CHM Hours - 12 Marks - 24

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1) Motherboard & its components

The main circuit board of a micro computer is known as motherboard. It contains the connectors for attaching the additional boards.

Typically, motherboard contains the CPU, BIOS memory, mass storage interfaces, USB, SATA, serial and parallel ports, expansion slots, and all the controllers required to control standard peripheral devices such as display screen, keyboard and the disk drive.

The CPU is the main component on motherboard or computer system. The CPU is the brain of the computer where most calculations take place with the help of ALU and CU. Collectively, all these chips reside on the motherboard known as motherboard chipset.

A mother-board, also known as a main board, system board, or logic boards and sometimes abbreviated as mobo is the central or primary circuit board making up a complex electronic system, such as modern computer.

Types of motherboards:
* Non-integrated motherboards
* Integrated motherboards

Non-integrated motherboards means have assemblies such as the I/o port connectors (serial & parallel ports), hard drive connectors, floppy controllers and connectors, joystick connections, NIC card etc. installed as expansion boards.

This motherboard is relatively cheap to produce but, because of cost of manufacturing, testing, and installing the expansion boards seperately, there's an added cost to the computer system.

The main advantage of this motherboard are if any thing goes wrong with the individual assemblies or expansion cards, such as a bent or broken pin or controller in connector, or defective controller chip, etc. you could repair the problem by replacing the

individual expansion card at a relatively minor cost.

Integrated motherboards also called as All in one motherboard. This type of motherboard has all I/O ports other peripheral connectors such as Network RJ-45 connector, USB port, audio jack and SATA HDD connector, DVD ~~rom~~ ROM connector, etc. all connect directly to the motherboard.

This type of motherboards is cheaper to produce because there's less material involved, less installation and testing can be done at the same time.

This type of motherboard is more expensive to repair because if you end up with the controller failure or broken pin, it means a new motherboard

Form factor: The shape and layout of motherboard is known as form factor. The form factor refers to the physical dimensions (size and shape) as well as certain connectors, screw hole and other position of that board will fit. The form factor determines the general layout, size and feature placement on a motherboard. A different form factor usually requires different style cases/cabinates. Differences between form factor can include: physical size and shape, mounting hole location feature placement, power supply connectors and others

Types of form factors: While there are 12 official form factors, but only a couple has dominated the PC industry while the others occupy proprietary systems. The following list shows the dominant form factors and the time frame they ruled the world. There is an overlap (1995-1997) when the Baby AT and ATX form factors were fighting in the market.

19?? - 1993 : AT
1993 - 1997 : Baby AT
1995 - 2004 : ATX
2004 - ???? : ATX or BTX or other ?

1] PC/XT : The PC/XT form factor was the first 'official' form factor. It originated with the first desktop PC the IBM PC. The PC/XT form factor become the de-facto standard, at least until the AT form factor was introduced.

2] AT : The AT, also called full AT form factor. It was the oldest and biggest form factor. It was popular until the Baby AT was released, which was around the time of the 386 processor (1992-1993). The reason that prompted the Baby AT was the width of AT (12") and fact that the board was difficult to install, service and upgrade.

3] Baby AT : The Baby AT was the standard in the PC industry from roughly 1993 - 1997. Some issues with the AT and Baby AT design is the location of the features on the board. The CPU socket is placed so that it may interfere with longer bus cards. In some designs the memory sockets are similarly placed. This can limit the amount and selection of peripheral cards you can install. Also the I/O ports are seperate and mounted on the case and connected to pin-outs of the motherboard. These are usually located near the floppy and IDE pin-outs and can result in quite a jumble of ribbon cables.

4] ATX: ATX was developed as an evolution of Baby AT form and was defined to address four areas of improvement:
① Enhanced ease of use
② Better support for current and future I/O
③ Better support for current and future processor technology
④ Reduced total system cost

5] Mini-ATX
6] Micro-ATX
7] FlexATX
8] LPX
9] Mini LPX
10] NLX
11] BTX
12] PicoBTX
13] Micro BTX
14] MiniITX

are some of the other functional form factors.

The CPU: CPU (Central Processing Unit) was first developed at Intel with the help of Ted Hoff in the early 1970's. It is the main IC on the computer motherboard. They come in different size, shapes and pakages. The Central processing Unit is responsible for interpreting and executing most of the commands from the computer hardware and software. The major CPU manufacturers are Intel, Motorola, IBM, Advanced Micro Devices (AMD) and Cyrix.
Modern CPU's are what called as 'integrated chips'. The idea behind the integrated chip is that several types of components are integrated into a single piece of silicon (a single CPU), such as one or more execution cores, ALU or 'floating point' processor, registers, instruction memory,

cache memory and the input/output controller (bus controller).

The modern computer's CPU usually contains an execution core with two or more instruction pipelines, a data and address bus, a dedicated arithmetic logic unit (ALU, also called as math co-processor), and in some cases special high speed memory for caching program instruction for RAM

(1) CPU's Address Bus, Data Bus and Internal registers:

Address Bus:

* Collection of wires connecting the CPU with main memory that is used to identify particular locations (addresses) in main memory is known as address bus.
* It is a uni-directional bus means data travels in only one way i.e from CPU to memory or I/O devices.
* The width of address bus determines how many unique locations can be addressed.

Data bus:

* A data bus is a group of electrical wires used to send data back and forth between two or more components i.e the connections between and within the CPU memory and the peripherals used to carry data. It is a bidirectional bus.
* Data bus carries the actual data or information and address bus to determine where it should be sent.
* The width of data bus refer to the numbers of bits (electrical wires) that make up the bus. Common data bus widths include 8, 16, 32 and 64 bits.
* When it is stated that "This computer uses a 64-bit processor" by the manufacturer, it means width of data bus which they are referring to.

Internal registers:

* There are 16 general, control and system registers in the CPU.
* The 8 general registers are configured in two banks, to reduce register save/restore and to shorten time for responding to the interrupt.

Program Counter (Read from MAP tution copy)
Stack pointer (Read from MAP tution copy)
(Accumulator register, Index registers, Flag registers)

(2) ★ Processor modes: Processor mode also called CPU modes or CPU previlage level. The mode of operation refers to the capability of CPU and the operating environment. The mode of operation determines how the CPU manages applications and memory.

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There are three different modes of operation, but one mode is added for 64 bit processor:

1) Real mode
2) Protected mode
3) Virtual Real mode
4) 64 bit extension mode

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1) Real mode: When a processor is running in real mode, it acts like an "8088 on steroids" i-e it has the advantage of speeds, but it otherwise accesses memory with the same restrictions of the original 8088. Real mode is used by Dos and other standard Dos applications.

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2) Protected mode: Starting with the 80286 chips in the IBM AT, a new processor mode was introduced called protected mode. This is a much more powerful mode of operation than real mode and is used in all modern multitasking operating system.

