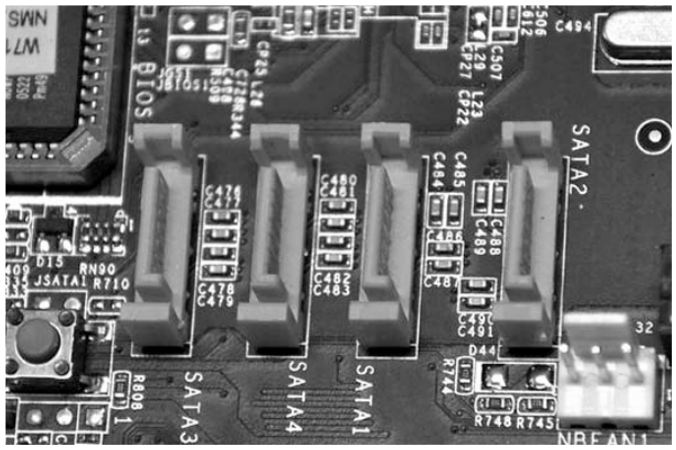
- USB supports plug-and-play with dynamically loadable and unloadable drivers.
- The USB connector provides a single 5-volt wire from which connected USB devices may power them. A given segment of the bus is specified to deliver up to 500 mA. Devices that need more than 500 mA current can use an external power source – thus we see printers and certain external hard disks with external power supply, while USB-based mice and keyboards do not need any extra power.

EXPANSION BUSES

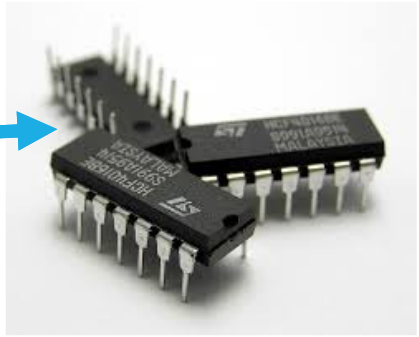
- ATA (IDE or Integrated Drive Electronics)/SATA

This type of interface implies that the controllers of the hard disk drive have been integrated into the drive itself, instead of having it as a separate add-on card plugged on to the ISA bus. Serial ATA interface (SATA)-with HD to PC	SATA-2 300MBs/second

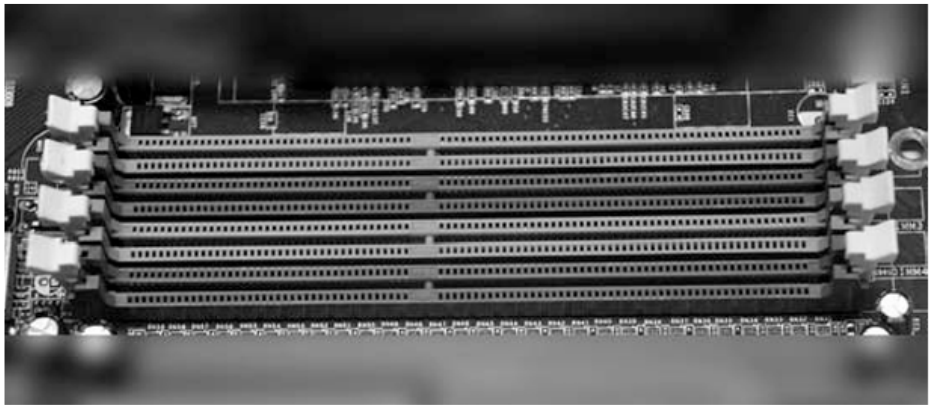




SIMM AND DIMM



- RAM in the early days was manufactured as a DIP (Dual In-Line Package) chip.
- Nowadays, memory cards with RAM chips embedded in them, and can be plugged into sockets.
- SIMM (Single In-Line Memory Module): SIMM modules with 30 connectors are 8-bit memories and SIMM modules with 72 connectors are memories able to store 32 bits of data.
- DIMM (Dual In-Line Memory Module) **with 64-bit memory**.
  - two SIMMs installed in matched pairs, can be replaced by just one DIMM.

