The INTEL 16 bit Microprocessors

The IBM PC and PC/XT used an INTEL **8088** processor. The 8088 processor is a 16 bit processor that has a 16 bit internal data bus and an **8 bit external data bus**. The 8 bit external data bus meant that the PC could use the cheap, readily available old 8 bit I/O chips, used in the 8 bit computers. This processor has a **20 bit address bus** and this gives it access to a maximum of 1 Meg Byte of addressable memory. The **Bus Slots** in computers using this processor are called **Eight bit Slots** because of the eight bit external data bus. The Bus Connector is a double sided edge connector and has **62 pins**.

Some other *early DOS Computer manufacturers used the* ***8086*** *processor instead of the* ***8088****. The 8086 is a true 16 bit processor with a 16 bit internal data bus and a 16 bit external data bus*. These computers accessed the memory 16 bits at a time, instead of eight bits at a time like the real IBM but they still used the same eight bit external data slot. Another processor that was sometimes used in PC/XT type computers, **from other manufacturers**, was the **V20** from NEC. This chip is a cloned 8088 and performs faster for the same clock speed than the original Intel 8088 processor. V20 was the industry name for the chip but it's actual type number was D70108C-x where x is a number that indicated the maximum clock speed the chip could operate at. NEC also built a V30 chip, a cloned 8086 processor.

The IBM PC and PC/XT

The original **IBM PC**, released in 1981, used an **8088 processor**, had 16k of RAM as standard (expandable to 64k on the system board), 5 Bus Slots, a Cassette Tape I/O Port for program and data storage, a Basic Interpreter in four 8 KByte ROMs, and an 8 KByte BIOS ROM. The Power Supply provided 63 Watt of power as **+/- 5 volt and +/- 12 volts**. The **Internal Data Bus was 16 bit wide** but the **External Data Bus was only 8 bit wide**, and the **Address Bus was 20 bit wide**. The Firmware that started up the computer and provided Basic Input Output Services was contained in the 8KByte BIOS ROM.

A Floppy Disk Interface and Floppy Disk Drives were available as an option, as were plug in cards that provided Parallel, Serial and Games Ports, and more RAM.

Two optional Video Interfaces were available, a Colour Graphics Adaptor (CGA) and a Mono Display Adaptor (MDA). The MDA card provided a character based only display with no graphics capability, and also had a built in Parallel Port for connection of a printer.

The **IBM PC/XT**, XT stands for an eXTended PC, released in 1982, was a more advanced PC with one Floppy Drive, a 10 MEG Hard Disk Drive and 256k of RAM as standard. The System Board had 8 bus slots and no cassette tape interface, and the power supply could supply 130 Watts. This computer also had a Basic Interpreter, but did not have the Cassette Tape I/O Port. The PC/XT still used the 8088 processor so it had a 1**6 bit internal data bus** and an **8 bit external data bus** and a **20 bit address bus**.

Note:- The 8 bit bus slots first used in the IBM PC are still in use today in our most modern hardware - they form part of the ISA Bus slots. The **ISA Bus** was introduced with the PC/AT and was created by adding an extra 36 pin connector to provide the extra data and address lines. The eight bit data bus slots used in the PC and PC/XT type computers use a 62 pin double sided edge connector and are referred to as the Eight bit Bus slots.

The PC/AT (80286 based) Computer

IBMs next development of the PC was the **PC/AT**, AT stands for an Advanced Technology PC, released late in 1983. The AT used a **80286 processor**, a true 16 bit processor with a **16 bit External Data Bus** and a **24 bit Address Bus**. The 24 bit Address Bus gave the AT

access to a maximum of 16 Meg Byte of addressable memory space (2^{24} = 16,384,000). Other manufacturers built similar computers based on an 80286 processor and the alternative title, a 286 Computer, was often used to describe them. The 16 bit bus introduced in the IBM PC/AT became known as the **ISA Bus,** (Industry Standard Architecture) and was based on the original eight bit Bus introduced in the original IBM PC. A **36 pin connector** was added to the end of the **62 pin connector** to provide the extra eight data lines and four address lines. The ISA Bus also provides more "IRQ" and "DMA" lines.

Other manufacturers soon pushed the ATs clock speed from IBMs 6 MHz to 8, 10, 12, 16 and then 20 MHz. IBM stuck to its 6 MHz and did not develop the AT computer any further.

Differences Between PC/XT and AT Systems

System Attributes	**(8-bit) PC/XT Type**	**(16/32/64-bit) AT Type**
Supported processors	All x86 or x88	286 or higher
Processor modes	Real	Real/Protected/Virtual Real
Software supported	16-bit only	16 or 32-bit
Expansion slot width	8-bit	16/32/64-bit
Slot type	ISA only	ISA, EISA, MCA, PC-Card, Cardbus, VL-Bus, PCI
Hardware interrupts	8 (6 usable)	16 (11 usable)
DMA channels	4 (3 usable*!8 (7 usable)	
Maximum RAM	1M	16M/4G or more
Floppy controller speed	250 Kbit/sec	250/300/500/1,000 Kbit/sec
Standard boot drive	360K or 720K	1.2M/1.44M/2.88M
Keyboard interface	Unidirectional	Bi-directional
CMOS memory/clock	None standard	MC146818 compatible
Serial-port UART	8250B	16450/16550A

The third generation DOS computers

In 1987, when the 32 bit 80386 processor was released, IBM changed direction with a new naming convention, a new bus and a new operating system. IBM went to its PS/2 range of computers, many with a new bus called MCA (Micro Channel Architecture) and a new Operating System, called OS/2.

Two things prevented the MCA bus achieving much market penetration.