The advantages of protected mode compared to real mode are:
1) Full access to all the system's memory. No 1MB limit
2) Ability to multitask
3) Support for virtual mode memory
4) Faster (32-bit) access to memory and faster 32-bit drivers to do I/O transfers.

-11 Comparison of real and protected mode:

Real mode	Protected mode
① In this mode, processor works as 8088/8086	① In this mode, processor in full capacity.
② It has only 1MB addressing capability	② It has more than 1MB to few GB addressing capability.
③ Handles one task at a time	③ Handles multiple tasks at a time
④ Memory address translation not required	④ Memory address translation required
⑤ Processor or computers directly communicate with ports and devices	⑤ Processor communicate with ports and devices through OS
⑥ Memory management not supported	⑥ Memory management supported.
⑦ Less addressing modes & instructions	⑦ More addressing modes & instructions
⑧ This mode is for backward capability to support 8086/88	⑧ This mode processor works in its real power

3) Virtual Real Mode: This mode is also called as virtual 8086 mode. The third mode of processor operation is actually an additional capability, an enhancement of protected mode. Protected mode is normally used to run graphical multitasking operating systems such as various flavours of windows. In essence, it emulates real mode from within protected mode, allowing Dos program to run

4) IA-32 mode: When 32 bit processors were developed by manufacturers, this processor works on 32-bit new instruction set. IA-32 processors have three basic modes of operation:

1. Protected mode
2. Real address mode
3. System management mode
4. In addition, the virtual 8086 is a special case of Protected mode.

(1) Protected mode: This is the preferred mode of a modern operating system. It allows applications to use virtual memory addressing and supports multiple programming environment & protections.

* Users' full 32-bit features
* Can process new 32-bit instructions
* 32-bit integers and physical address
* The address can access 4GB of RAM
* Hardware support for Operating System functions
* Windows / Linux / UNIX / OS2 run in protected mode.

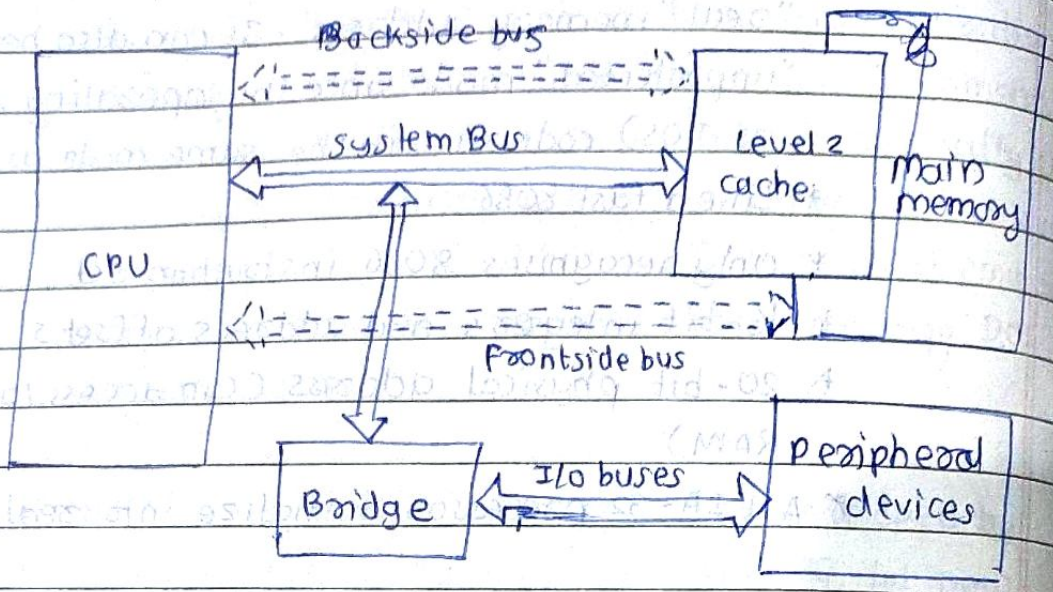
(2) Real address mode: This mode lets the processor to address "real" memory address. It can also be called "unprotected" mode since the operating system (such as DOS) code runs in the same mode as user applications.
* Like a fast 8086
* only recognises 8086 instruction set
* 16-bit integers and address offsets
* 20-bit physical address (can access lowest 1MB of RAM)
* All IA-32 processors initialize into real mode.

(3) System management mode: System Management mode (SSM) provides an operating system with a mechanism for implementing such functions as power management and system security. These functions are usually implemented by computer manufacturers who want to customize the processor for a particular system setup.

(4) IA-32 Virtual Real Mode (Virtual 8086 mode): This mode is used for backward compability of the 32 bit windows environment. This mode is working on 16 bit environment but while running inside it runs on 32 bit protected mode.

(3) Process Technologies:- The process technologies are used to improve the performance of the processor. The design complexity of CPU increased as various technologies facilitated building smaller and more reliable electronic devices. The first such improvement came with the advent of transistor.

* The Dual Independent Bus (DIB) architecture:



DIB architecture of CPU

DIB uses two buses: one from the processor to main memory and other from the processor to the L2 cache memory as shown in figure.

The processor reads and writes data to and from the Level 2 cache using a specialized high speed bus, called backside bus, it's seperate from the CPU to main memory system bus (now called front-side bus). The DIB architecture allows the processor can access both buses simultaneously, which increases throughput.

Advantages:

1. This allows for faster cache access.
2. DIB architecture is a pipeline on a cache to the processor bus it allows multiple simultaneous cache requests.
3. Improves bandwidth performance
4. It allows the processor can access both buses simultaneously which increases through put of CPU.

Drawback:
HT processors were released, many operating systems were not optimised for hyper-threading technology. Writing programs to take advantage of the feature on their own wasn't cost effective.

* Hyper threading technology: Hyper threading is an Intel-proprietary technology used to improve parallelization of computations (doing multiple tasks at once) performed on PC microprocessors. For each processor core that is physically present, the operating system addresses two virtual processors and shares the workload between them when possible.
① Hyper threading technology brings the simultaneous multi threading approach to intel architecture.
② Hyper threading technology makes a single physical processor appear of two or more logical processors.
③ Hyper threading technology was invented by Intel Corp.
④ Hyper threading technology provides thread level parallelism (TLP) on each processor resulting in increased utilization of processor and execution resources.
⑤ Each logical processor maintains one copy of the architecture state.

