UNIT-II

MOTHERBOARDS

- Motherboard is the heart of any personal computer.
- It provides system resources interrupt request (IRQ lines), DMA channels, and Input Output locations).
- Support the core components such as CPU, chipsets & Real Time Clock (RTC).
- It handles all system memory includes SD-RAM, BIOS RAM, CMOS RAM.
MOTHER BOARD TYPES

- Motherboard is a printed circuit board.

❖ Active:
  - It is comprehensive and the RAM, ROM, CPU is attached in the motherboard.
  - So we can’t able to upgrade by adding RAM or processor in the motherboard.
  - One way to upgrade is replace with newer.
  - Example: Only PCI bus slots we can add.

❖ Passive:
  - More than interconnecting slots.
  - No major chips on the black plane.
  - The CPU, RAM, BIOS ROM and other central process component are fabricated on the board that simply plug in to one of the back plane slots.

❖ Black Plane:
  - It is a group of electrical connector in parallel with each other.
  - So the pin and connectors is linked to the same relative pin of other connector forming a computer bus.
  - The back plane is a printed circuit board containing connections (slots) for expansion boards and allows for communication between all connected boards.

SOCKETS & SLOTS

Sockets- eg, Processor socket (PIN GRID ARRAY)

FIG: SOCKET
Slots - eg, PCI, DIMM (RAM slot)

FIG:SLOT

- **Socket 7:**
  - Designed for Pentium MMX, AMDK6-2, Cyrix MIII processors
  - 321 pins, super socket 7 is support processor up to 500MHZ.

- **Socket 8:**
  - It is used in Pentium pro, Pentium II
  - It is Rectangular shape - 387 pins.
  - It supports bus speed 60-66MHZ.

- **Socket 360:**
  - It is used in Pentium III, Celeron Pentium processor.

- **Socket A (or) Socket 462:**
  - Later model AMD Athlon, AMD Duran processor.
  - It used in fs (133MHZ & 166MHZ ) 200MHZ.

- **Socket 432:**
  - It is used in Pentium 4 processor.
  - Intel D850 GB motherboards used for Pentium 4 processor.

- **Slot 1:**
  - These motherboards SEC single edge cartridge.
  - Processor box is used rather than a pin grid array chip.
  - It has 242 contacts.
  - It is used in Pentium II, pentium III.
Slot 2:
- It has 330 contacts.
- It is used in Pentium II, pentium III xenon processor.
- Slot motherboards are used high end network server & work station systems.

Slot A:
- It has 242 contacts.
- It is used in AMD Athlon, Duran processor.

**INTEL D850 GB MOTHERBOARD**
- Used in Pentium IV motherboard.

- Modern motherboards there are two or three longer chips on a whole motherboard i.e., power full inter related chips (chip set).

**Chip set:**
- Used to connect processor & memory with drive controller (FDD, HDD) & expansion buses (ISA, PCI, AGP) I/O ports (serial, parallel PS 12, USB).
Expansion slots:

- ISA (1981) - Industry standard architecture - Accommodate low band width device such as modem, sound cards
- PCI (1993) - Peripherals component interconnect - Video cards and Network interface card.
- AGP: Accelerated Graphics Card
  - Used for 3D graphics
  - It provides a high speed data path directly between the graphic card & system memory.

**FORM FACTOR**

- It is the Specification of the motherboard
- Depend on Dimension, power supply types
- Depend on Location of mounting holes & Number of ports on back panel.
o Placement of key component such as CPU, memory module, expansion slots, I/O parts.

**FORM FACTOR TYPES**

```
AT           ATX          NLX
Baby AT
       Micro ATX     EATX (Extended Advance Technology Extended)
                     BTX
```

❖ **AT (Advanced Technology):**
  o AT is introduced by IBM 1984.
  o Two sets of 6 pin inline connector:
  o CPU is positioned in line with one or more ISA between slots.
  o I/O ports (LPT, PS2, USB) are spread out in the board.

