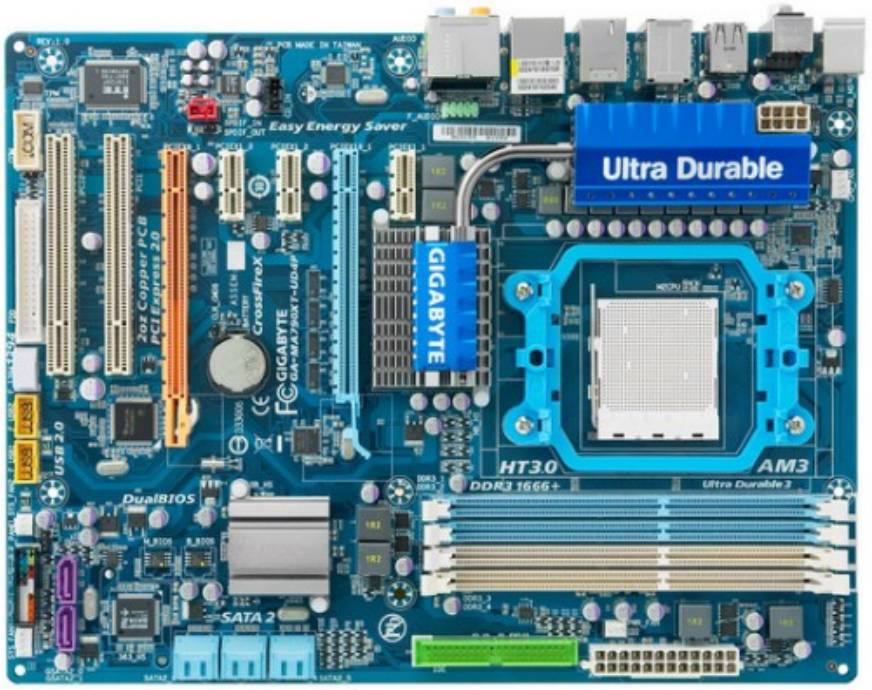
220-1101

Motherboards, Processors, and Memory

Motherboard

- Main component of any PC
  - PCB
  - All other components plug or connect to motherboard.
  - Different form factors

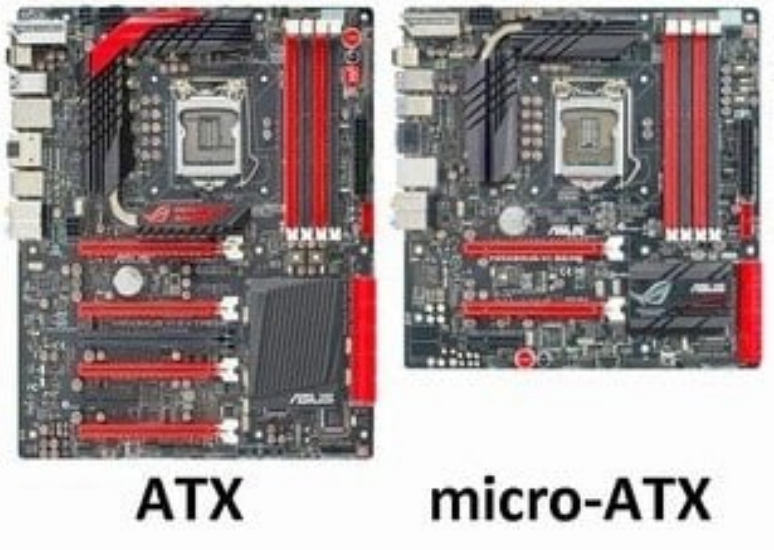


Motherboard Form Factors

- The “Form Factor” identifies different sizes
- ATX – Advanced Technology Extended
  - 305mm x 244mm
  - Processor and memory slots at right angle to expansion slots – position allows better cooling
  - Allows full length expansion card installation

Motherboard Form Factors

- Micro ATX
  - 244mm x 244mm
  - Smaller than ATX
  - Component placement still important for cooling
  - Compromise is required
    - Less memory slots
    - Less expansion slots
    - Less headers (SATA, USB, etc.)
  - Can be used in an ATX case
  - PSU often have lower watt rating



Motherboard Form Factors

- ITX – Information Technology eXtended
  - Low power
  - Small Form Factor (SFF)
    - Useful for HTPC (Home Theatre PC), Compact Systems, Embedded Systems.
  - Mini-ITX can be mounted in ATX, Micro ATX Cases
    - Rear interface aligned with ATX, mini-ATX