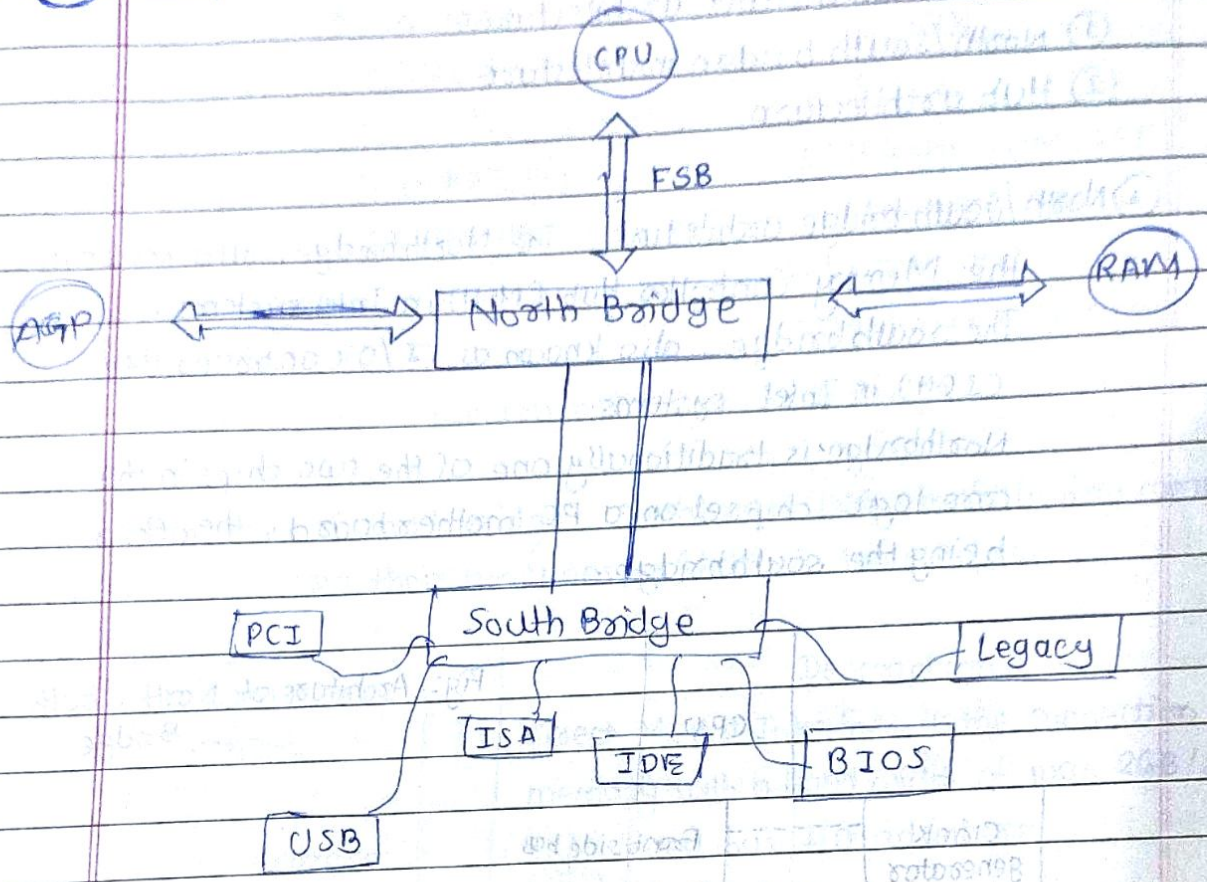
Advantages:
① Improved support for multi-threaded code.
② Allowing multiple threads to run simultaneously.
③ Improved reaction and response time
④ Significant performance improvements with a hyper threading enabled Pentium 4 processor in some artifical intelligence algorithms.

Requirements for Hyper Threading: Hyper threading technology does not require any special drivers to be installed, but does require:
BIOS to support this feature:
① A processor that supports Hyper Threading Technology.
② Hyper Threading Technology enabled chipset.
③ HT technology enabled system BIOS
④ HT technology enabled / optimised operating system
⑤ HT requires not only the OS system support multiple processors, but also that it be specifically optimised for Hyper Threading technology.

1) Processor sockets and slots: A CPU socket or processor socket is a connection that allows computer processors to be connected to a motherboard. A CPU socket or CPU slot is a mechanical components that provides mechanical and electrical connections between microprocessor and the printed circuit board (PCB). This allows CPU to be replaced without soldering.

List of CPU sockets:
(Important table)
Refer textbook

(5) Chipset basics:



Chipset basics

A motherboard chipset has both a general definition and a specific definition that varies by chipset manufacturers. Generally speaking, a motherboard chipset controls the features and abilities of motherboard.

Modern motherboard chipsets nearly always consist of two seperate chips. These two chips on the motherboard are called North Bridge and the south Bridge. Together handle all the communication between the processor, RAM, video options, PCI slots, BIOS, ATA controller, USB ports, integrated modem, integrated LAN port and integrated sound. The chipset also determines the type of RAM that can be used.

* Chipset architecture:

There are two distinct architectures:

1. North/South bridge architecture
2. Hub architecture

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(1) North/South bridge architecture: The Northbridge, also known as the Memory Controller Hub (MCH) in Intel systems. The Southbridge, also known as I/O controller Hub (ICH) in Intel systems.

Northbridge is traditionally one of the two chips in the core logic chipset on a PC motherboard, the other being the southbridge.