❖ **Baby AT:**
  o 1987, size 12” to 8.5”
  o The smaller version of original AT motherboard.
  o The I/O ports which were cabled to connectors on the back of the case.
  o Socket 7 was used.

❖ **ATX (Advanced Technology Extended):**
  o It is introduced in the year 1995, size 12” wide × 13.8” deep.
  o Ex: Intel 850GB ATX
  o All I/O are connected in to single I/O panel located rear of the motherboard.
  o It has 20, 24 pin power connector.
  o CPU is connected away from all expansion bus slots.
- ATX uses (socket 7, 360, 432, slot 1, slot 2, slot A) CPU.

- **Micro ATX:**
  - It is Slim & small in structure.
  - Dimension is 9.6 by 9.6 inches or 7 by 7 inches.
  - It used in digital cable boxes & HD recorders.

- **Extended ATX:**
  - It is Used in Work station level motherboard specification.
  - It has 12 by 13 inches.

- **NLX (New Low profile Extended):**
  - It is introduced 1997, 9” wide X 13.6 deep.
  - All expansion slots, power cable & PCI are located on edge mounted riser card.
  - This allows easy removal of motherboard.
  - AT & ATX is time consuming to upgrade & replace.
  - To overcome the replaceable motherboard.

- **BTX (Balanced Technology Extended):**
  - North Bridge & south bridge are located near each other and hardware they control line CPU, RAM, expansion ports.

### CHIPSET TYPES

- **North bridge:**
  - One chip responsible to interface CPU, main memory, AGP.
  - The path between CPU & RAM is referred as FSB.
  - North Bridge play important role in over clocking.
  - It supports:
    - P II, P III, Athlon, Duran, Celeron.
    - Multiprocessing.
    - Processor speed 250 MHZ, 800 MHZ, and 1.5 GHZ.

- **Southbridge:**
  - It handles peripherals controller & I/O controller & Integrate controller.
1. It supports:
2. ISA bus, serial ports (Rs232).
3. Parallel (IEEE 1284 port).
4. Hard drive controller.
5. Power management features.

**UPGRADING THE MOTHERBOARD**

Considering the motherboard:

- **Compare features:**
  - Check the specification closely before making choice.
  - BIOS play a vital role in such advanced features as plug & play.
  - Power conservation features ACPI.
  - The number & type of I/O slots provide on board features, video adapter, and sound devices.

- **Dimension & Mounting:**
  - Physical dimension of the motherboard must fit available in pc.
  - Mounting holes (new motherboard will not match the original mounting holes).

- **Check CPU slot location:**
  - Check the CPU location & expansion slots.
  - Pentium III and pentium 4 heat sink and fans will be mandatory.
  - CPU fan easily interface with expansion slots.

- **Consider collator upgrades:**
  - Changing new motherboard.
  - It requires any other upgrades.
  - It evaluates other sub assemblies.
  - Check the cost.

Example: RAM slots.

Performing the upgrade:
Static precaution:
- Computers are fabricated with technology ESD (Electro Static Discharge).
- ESD is a sudden flow of electricity.
- It uses antistatic mat to eliminate static electricity.
- It handles PCB boards by edges.

Save your CMOS:
- Print screen of CMOS setup.

Prepare the system:
- Turn off, unplug a current.
- Use screwdriver blades carefully; if it slips, it damages the motherboard.

Remove the motherboard:
- Dismantle expansion cards.
- Heat sinks, processor.

Install the new motherboard.

Reassemble the system.

Testing the system.

CMOS
- CMOS complementary metal oxide semiconductor.
- IBM choose to store the system setup in small low power RAM chip called CMOS RAM.
- CMOS RAM is often combined on the same chip with RTC.
- Modern PC starts the system attributes stored in the CMOS RAM read by BIOS.

Role of CMOS:
- CMOS RAM is nothing very low power than static RAM.
- Older CMOS RAM had only 64 bytes.
- Later it had extra 64 bytes totally 128 bytes.
• Latest 512bytes to store CMOS setup along with ESCD(Extended System Configuration Data) i.e, information needed for PC plug & play(pnp) system.
• Ram is naturally lost data when system power remove.
• So battery is added to PC that continuous to provide power to CMOS RAM & RTC.
• It is CMOS battery backup that keeps the data, time & system parameter.