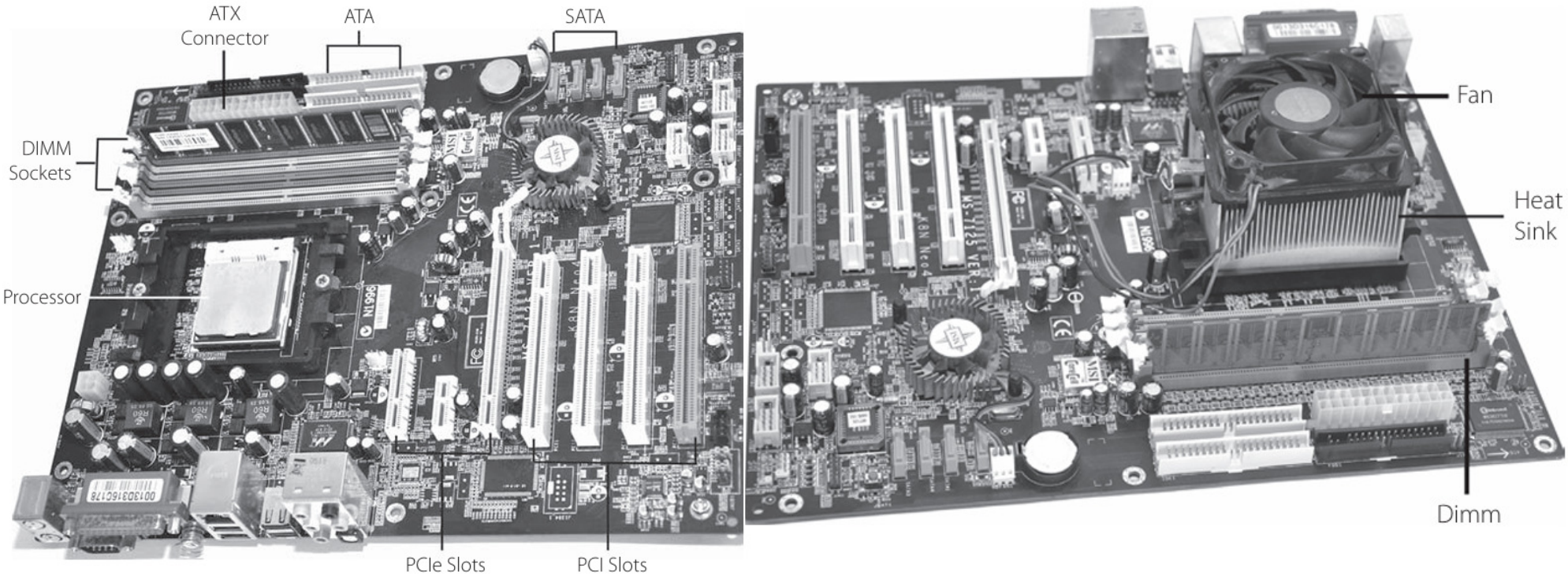


SYSTEM BIOS (BASIC INPUT OUTPUT SYSTEM)

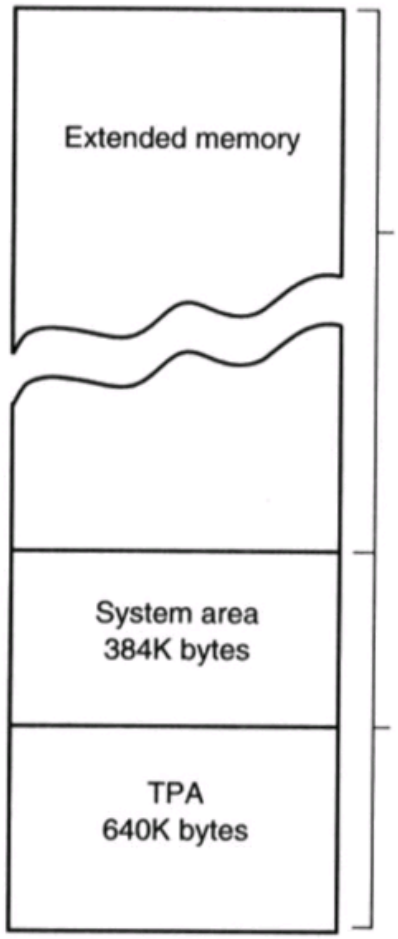
- Last ten(10) years BIOS has been in flash ROM and the advantage is that since flash ROM is re-writable while on the circuit board itself, its content can be changed.
- This makes sense if BIOS upgrades are available. The term 'flashing the BIOS' implies the changing of the contents of the flash ROM and is done to replace the original contents with an upgraded version of the same BIOS, if the user thinks the new version has some useful features for him.