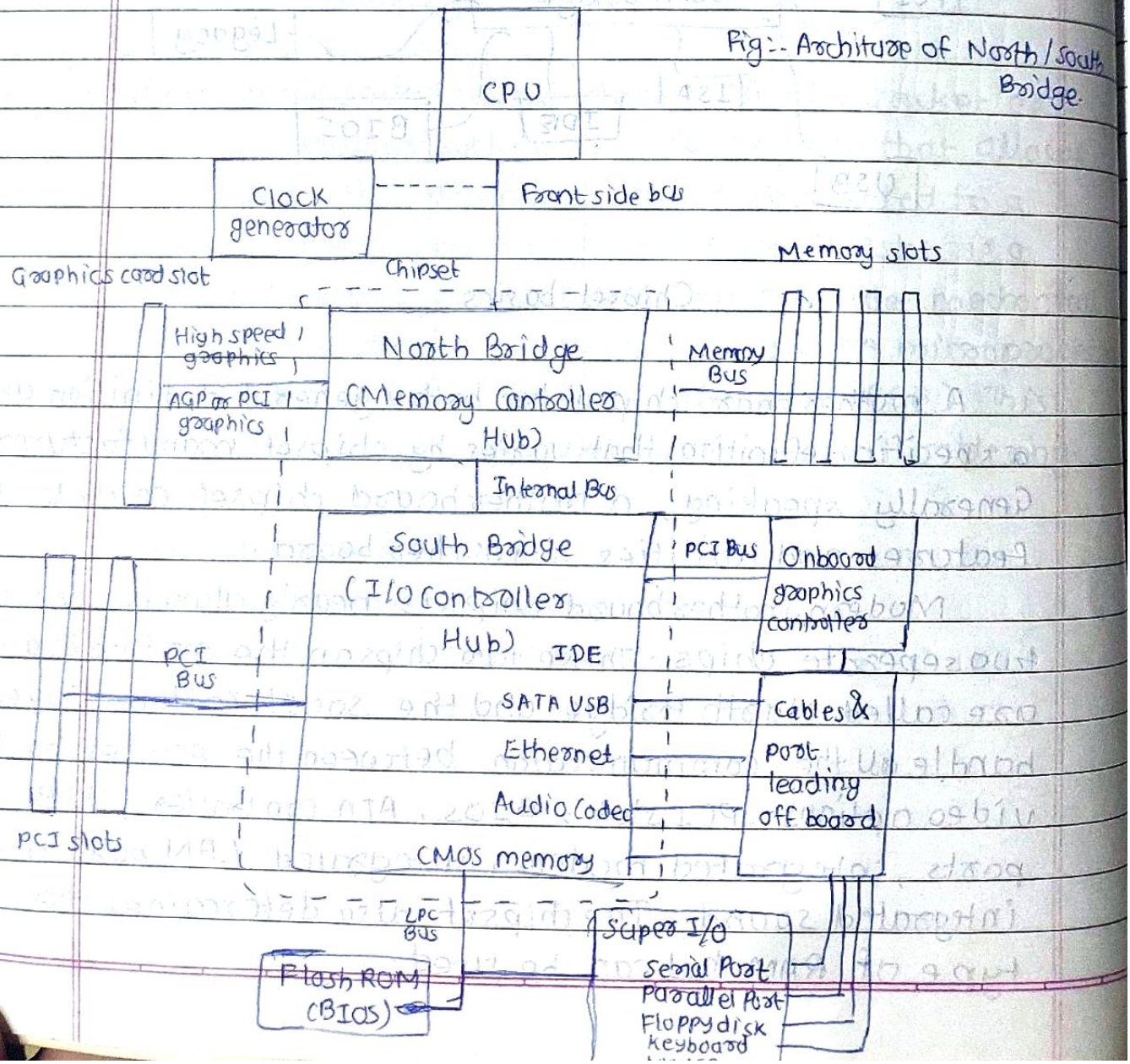
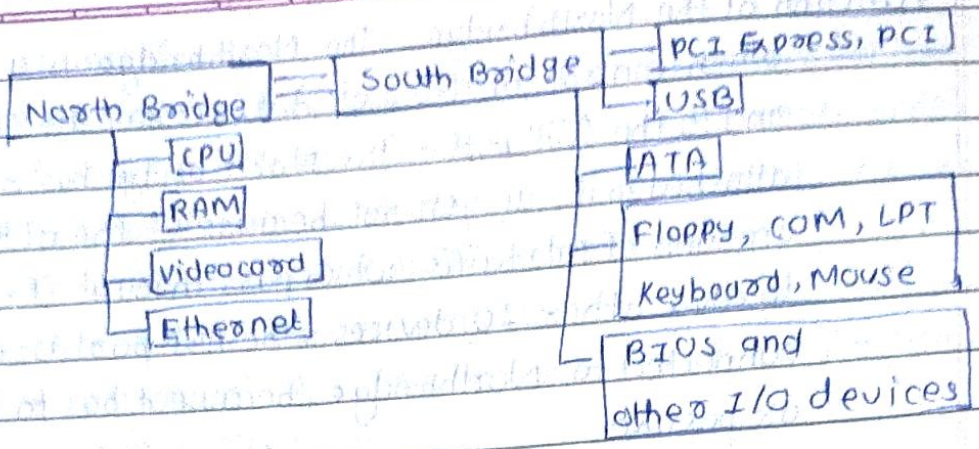


Fig:- Architure of North/South Bridge.



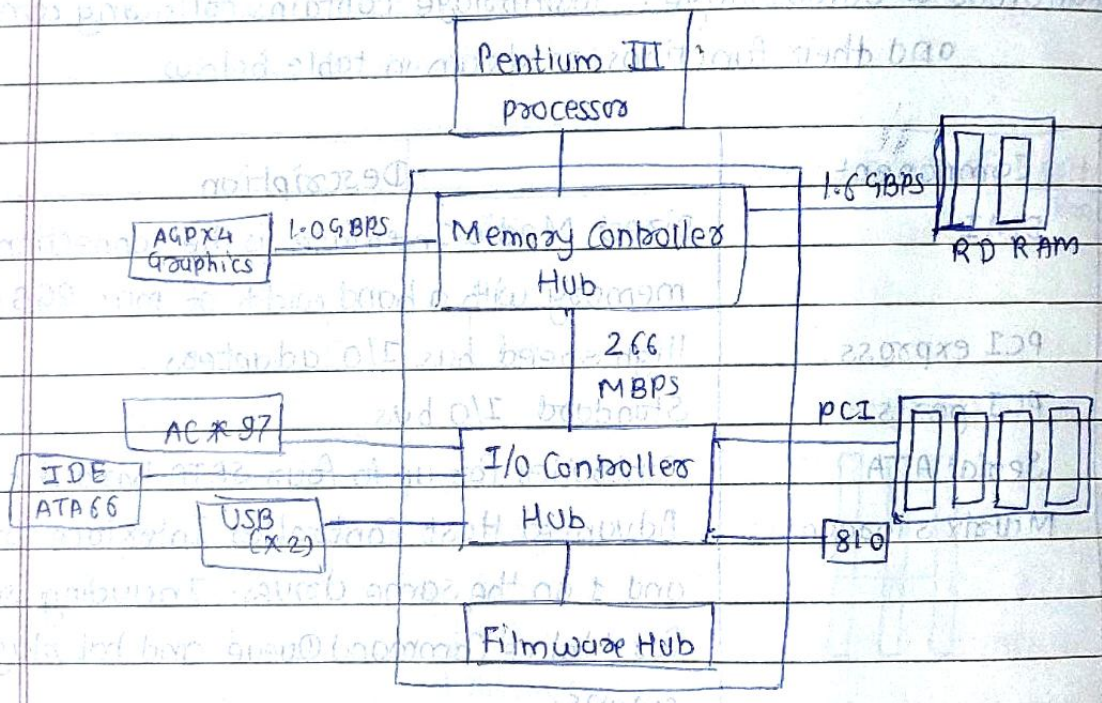
Connection of North/South Bridge

Functions of southbridge: Southbridge contains following components and their functions as shown in table below

Component	Description
DMI	Direct Media Interface is the connection to the memory with a band width of max 2GB/sec.
PCI express	High speed bus I/O adapters
PCI ports	Standard I/O bus
Serial ATA	Controller for up to four SATA hard disks
Matrix storage	Advanced Host Controller Interface for RAID 0 and 1 on the same drives. Including support for Native Command Queue and hot plug device swaps.
Ultra ATA/100	Controller for PATA devices like hard disks, DVD- and CD-drives.
USB ports	Hi-speed USB 2.0 ports
7.1 channel audio	Option for integrated sound devices with surround, Dolby Digital and DTS
AC97 modem	Integrated modem
Ethernet	Integrated 10/100 Mbps network controller.