**BASIC CMOS OPTIMIZATION TACTICS**

- The PC continue evolve to increasing the variety of memory types, buses.
- PC initiatives and system architecture has forced BIOS makers to provide more and more entries in CMOS setup.

❖ Check the basics:
  - All standard CMOS setting correspond to the installed components at your system (Hard disc, CD drivers).
  - Date & time available in memory.

❖ Enable all system cache:
  - All cache memory (both internal L1 & external L2) cache memory present in the system.

❖ Minimize RAM wait status:
  - Wait state values used for your main system RAM are set at minimum possible.
  - Wait value too low, will make your system freeze.

❖ Enable RAM shadowing:
  - Shadow the video & system ROM contents to RAM it is initiated when booting.
  - Newer system uses fast flash ROM devices.

❖ Enable power management:
  - Check the power devices.
  - Proper power management conserve electricity.
- Extend the working life at may system components.

  - Optimize device access:
    - Hard disk data transfer speeds are major bottle neck of system performance.
    - Use fast data transfer protocol that the hard disk support.
      Example: ultra DMA 100

  - Go with BIOS default:
    - In modern systems it’s unnecessary to re-enter every CMOS setup parameter from scratch.
    - Suitable default setting are now typically in corporate in to BIOS itself.
    - BIOS not optimize your system performance.

**What is interrupt request?**

In a computer IRQ is a hardware signal sent to the processor that temporarily stops a running program and allow a special program.

Example: key process, mouse movement.

**CONFIGURING THE STANDARD CMOS SETUP**

- The standard CMOS setup usually shows the basic data about your system.
  
  (i) Date,

  (ii) Time,

  (iii) Attached devices(HD)

- It is important for you to get the data correct because the system will refuse to boot unless it is aware of all the drives installed.

  - Assign IRQ for VGA:
    - When enable this option the system assign IRQ for video card in order to speed the data transfer between CPU & video card.

  - Date & time:
    - It use to change date & time of the system clock.
Day light saving:
- It enables the RTC allows automatically adapt to the day light saving scheme.
- It maintains date & time.

Error Halt:
This entry determines whether the PC will stop it if an error detected during initialization.
1. No error
2. All error
3. All but disk

HDD delay:
Some hard drive require several seconds to be identified correctly by BIOS. This setting allows you to artificially delay boot up so that the drive may be initialized.

Key board:
Whether key board is attached.
Proper entry is initialized in BIOS.
If not, it allow the PC to boot without key board.

Memory:
Details about memory elements:
Which memory element should be displayed in start time
- Base memory
- Extended
- Other memory is used by AGP.
- Total memory sum of all.

Quick power on self-test:
If hard disk that initialize quickly.
Able to speed your boot time by using quick post.
ie, post disable when you disable.
**BIOS**

- Basic I/O system:
  - Basic I/O system is added on ROM chips.
  - To provide interface between the raw PC hardware and the standard operating system.
  - BIOS ROM chip used for major sub systems such as video & drive control.
  - BIOS ROM in UMA upper (640 KB to 1MB) memory area.
  - In general PC filled with
    - System(motherboard) BIOS.
    - Video adapter firmware BIOS.
    - Modem card firmware BIOS.
    - SCSI(Small computer system interface) adapter BIOS.

- **TYPICAL MOTHERBOARD BIOS**
  BIOS occupies 128 KB in upper memory. It is arsenal individual routines.

- POST – power on self test
  - Manages entire system start up.
  - It handles all initialization activities of PC.
  - It performs low level diagnostic & reliability test of main processing components
    1. ROM programs.
    2. System ROM.
    3. Test CPU.
5. CMOS-system configuration data.

**CMOS setup routine:**
- CMOS setup integrate in the BIOS.
- Hardware configuration for any given computer is maintained in a small amount of very low power CMOS RAM.
- Post gathers information about the system hardware and compares the setting in CMOS RAM.