ROM
Programmable read-only memory (PROM)
Erasable Programmable (EPROM)-full erasable-dense
Electrically Erasable (EEPROM) byte writeable-less dense
Flash memory EPROM+EEPROM-dense 1transistor/bit

INTEL MOTHERBOARD



MEMORY MAP OF THE PC



XMS-Extended Memory System

No Extended Memory System 8086, 8088

15M bytes in the 80286 or 80386SX
31M bytes in the 80386SL/SLC
63M bytes in the 80386EX
4,095M bytes in the 80386DX, 80486, and Pentium
64G bytes in the Pentium Pro

64G less 1M for servers
4G less 1M for PC

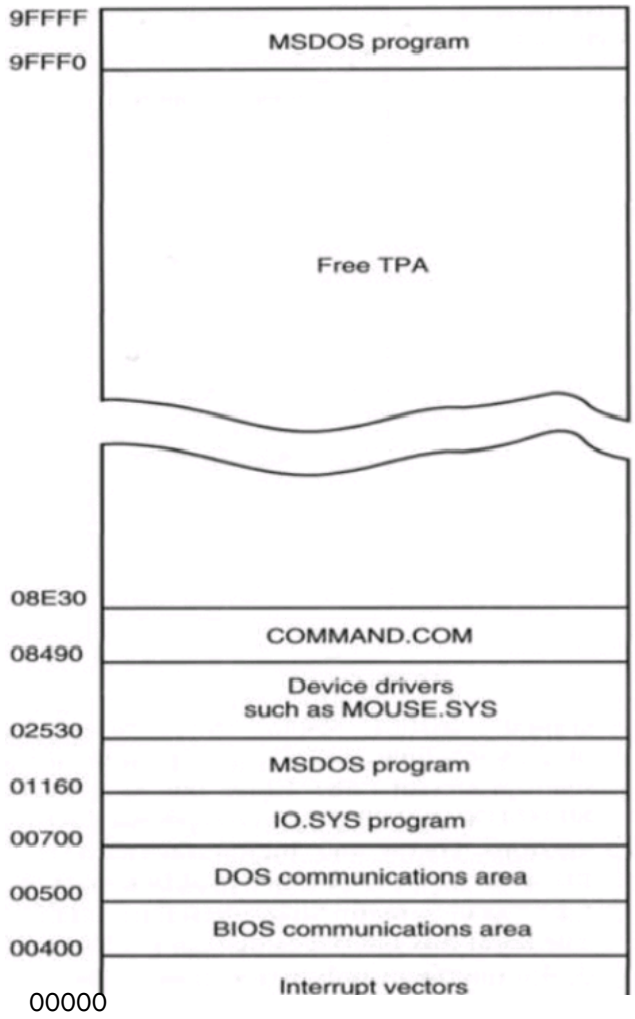
1M bytes of real (conventional) memory

Before 80286:
Real mode provides no support for memory protection, multitasking, or code privilege levels.

After 80286:
Protected mode.

Transient Program Area-**transient** is a property of any element in the system that is temporary.

0X00000-9FFFF: TRANSIENT PROGRAM AREA (TPA)



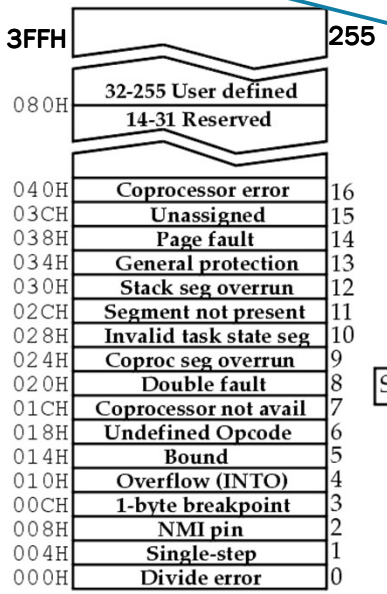
TPA is a DOS Concept

DOS, device drivers, TSR(terminate and stay resident) programs (UTILITY), and applications

MSDOS9 version 7.x lefts 628k, Other DOS lefts only 530k for application programs

8086 Instruction INT X

Interrupt vectors: access various features of the DOS BIOS, and applications.