Function of the Northbridge: The Northbridge is a controller which controls the flow of data between the CPU and RAM and to the AGP port. The Northbridge has a large heat sink attached to it. It gets hot because of the often very large amounts of data traffic which pass through it. In contrast to other other IO devices, the AGP port is directly connected to Northbridge, because it has to close to RAM as possible.

(2) Hub architecture:



Intel Hub Architecture is also known as Accelerated Hub architecture as shown in above figure. It is Intel's architecture for the 8XX family of chipsets, starting with intel 810. It uses a Memory Controller Hub that is connected to an I/O controller Hub via a 266 MB/s bus. This connection is sometimes called Direct Media Interface (DMI).

(6) Latest Chipset for PC:

* Intel X 79 Express chipset (Block diagram & features and benefits table)
* Intel Z 87 chipset (Block diagram & features and benefits table)
* Intel H 87 chipset (Block diagram & features and benefits table)
  ↑ Read from textbook (Not imp. for exam)

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* Intel H 67 or P 67 Express chipset:
  (Block diagram) Read from textbook (Not imp for exam

Features and Benefits:

① It support for 2nd generation Intel core processor with turbo boost technology 2.0.
② It enables over locking for unlocked 2nd generation Intel core processor family.
③ It supports Rapid Storage Technology for quicker access to digital photo, video and data files with RAID level 0, 5, 10 and advanced data protection against HDD failure with RAID 1, 5, 10. It also support for external SATA with speed 3Gbps
④ It supports Rapid Recover Recover Technology to recover corrupted data of HDD
⑤ It support next generation high speed SATA storage interface upto 6GBps transfer rates for optional access.

(4) Motherboard buses: A bus is a shared linear pathway that connects multiple devices to provide a communication channel between them. Any device connected to the bus can communicate bi-directionally with other devices connected to that bus.
(Read further part for informatory purpose)
(Diagram) ← ↑ Not imp for exam

PCI - The Peripheral Component Interconnect :

The Peripheral Component Interconnect or PCI standard, specifies a computer bus for attaching peripheral devices to a computer motherboard. The PCI bus is a high speed bus that connects high-performance peripherals like video adapters to the chipset processor, disk adapters and network adapters to the chipset processor and memory.

PCI bus width and speed:

PCI expansion bus differs in two respects that determine their performance : PCI bus width and bus speed. PCI with 32 bits width at 33.33 MHz generating 133.33 Mbytes/s is found in Desktops and Entry-level servers. PCI with 64 bits width at 66.66 MHz generating 533.33 Mbytes/s is more commonly found in Mid-range to High-end servers.

Specifications of PCI : Following are the common specifications found in normal PCI's :

1. PCI bus speed : 33.33 MHz clock with synchronous transfers.
2. DATA transfer speeds : 133 MB per second for 32-bit bus width and 266 MB/s for 64-bit bus width
3. Bus size supported : 32-bit or 64-bit
4. 5-volt / 3.3-volt signalling for both 32 bit and 64-bit PCI
5. Supporting of multiprocessor systems
6. Cache support
7. Single or Multimaster capabilities.

Features of PCI bus:

① Extremely high-speed bldata bonsfer: 32-bit wide data transfer @ 33 MHz gives maximum throughput of 132 Mega bytes per second. Data transfer @ 66 MHz with 64 bit wide data is now being offered.

② Plug and play facility: This circumvents the need for an explicit 'address' for a plug in board.

③ New approach: It moves peripherals off the I/O bus and places them closer to the system processor bus, thereby providing faster data bonsfer between the processor and the peripherals.

④ Processor independence: The PCI local bus fulfills the need of local bus standard that is not directly dependent on the speed and sbucture of the processor bus, that is both reliable and expandable.

⑤ Full multimaster capability: This allows any PCI master to communicate directly with other PCI master slave.

⑥ Parity on both address and data lines: This allows implementation of robust systems. Support for both 5V and 3.3V operated logic.

⑦ Forward and backward compatibility between 66 MHz and 33 MHz PCI.

Versions of PCI: (Read for informatory purpose)
Not imp for exam

PCI-X: (Peripheral Component Interconnect extended) is a computer bus and expansion card standard designed to supersede PCI. It is essentially a faster version of PCI, running at twice the speed, and is otherwise similar in physical implementation and basic design.

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Features of PCI-X :

1. Upto 133 MHz bus speed
2. 64-bit bandwidth
3. 1 GB/s throughput
4. More efficient bus operation for easier interface
5. Split Transactions allows an indicator device to make only one data request and relinquish the bus, instead of constantly needing to poll the bus for a response
6. Byte count that enables indicator to specify, in advance, the specific number of bytes requested, eliminating the inefficiency of speculative prefetches
7. Backwards compatibility.

PCI express ~~Speed for~~ PCI express is a new standard for faster video cards ~~comming~~. Most new video cards comming out today are designed for designed for PCI express as newer motherboards and computers being made today are supporting this new connection.

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Advancements of PCI express over PCI :

1. PCI express is a point to point bus topology.
2. The shared bus used for PCI is replaced with a shared switch, which provides each device its own direct access to the bus.
3. PCI Express increases the available bandwidth from 132 MB/s to 8 GB/s.
4. PCI express ~~flag~~ provides each device with its own dedicated data pipeline.

The main advantages of PCI express or PCI are the following:
① Software compatability with old version
② High throughput (upto > 4 GBytes/s)
③ Scalable bandwidth
④ Dedicated to bandwidth per slot.
⑤ Peer to peer communication
⑥ Long life (20+ years in mainstream market)

S-14 Difference between a PCI card and PCI express:
Peripheral Component Interface (PCI) and PCI Express are both types of PC expansion slot. PCI slots and PCI express slots are not compatible, therefore you should not try to interchange cards between these two slot types. PCI cards have a peak transfer rate of 133 MB/s (on 32 MB bus). PCI Express was created in 2004 to replace PCI. Its data transfer rate was increased to 16 GB/s. PCI express is much faster than PCI.

AGP - The Accelared Graphics Port: The Accelarated Graphics Port is also called Advanced Graphics Port. The AGP uses dedicated point to point channel that allows the graphics controller card to direct access the system memory. The AGP enables your computer to have a dedicated way to communicate with the graphics card, due to this enhances the look and speed of graphics.

The AGP transfer rate: The AGP transfers are 32 bits wide, but use 66.6 MHz clock speed. The latest AGP 8x transfers 8-bit per data line per clock cycle yeilding 2133.28 Mbytes/s. AGP 8x is usually used in graphics intensive application like video editing, 3-dimensional mapping, etc.

Advantages of AGP over PCI:

① AGP is superior to PCI because it provides a dedicated pathway between the slot and the processor rather than sharing the PCI bus, allowing for faster communication.