**System service routine:**
- BIOS services.
- Set of functions that form the layer between hardware and operating system.
- Contains hard ware interrupt .
- Software interrupts –hardware device must be checked or manipulated by the PC.
- CMOS & BIOS work together to make the system function propane.

**BIOS**
- Chip contains a special program that helps the computer processor interact & control the other components in the computer(disk drives, sound cards, video card, network card, USB ports hard disk).
- Without BIOS the processor would not know how to interact with computers components.

**CMOS Ram:**
- The RAM chip is a memory chip which stores information about the computer components.
- BIOS chip reads information from the CMOS chip during BOOT up process by post.

**BIOS Features:**
- PC technology advancing in CPU chip sets &memory.
- As hardware continuous in advance it makes advance in BIOS.
- Core features of modern BIOS.

**CPU support:**
 BIOS supports a rich range of CPU, Intel, AMD, Cyrix.

- **Chip sets support:**
  - BIOS supports latest chip sets.
    - Example: Intel 850, i7-4960x.
  - Chip set is critical because chip set allows motherboard to implements power management, USB, DDR-SD RAM(memory).

- **Memory support:**
  - The BIOS should be able to auto size and support most modern form of memory.
  - Memory error checking should also be support.

- **Power management:**
  - The BIOS should fully comply with the advance configuration & power interface(ACPI).
  - Used to reduce energy waste.
  - BIOS uses DPMS(display power management system) for monitors & other display devices.

- **Drive support:**
  - BIOS must support 32 bit disk transfer and large ultra ATA hard drivers with very fast data transfer modern ultra DMA /33, ultra DMA /66, ultra DMA /100 (ultra ATA 100=100 MB/s).

- **IO support:**
  - IO which allows dynamic assignment of ports & resources for I/O devices in PC.
  - It is used in servers platform.

- **BIOS versatility support:**
  - The BIOS should be able to boot from different drivers and include BIOS boot specification for Intial Program Load(IPL)devices.
  - It support boots from CD ROM, SCSI drives, removable media drives.
Plug & play support:
- The BIOS must detect & configure PNP devices during post.
- It also communicate with operating system to determine resources & support IR2 for PCI bus devices.

Parallel port support:
- BIOS support a full range of parallel port mode.
  1. SPP (standard parallel port)
  2. bidirectional mode (transmit receive)
  3. Enhance parallel port (EPP).
  4. Enhanced capability port (ECP).

PCI & AGP support:
- It supports PCI (2.1) specification.
- It includes PCI to PCI & PCI to ISA bridging.
- It supports AGP20.

USB (universal serial bus) support:
- BIOS support both universal and open HLL standard
- To provide legacy support for USB hardware and multilayered USB hubs.
  - 2.0 USB high speed USB.
  - 3.0 USB super speed.

Anti virus protection:
- Offer of virus protection.
- Protect change to master boot record.
**BIOS BOOT SEQUENCES**

- BIOS are to recognize how it boots.
- The series of steps that it takes place in PC from power on state to operating system loading state.
- AMI BIOS has 24 steps in order to check and initialize the PC.

**Disable NMI:**

- It disables non mask able interrupt line to the CPU.
- It is the highest priority interrupt capable of interrupting are software and non virtual hardware memory.
- It is not commonly used.
- It used only to verify serious error or stop all operation. Example: ctrl + Alt + Del->NMI send to CPU.
- Mask able is ignored by the CPU.

**Power on delay:**

- The fault here indicates a problem with keyboard controller chip or system clock generator chip.
- The system resets soft and hard reset bits.

**Initialize chip sets:**

- It initialize motherboard chip sets.
- A problem here may be caused by BIOS, the generator chip or chip set itself.

**Reset determination:**

- The system reads the reset bits in the keyboard controller to determine a hard or soft reset.
- A failure here may be caused by the BIOS or KB controller chip.

**BIOS ROM check sum:**
The system performs a check sum best of ROM contents and adds a factory preset value should make total equal to 00h. If this total does not 00h the BIOS ROM is defective.