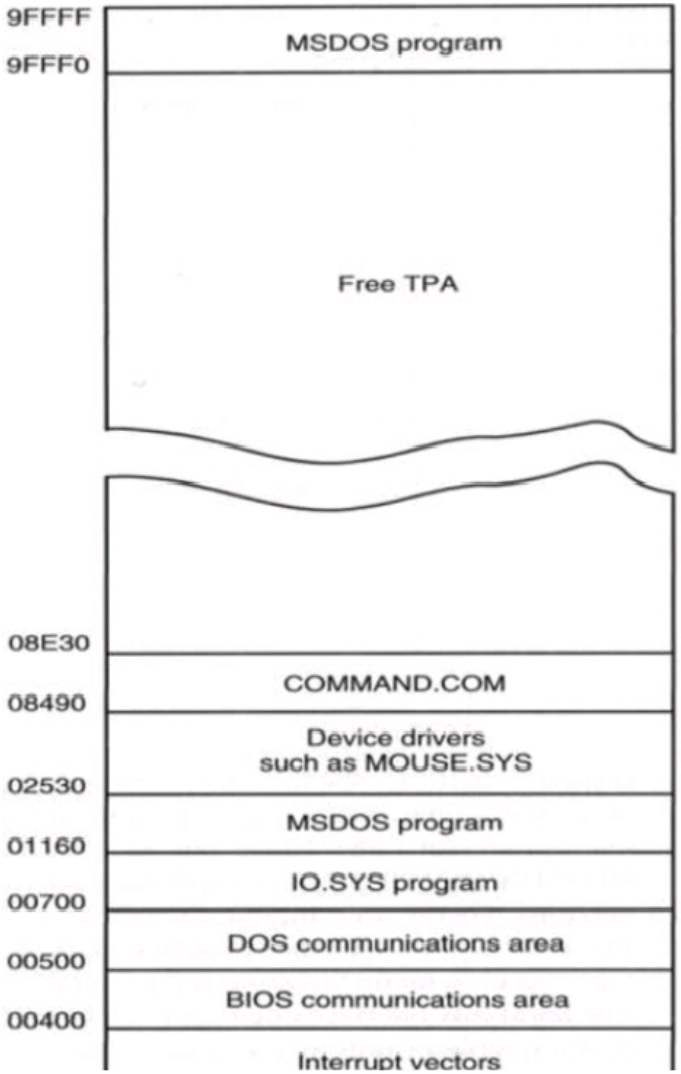
The interrupt vector table is located the first 1024 bytes of memory at addresses 000000H through 0003FFH

There are 256 4-byte entries (segn and offset in real mode).

TSR WHY?