② In PCI, to load a texture, a PCI graphics card must copy it from the system's RAM into the card's frame buffer, whereas an AGP card is capable of reading texture directly from system RAM using the Graphics Address Remapping Table (GART)

(8) Logical Memory Organisation:

Memory Layout in PC:

The system memory in PC, it is often referred to as a single number (512 MB of memory - for ex) is in fact broken into several areas. As a result of design made in the earliest PCs, memory is broken into the following four basic pieces:

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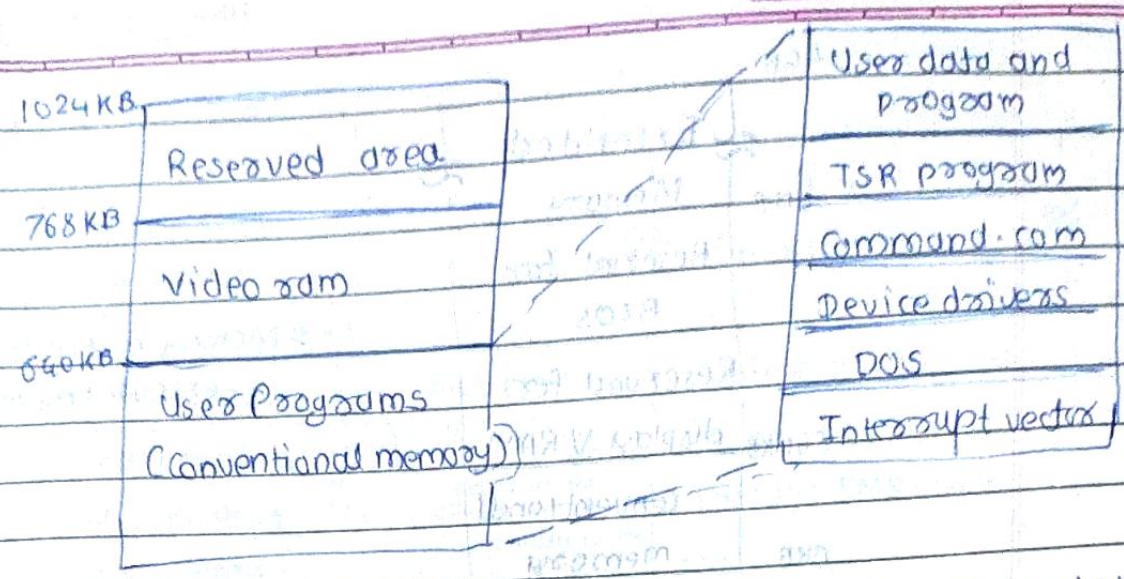
Conventional Memory: The first 640 KB of system memory is called as conventional memory. This is the area that is for use of standard DOS programs, along with many drivers, memory resident programs and most anything else that has to run under standard DOS. Originally, this was the only place that programs could run; today, despite much more memory added to the system, this 640 KB area remains the most important in many cases.

The reason is that without the special software support, DOS cannot run programs that are not in this special area. Conventional memory occupies addresses 00000H to 9FFFFH



The bottom 1K area is used to store interrupt vector pointers Above is DOS itself, it is hard to say about how much space it occupies as it depends on its version. Above DOS loads a special class of programs called device drivers.

Above of device driver Command.com, the most command shell is stored. This accepts input from the users and reformulate them in a manner that operating system can be understand.

Above of Command.com loads TSR (Terminate & stay resident) programs do much same thing as drivers, but they are loaded from AUTOEXEC.BAT.

Above TSR, you find the space for user Program and data. In this user can load data and program.

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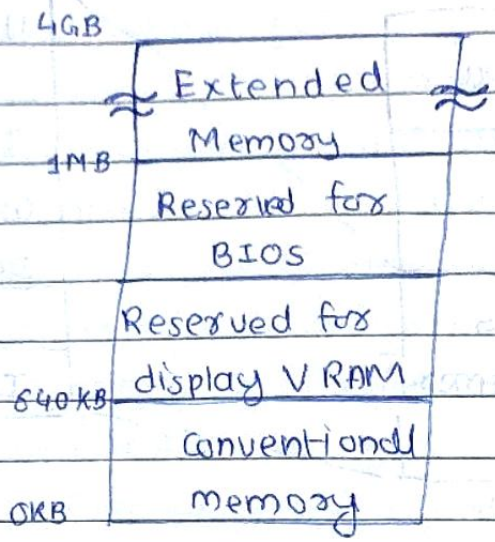
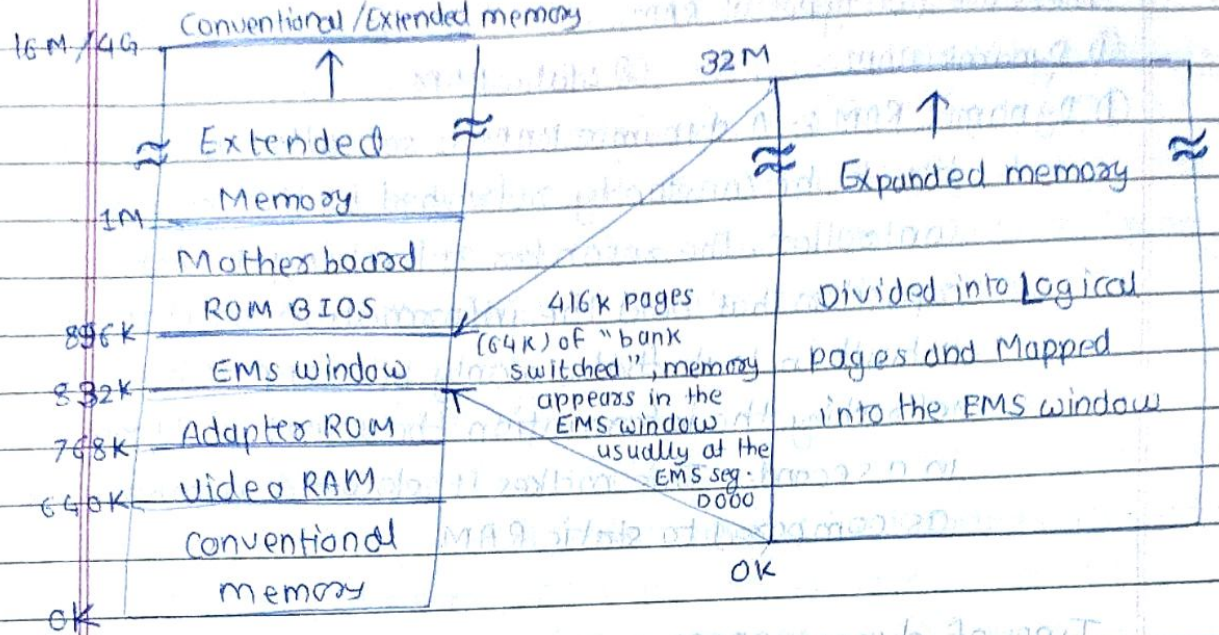
Extended Memory: All of the memory above the first megabyte is called as extended memory. This is all the memory above the high memory until the end of system memory. It is used for programs and data when using an operating system in protected mode, such as any version of memory. Extended memory is found from address 10FFFOH to the last address of system memory.