- MCA was expensive to implement and IBM wanted high licence fees.
- The MCA Bus was not compatible with cards made for the old PC and PC/XT eight bit bus or the 16 bit bus introduced with the PC/AT (the ISA Bus).

The rest of the personal computer industry went on to name computers after the processor they used, and many of these other manufacturers formed an Industry Committee to set standards for the personal computer industry.

Note: When IBM called its new bus, Micro Channel Architecture, the Industry Committee called the 16 bit bus, first used in the AT, the Industry Standard Architecture (ISA) Bus.

This same Industry Committee designed a new Bus, based on the ISA Bus, and called it the Extended Industry Standard Architecture (EISA) Bus. The EISA Bus has the advantage of being able to accept all the old plug-in cards that were made for the 8 bit (XT) Bus or the 16

bit ISA Bus.

The EISA Bus achieves compatibility by having a connector with two sets of contacts, one above the other. The ISA contacts are on the top and the extra EISA contacts are on the bottom. EISA cards have slots so that they can drop down and make contact with both row of contacts.

The **80386** processor was made in two variations, the **80386DX** which had **32 bit external Data and Address busses**, and the **80386SX** with **16 bit external Data bus** and **24 bit Address bus**. The 80386 chip had a 32 bit internal Data bus. The 32 bit Address bus of the 80386DX processor gave this "chip" an Address range of 4.29Gig (2^{32} = 4,294,967,296).

Fourth generation PC computers

The **80486** processor was the fourth generation processor and had 32 bit internal and external Data and 32 bit Address busses. This chip was also produced in several versions, starting with the 80486SX, then the 80486DX, 80486DX2 and the 80486DX4. The Cyrix / IBM 80586 chip is a Pentium OverDrive clone with a 64 bit internal data path and a 32 bit external data path and belongs to a "four and a half generation" !.

The fifth generation PC computer

Intel changed the naming of its processor chips with the introduction of the Pentium processor to stop other manufacturers using the name for their products. If Intel had called this chip the 80586 any other manufacturer could have called their clones of the chip, the 80586, because this is an industry standard naming convention. All of the Intel family of processor chips have been cloned by other manufacturers, Cyrix and IBM and AMD being the most prominent in recent times. Some manufacturers used the names 80586 and 80686 for clone Pentium chips.

The **Pentium** is a **64 bit processor** and it works with 64 bit data. The Pentium has a 32 bit external Data bus and a 64 bit internal Data bus. The Address bus is still 32 bits.

The Pentium processor was soon enhanced with the release of the Pentium Pro processor in early 1996. This processor has the level 2 cache built into the processor rather than being located on the system board. In mid 1997 Intel released a Pentium II (Pentium two) processor and new versions of the original Pentium called the Pentium MMX. The other manufacturers, IBM and Cyrix and AMD also have more advanced processors on the market. You will learn about these in PC Servicing Two.

Alternative Personal Computer Platforms

The IBM personal computers were based on microprocessors from Intel. As other manufacturers started to make DOS computers the term PC tended to be used to describe any hardware that used the DOS operating system. It is possibly more correct to refer to these computers from "other" manufacturers as DOS computers or Intel processor based computers, rather than PC computers.

The term PC was registered by IBM as a trade name and strictly speaking, the other manufacturers of DOS computers could not use the name PC. In the early eighties the term PC referred to a particular model of IBM personal computer but as time has gone by, the term has been used to refer to any PC type computer, a computer using one of the Intel microprocessor chips or one of the clones of these processors.

You will see the term Platform used in describing the processor used in a personal computer, the computers we are studying in this course use the Intel Platform. Remember not all the processors we use in this platform are built by Intel, alternative devices are made by Cyrix and IBM and by AMD. The Apple Macintosh used a Motorola 68000 series processor and so this is referred to as being a Motorola Platform.

A traditional PC Computer system consists of:

- **A System Unit (also referred to as the CPU) that contains**
    - A switch mode Power Supply that provides DC voltages of plus and minus 5 and 12 volt.
    - The System Board that provides
        - The CPU
        - The BIOS ROM (firmware in read-only memory)
        - User Memory (RAM)
        - Level 2 Cache Memory
        - Keyboard interface
        - External Bus slots
        - The Hard Drive and Floppy Drive Interfaces *****
        - The Parallel and Serial I/O Ports *****
    - Floppy Disk Drive/s
    - Hard Disk Drive/s
    - A Video Interface card, usually plugged into a bus slot
- **Video Display Unit (also called VDU or Monitor)**
- **Keyboard**
- **Printer** This may be a local or a Network printer
- **Mouse or Track Ball**
- **Common options also found in PC Computers**
    - Sound Interface, Speakers and Microphone (and Games Port for a Joystick)
    - CDROM Drive
    - DVD CDROM drive and JPEG decoder video interface
    - 3D sound card (used with DVD CDROM drive)
    - 3D Graphics Accelerator card
    - Telephone Modem / Fax (either internal card or external device)
    - Network Interface card
    - Optical Scanner for Images and OCR
    - Video Capture card and/or TV Tuner card
    - Radio Tuner card
    - High Capacity Removable media
    - Tape back-up drive
    - Data aqusition and control interface

***Note:** In older traditional DOS computers the Floppy and Hard Drive Drive Interfaces, and the basic I/O functions were provided by plug in cards. Today the Floppy and Hard Drive

Interfaces and the Parallel and Serial I/O Ports are provided on the System Board. The Games Port is usually provided on the Sound Card.

PC Computer case options

Modern PC computers are available in a wide range of cases and these include.

- The traditional Desk Top case
- Compact Desk Top
- Full Tower
- Midi Tower
- Mini Tower
- Multi-media (These cases have built in audio power amplifiers and loud speakers)