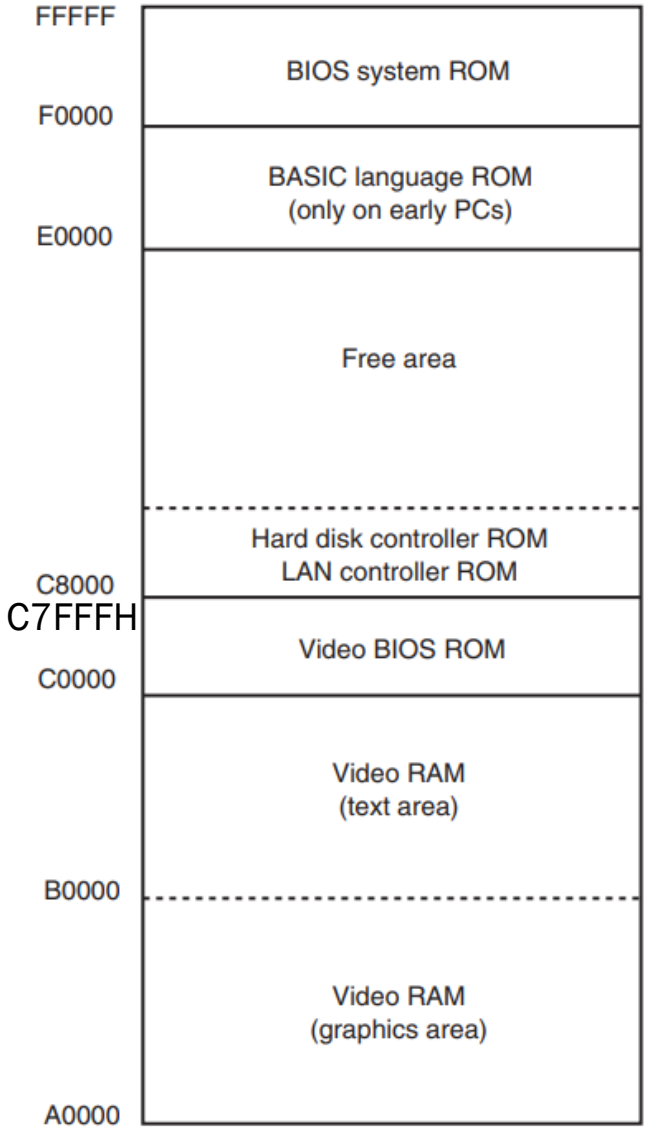
- Normally DOS can run only one program at a time. When a program finishes, it returns control to DOS using the system call `INT 21h/4Ch`.
  - The memory and system resources used are then marked as unused. This makes it impossible to restart parts of the program without having to reload it all.
- However, if a program ends with the system call `INT 27h` or `INT 31h`, the operating system does not reuse a certain specified part of its memory.
  - The original call, `INT 27h`, is called **"terminate but stay resident", hence the name "TSR".** Using this call, a program can make up to 64 KB of its memory resident.

0x00000-9FFFF: Transient Program Area (TPA)



- **BIOS and DOS Communication Area**
  - contain transient data used by programs **to access I/O devices** and the internal features of the computer system.
- **MSDOS Area**
  - **controls the operation** of the computer system.
- **IO.SYS**
  - Loads into TPA from HD when DOS is started
  - Contains **link programs for keyboard, video display, printer, etc.**
  - links DOS to the programs stored on the system BIOS ROM
- **Command.com**
  - Control the PC and I/O devices (keyboard) when working in DOS
- **Free TPA: Holds TSR programs**
- **Interrupt Vectors**
  - Access various features of the DOS, BIOS, and applications

SYSTEM AREA


FFFFF
BIOS system ROM
F0000
BASIC language ROM
(only on early PCs)
E0000
Free area
Hard disk controller ROM
LAN controller ROM
C8000
C7FFFH
Video BIOS ROM
C0000
Video RAM
(text area)
B0000
Video RAM
(graphics area)
A0000

0XA0000-FFFFF: SYSTEM AREA

The system area contains the programs from

- a read-only memory (ROM) or
- flash memory(EEPROM), and
- areas of read/write (RAM) memory for data storage.

- **Video RAM:**
  - covers first 128 KB area (depends on video adapter)
  - 64 KB graphical or bitmapped data
  - 64 KB text area
- **Video BIOS ROM**
  - located on a ROM or flash memory
  - Contains program that control the DOS video display
- **Hard Disk Controller ROM**
  - HD memory attached to the computer (HD ROM/ HD BIOS)
- **Free Memory System**
  - used for the **expanded memory** in a PC system, or the upper memory system in an AT system.
- **IBM Cassette BASIC Language ROM**
- **BIOS System ROM**
  - contains programs that set up the computer.
  - contains procedures that control the basic I/O system