→ Memory map with extended memory

① → Best for windows and multitasking operating systems
② → Only possible with machines based on 286 and later chips ; impossible with XT's
③ → Used by OS/2 , Unix, windows (3.x, 95, 98 and NT/ 2000/XP).

S-15 Expanded memory: An oldes standard for accessing memory above 1MB which is called as expanded memory. Unlike conventional or extended memory, expanded memory is not directly addressable by the processor. Instead, it can only be accessed through a small 64k window established in the upper ~~area~~ memory area. This type of memory is generally useful only in a system that does not have extended (advance processor) memory available to them.



Conventional, Extended & Expanded memory.

Figure shows expanded memory fits with conventional and extended memory. Intel developed memory board that is necessary for EMS bank switching hardware. The EMS was designed with 8-bit systems in mind because they had no capability to address extended memory. ~~which is~~ The 286 and above processor have the capability of extended memory, which is more efficient than slow bank switching EMS scheme. The EMS board is no longer manufactured and EMS memory concept is extremely absolute

(9) Overview and Features of SDRAM, DDR, DDR2 and DDR3:

Random Access Memory or RAM is a type of data storage used in computers. RAM is our working memory storage. All the data, which the PC uses and works with during the operation, are stored here. Data are stored on drives, typically the hard drive.

There are two types of RAM:
① Dynamic RAM & ② Static RAM

① Dynamic RAM :- A dynamic RAM is so called because it has to be constantly refreshed by the memory controller. The reason for refreshing is that capacitors that hold the information or data have a built in leak that can only be stopped by refreshing the information thousands of times in a second. This makes it slower & cumbersome as compared to static RAM.

Types of dynamic RAM:
i) FPM (First Page Mode)
ii) ECC (Error correcting code)
iii) EDO (Extended Data Output)
iv) SDRAM (Synchronous Dynamic RAM)

SDRAM (Synchronous DRAM) : SDRAM is the replacement for DRAM, FPM and EDO RAM types. SDRAM synchronises the memory access to the CPU lock - while one portion of data is transported to the CPU, another can be prefetched for transfer.

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Features of SDRAM:
① All SDRAM chips for desktop PCs have 168 pins
② Speed of SDRAM is 100 MHz and 133 MHz
③ Generally available in sizes 32 MB, 64 MB, 128 MB, 256 MB, 512 MB, 1 GB, etc.
④ Operating voltage 3.3 V
⑤ The architecture used synchronous
⑥ Operation Max Temperature - 85°C
⑦ It prefetches 1 byte at a time

DDR (Double Data Rate SDRAM): DDR basically doubles the rate of data transfer of standard SDRAM by transferring data on the up and down of the tick cycle. It is incompetible with SDRAM physically, but uses a similar parallel bus, making it easier to implement than RDRAM, which is a different technology.

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Features of DDR:

1. All DDR RAM chips have 184 pins
2. DDR RAMs comes in different speeds i.e 100MHz, 133 MHz, 166 MHz, 200MHz.
3. DDR RAM is twice as fast as SDRAM
4. Operating Voltage 2.5V
5. The architecture used source - synchronous (2n / prefetch)
6. Operation Max Temperature - 85°C
7. It pre-fetches 2 bits at a time.

DDR2: These chips are the next generation of DDR SDRAM memory. DDR2 has twice the latency of DDR but delivers data at twice the speed of DDR, theoratically performing at the same level.

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Features of DDR2:

1. The DDR2 RAM chip has 240 pins.
2. DDR2 to operate at data rates of 400MHz, 533 MHz, 667MHz, and above.
3. Higher bandwidth
4. Lower power 1.8V
5. The architecture used source - synchronous
6. It prefetches 4 bytes at a time
7. Operation Max Temperature 95°C

DDR3: DDR3 SDRAM or double data rate three synchronous dynamic random access memory is a random acess memory technology used for high speed storage of the working data of a computer.

Features of DDR3:
① Introduction of asynchronous RESET pin.
② Support of system level flight time compensation
③ On-DIMM mirror friendly DRAM pinout
④ Inbroduction of CWL (CAS write Latency) per speed bin
⑤ On-die I/O calliberation engiene.
⑥ Read and write calliberation.
⑦ It works on very low power i-e 1.5V
⑧ DDR3 to operate at data rates of 800 MHz, 1066 MHz, 1333 MHz, 1600 MHz and above
⑨ It prefetches 8-bit a time.

S-14 Comparison between SDRAM, DDR, DDR2, DDR3 & DDR4:

	SDRAM	DDR	DDR2	DDR3	DDR4
No. of pins	168	184	240	240	288
Memory density	64MB - 512MB	128MB - 1GB	256MB - 4GB	512MB - 8GB	2GB - 16GB
Clock speed	100 & 133 MHz	100 - 200 MHz	400 - 1066 MHz	800 - 2133 MHz	2400 - 3200 MHz
Max. Transfer Rate	533 - 1066 MBPS	1600 - 3200 MBPS	3200 - 6400 MBPS	6400 - 12800 MBPS	2133 MT/s & 4266 MT/s
Bank used	4	4	8	8	16 (4-bank groups)
Voltage	3.3V	2.5V	1.8V	1.5V	1.2V

MT/s → Million Transfers Per second

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(10) Concept of Cache Memory: Cache memory is a high speed memory kept in between the processor and RAM to increase the data execution speed. It is kept near to the processor.

The CPU uses cache memory to store instructions that are repeatedly required to run programs and improving overall system speed.

Need of Cache Memory:

1. To increase the speed of processes to store frequently accessed memory location in that cache so that CPU can access immidiately.
2. It is directly accessible memory to CPU or processor.
3. It is the fastest memory as compared to all other memory.
4. When a program executes, the cache memory is searched first
5. It increases the speed of CPU and processor.

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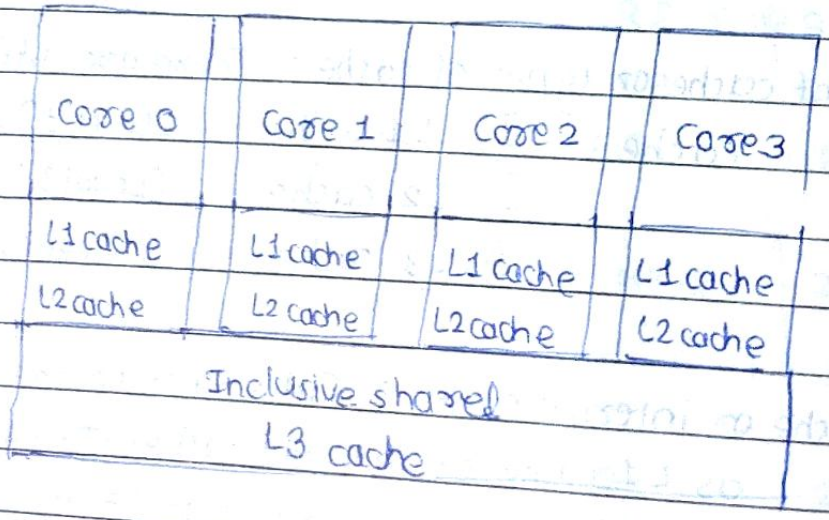
Levels of cache or types of cache: There are different levels of cache: (1) L1 cache (Level 1)
(2) L2 cache (Level 2)
(3) L3 cache (Level 3)