Key board test:
- The command is sent to the 8042 (keyboard controller) which perform test and sets a buffer space for commands.
- After buffer is defined the BIOS sends command byte, writes a data on buffer.
- It check the high order of internal KB controller.

CMOS shutdown check:
- BIOS test the shutdown byte in CMOS RAM and calculate the CMOS check sum and update a diagnostic byte.
- System the initialize a small CMOS area in conventional memory and update the date and time.
- Problem here is like RTC or CMOS back up battery.

Controller disable:
- BIOS new disable the DMA & IRQ controller chip before proceeding.
- Problem suggests trouble respective controller.

Disable video:
- BIOS disable the video controller chip.
- It this procedure fails trouble in video adapter board.

Detect memory:
- The system proceeds to check the amount of memory available.
- BIOS measures system memory in 64KB blocks.
- Problem may be in memory chips.
PIT test:
  o Programmable interrupt time for memory refresh.
  The problem with PIT test may reflect the fault in PIT IC or RTC chip.

Check low address line:
  o The system checks the first 16 address lines controlling the first 64 KB of RAM.
  o Problem with this test typically fault in address line.

Check low 64KB RAM:
  o The system checks first 64KB of system RAM.
  o This area must hold information that is critical for system initialization.
  o Problem in RAM chip.

Initialize support chips:
  o BIOS proceeds to initialize the programmable interrupt timer(PIT),
    the programmable interrupt controller(PIC) and the DMA chips.
  o The problem would be located in one of those locations.

Load INT vector table:
  o BIOS load system interrupt in to the first 2KB of system RAM.

Check memory refresh:
  o BIOS now uses the PIT to try refreshing memory
  o A failure indicates a problem with PIT chip.

Check KB controller:
  o BIOS reads the keyboard controller buffer at I/O port 60h.
  o Fault in KB controller chip.
video test:
  o System checks type of video adapter then tests and initialize the video memory and adapter.
  o Problem in video adapter.

load the BDA(BIOS Data Area):
  o The system now loads the BDA in the conventional memory.

Test memory:
  o BIOS checks all memory below 1MB.
  o Fault in one or more RAM modules.

Check DMA register:
  o BIOS perform a register level of check of DMA controller using binary test pattern.
  o Failure in DMA chips.

Check the keyboard:
  o Final check in KB interface.
  o Fault in KB.

Perform high level test:
  o Test to check high level devices as hard disk drive serial adapter, parallel adapter, mouse adapter.
  o When error occurs the corresponding text message will displayed.
  o If the hardware does not match the setup show in CMOS.

Load the operating system:
  o The routing loads on operating system.
  o Error generally results in error message non system disk.

Keyboard controller:
It is a device that interfaces a keyboard to a computer.
It informs the computer when a key is pressed or released.
When data from the keyboard arrives the controller raises an interrupt to allow the CPU to handle the input.

**Clock generator:**
- It is a circuit that produces a timing single used for synchronizing a circuit operation.

**BIOS SHORT COMINGS AND COMPATIBILITY ISSUES**

BIOS can come up shortcomings before you start troubleshooting, you should understand the places where BIOS is weakest.

- **Device drivers:**
  - Computer program that operates or controls a particular type of device that is attached to a computer.
  - A driver communicates with the device through computer bus to the hardware connection.
  - Drivers are hardware dependent and operating system specific.
  - The low-level device drivers loaded in the conventional memory.

- **Flash laziness:**
  - Flash memory allows BIOS to be reprogrammed so no need to exchange BIOS chip.
  - BIOS updates can be directly updated by interrupt.

- **BIOS shadowing:**
  - The problem with BIOS chips is slow speed.
  - BIOS recorded on to flash ROM chips.
  - To overcome this they use shadowing.
- Copies ROM contents from the BIOS chip into available RAM in the upper memory area (UMA).
- BIOS routing to forked advantage of faster RAM.

- **Direct control:**
  - New technology hardware works with drivers.
  - Not involve in BIOS.
    - Example: 3D accelerator
  - Direct hardware may not work on all system configuration.