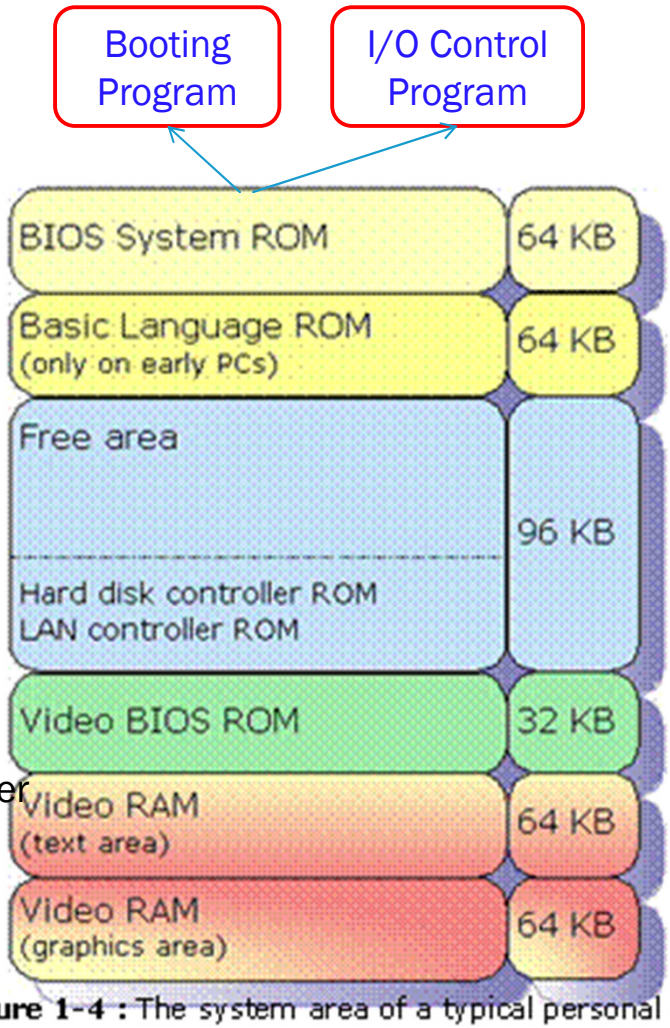
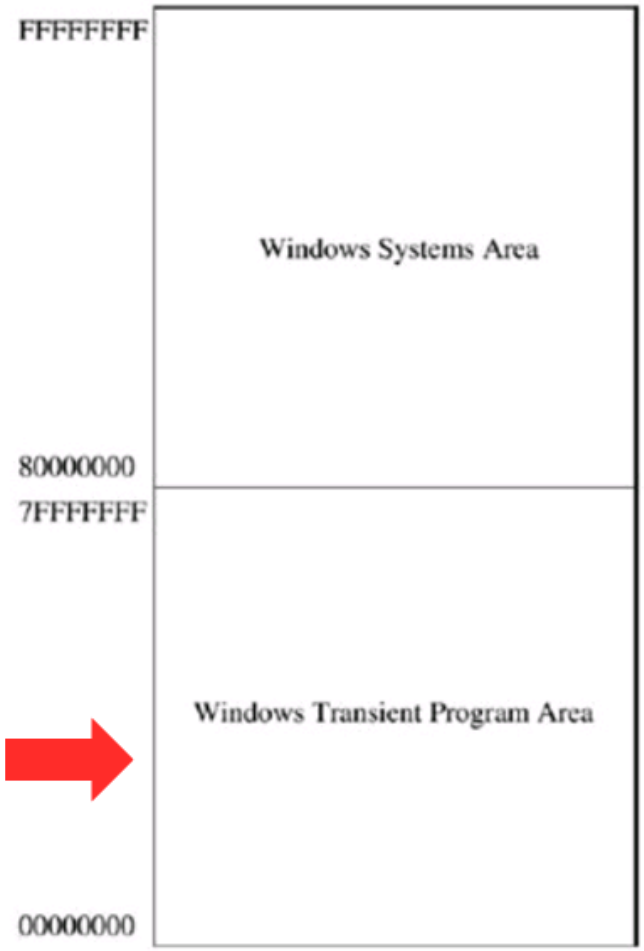


Figure 1-4 : The system area of a typical personal computer.

IBM Cassette BASIC was a version of the Microsoft BASIC programming language licensed by IBM for the IBM PC. It was included in the BIOS ROM of the original IBM PC.

Cassette BASIC provided the default user interface if there was no floppy disk drive installed, or if the boot code did not find a bootable floppy disk at power on. The name Cassette BASIC came from its use of cassette tapes rather than floppy disks to store programs and data.

MEMORY MAP USED BY WINDOWS XP



- TPA is the first 2G bytes from 00000000H
- Every program written for Windows can use only up to 2G bytes of memory (even in a 64-bit system)