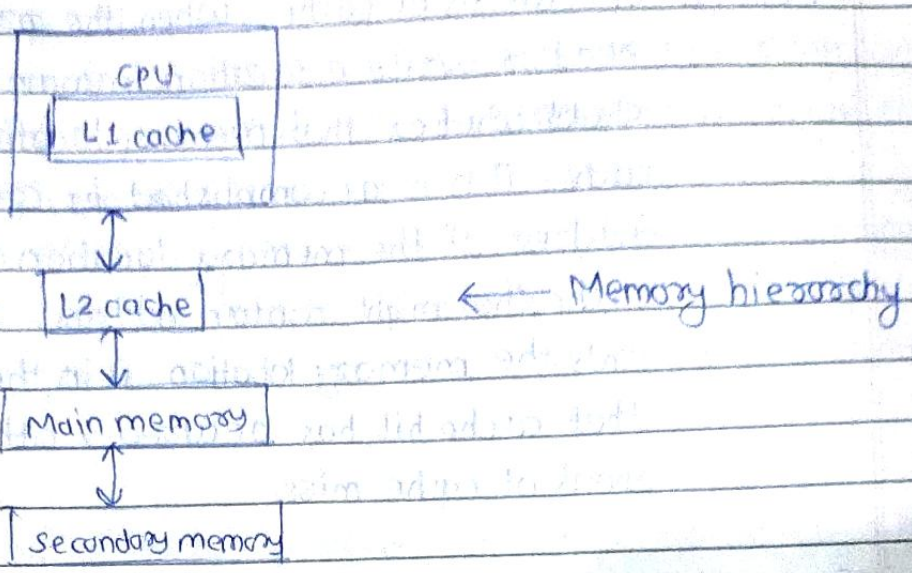
L1 cache or internal cache: Cache built in the CPU itself is known as L1 cache or internal cache. It is a small, high speed cache incorporated right into the processor's chip. The L1 cache typically ranges in size from 8KB to 64KB and uses high speed SRAM (static RAM) instead of slower, cheaper DRAM (Dynamic RAM) used for main memory.

L2 cache or external cache: A cache that resides on seperate chip next to the CPU is called Level 2 (L2) cache or external cache. It is a memory between the RAM and the CPU and is bigger than the primary cache (typically 64KB to 4MB).
The L2 cache is also a unified, non-blocking cache, which improves performance over the cache-on-motherboard solutions through dedicated 64-bit cache.

L3 cache or shared cache: L3 cache has come into trend with the advent of multi-core CPU. Whereas these chips will have both L1 and L2 caches for each seperate core; there is common fairly large L3 shared by all cores. It is usually the size of all other caches combined or a few multiples of all other caches combined.



L1, L2 and L3 levels of cache on CPU chip



Advantages of cache:

1. The cache memory enhances the speed of system or improving performance.
2. Cache memory reduces a traditional system bottleneck.
3. As the cache memory lines on the same chip (for L1 cache) access time is very small.
4. The same block of data which are stored on the main memory resides on the cache. Thus the instructions take less time to execute.
5. The CPU and the cache are connected with a local bus which is of high capacity and speed due to which the data transfer is quick.
6. Cache memory is intelligent memory.
7. It holds the current working set of code and data.
8. It reduces wait state or no wait state (L1 cache) in the system.

Disadvantages of cache:

1. Size is very small
2. Cost is very high

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Detail of operations of cache: When the processor needs to read or write a location in main memory, it first checks whether that memory location is in the cache. This is accomplished by comparing the address of the memory location to all tags in the cache that might contain address. If the processor finds the memory location is in the cache, we say that cache hit has occured; otherwise we speak of cache miss.

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Comparison of L1 and L2 cache

L1 cache	L2 cache
(1) Cache built in the CPU itself is referred to as L1 cache or internal cache	(1) Cache that resides on a seperate chip next to the CPU is called as L2 cache or external cache.
(2) This is directly accesible to the processor	(2) This is resides in between the processor and RAM
(3) It is small in size	(3) It is bigger in size
(4) It is faster cache	(4) It is slower cache
(5) The cost is more	(5) The cost is less
(6) This is resides on level 1 cache of memory hierarchy.	(6) This is resides on level 2 cache of mememory hierarchy.
(7) In this waiting delay is less	(7) In this waiting delay is more

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BIOS & CMOS setup:

BIOS: The Basic Input Output System also called as ROM BIOS, PC BIOS, System BIOS. It is a software program that tests the computer hardware components.

The BIOS is a ROM memory chip on the mother board. It contains a set of routines to check the computer hardware configuration, if all tests passed then load the operating system.

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Main functions of BIOS:- A main function of the BIOS is to give instructions for the power on self test (POST). This self test ensures that the computer has all of the necessary parts and functionality needed to sucessfully start itself, such as use of memory, a key board and other parts.

If errors are detected during the test, the BIOS instructs the computer to give a code that reveals the problem. Error codes are typically a series of beeps heard shortly after startup.

The BIOS also works to give the computer ~~have been loaded~~ basic information about how to interact with some critical components, such as drives and memory that it will need to load the Operating System.

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C-MOS setup: The data on the CMOS chip can be accessed and updated via the CMOS setup program. The main manufacturers of BIOS are:

1] American Megatrends (AMI)
2] Award software
3] Pheonix technologies

The CMOS setup can be accessed when the system boots, but there are different ways of doing that:
① AMI and Award BIOS use the DEL key to enter into CMOS setup.
② Pheonix BIOS use Ctrl-Alt-Esc or F2 key to enter into CMOS setup.

CMOS is used to store or update specific information about your system:
i] Amount of RAM present
ii] Type of hard disk drive
iii] Date and time.
Needs battery power to "remember" when power is off

The following CMOS setting options are available (This will change manufacturer to manufacturer):
① CPU soft menu - Enables you to set the voltage and multiplier settings on the motherboard for the CPU.
② Advanced BIOS features - Used for selecting boot options
③ Advanced chipset Features - Deals with extremely low level chipset functions
④ Integrated peripherals - Allows you to configure, enable, or disable on-board ports.
⑤ Power management setup - Used to setup power management settings for the system for the system.
⑥ PnP/PCI :- Used for assigning IRQs to certain resources.

Other options include:
① Load Fail-Safe Defaults: Used when low-level problems occurs
② Load optimised defaults: sets the CMOS to the best possible speed and stability of the system
③ Set password
④ Save and exit setup
⑤ Exit without saving.