- **BIOS bugs:**
  - BIOS code is to accidental errors.
  - If a bug is present in the BIOS the system will typically lock up or crash unexpectedly.
  - We can update the BIOS, and cash the BIOS.

- **Power supply and power management:**
  - Power supplies play a vital role in the operation of PC and their peripherals.
  - Power supply converts commercial AC into one or more level of DC that can be used by the electronic devices used in the computers.
  - The disadvantage in linear power supply is tremendous waste.

**CONCEPT OF SWITCHING REGULATION**

- Instead of throwing extra I/O energy switching power supply creates a feedback loop.
- Feedback circuit sensor the output voltage provides then switches the AC primary voltage on or off as need to maintain steady level in output.
- Switching power supply is constantly turning on and off to keep the output steady.

![Switching Power Supply Diagram](image1)

**Fig:** Switching power supply

- Raw AC line entering the supply converted to pulsating DC and filtered by rectifier.
- AC current not transformed before rectification, Capacitor charge the peak voltage.
- Switch transistor is turned on & off at high frequency.
- The switching transistor acts as chopper which breaks up primary DC to form a chopped DC ie, used as primary signal i-e input of step down transformer.

![Simplified Diagram](image2)

**Fig:** Simplified diagram of switching power supply
Duty cycle:
  - It refers the amount of time that a signal is on.

A long duty cycle:
  - Large output voltage (heavy loads).

Short duty cycle:
  - Lower output voltage (light loads).

Advantages:
  - Little power is wasted in primary circuit.
  - Secondary circuit will supply just enough power to keep load voltage constant.
  - 85% efficient.
  - Less heat is generated by the supply, so components can be smaller and package.

**POTENTIAL POWER PROBLEMS**

  - Malfunction in power supply prevent PC from booting.
  - It is not able to supply enough power to keep the system running properly.
  - The chronic problems can help you navigate the gray area.

The computer freezes intermittently:
  - Most computers freeze due to the software applications and configuration error.
  - The time you suspect power problem is when your system suddenly starts freezing for no reasons at all.
  - Freezes several times a day or several times at a hour.
  - Check it, may be power problems.
If the system ends to freeze when it is running on a different power circuit.

There are random memory error:

- If you added a new application or device driver or upgrading the system.
- Suddenly see a rash of memory errors.
- Occasional memory error message does not necessarily indicate a power problem.
- Memory error occurs when the PC running in different power.

Data is lost or corrupted on the hardware:

- Hard drive problem can be result of several problem (lose data cable or operator error).
- If the drive seems to be having difficulty reading or writing the disk.
- Check the power first before attempting to back up the disk or run any disk based diagnostics.
- If you attempt to defragment with present power problem it will damage HDD more.

There is trouble communicating with modems or peripherals:

- You may see rash of communication error when trying to use a modem or mouse if the peripherals connected and installed properly.
- The system suffers from chronic hardware failures:
- Fault may reoccur after a few day or a week
  Example: memory error, replace the memory and the fault.
  It goes away but the same fault occurs after few days.
  This type of problem suggest there is power spikes are entering the system AC line.
POWER MANAGEMENT

- It used to conserve power.
- Power conservation is important for mobile PC.
- Operating system provides the controls needed for selecting power management.
  - Basic conservation:
    - You can turn off your monitor and hard drive automatically after the period of inactivity.
    - This conserving the great deal of power while the system is in rest.
      - Stand by:
        - When it is idle.
        - In stand by your monitor and HDD turn off and some computer devices are powered down.
        - When you want to use again it comes out quickly from stand by and restore exactly as you left it.
  - Hibernation:
    - After longer periods of inactivity power manage hibernate feature.
    - Turn off your monitor hard drive first.
    - It idle time continuous the system will save everything in memory on disk then turn off the computer.
    - When you restart your computer last state is restored to memory for the disk.
    - Desktop restored exactly as you left.
  - Selecting the power scheme
    - To enable stand by mode we use power management features and select power schema
      - Stand by after -after 20 min
      - Turnoff –after 15 mins
    - Manually invoke stand by & hibernate modes.