Motherboard Form Factors

- ITX – Information Technology eXtended
  - Four form factors
    - Mini-ITX (170mm x 170mm)
      - Also called mITX
      - ATX case compatible
    - Nano-ITX (120mm x 120mm)
    - Pico-ITX (100mm x 72mm)
    - Mobile-ITX (60mm x 60mm)

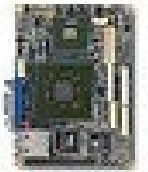
Motherboard Form Factors

Standard-ATX

Micro-ATX

Mini-ITX

Nano-ITX



Pico-ITX

Motherboard Components

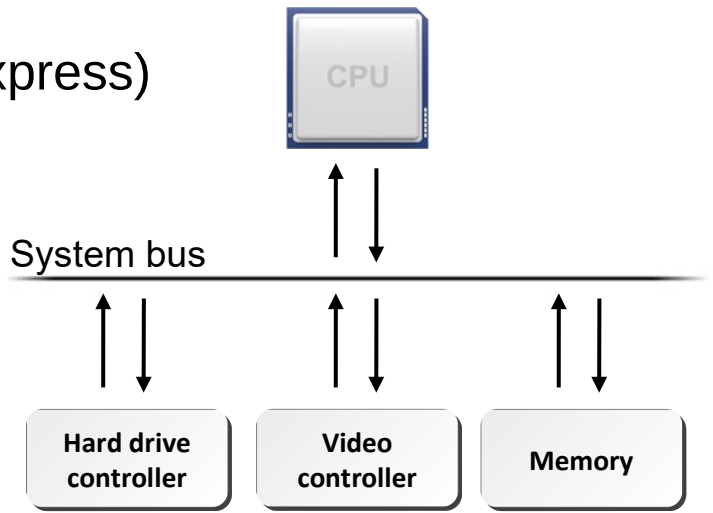
- Need to understand the following:
  - Bus architecture
  - Chipsets
  - Expansion Slots
  - Memory Slots and external cache
  - CPU’s and their sockets
  - Power Connectors
  - Onboard disk drive connectors
  - BIOS/UEFI/firmware
  - CMOS battery
  - Front panel connectors

Bus Architecture

- Data communication between components on a bus
  - More than one on a motherboard
    - Closed bus – no access to external devices
    - Open bus – interfaces provided to external devices
- Higher bus speeds = higher performance
- Internal bus speed defined by the front side bus clock (more later)

Bus Architecture

- Serial Bus v Parallel Bus
  - Serial – one bit at a time
    - Simple
    - Originally inferior to parallel, but technology advancement makes it faster than parallel e.g. SATA (Serial Advanced Technology Attachment), USB (Universal Serial Bus), PCIe (Peripheral Component Interconnect Express)
  - Parallel – 8 bits or more at a time
    - Reduced bus distance
    - SCSI (Small Computer System Interface)

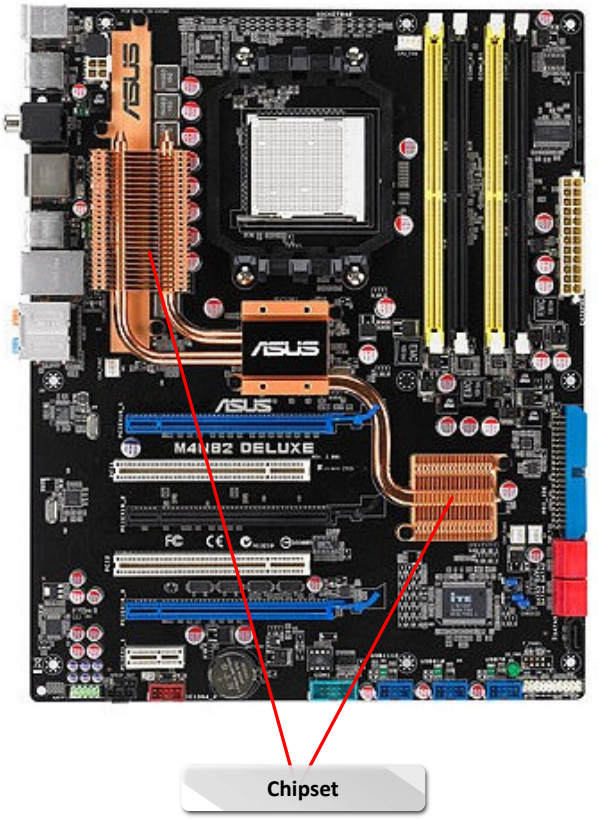


Chipsets

- Collection of chips/circuits for motherboard operation
- Defines what the motherboard supports
- Each has a name and model number
- Check manufacturer documentation

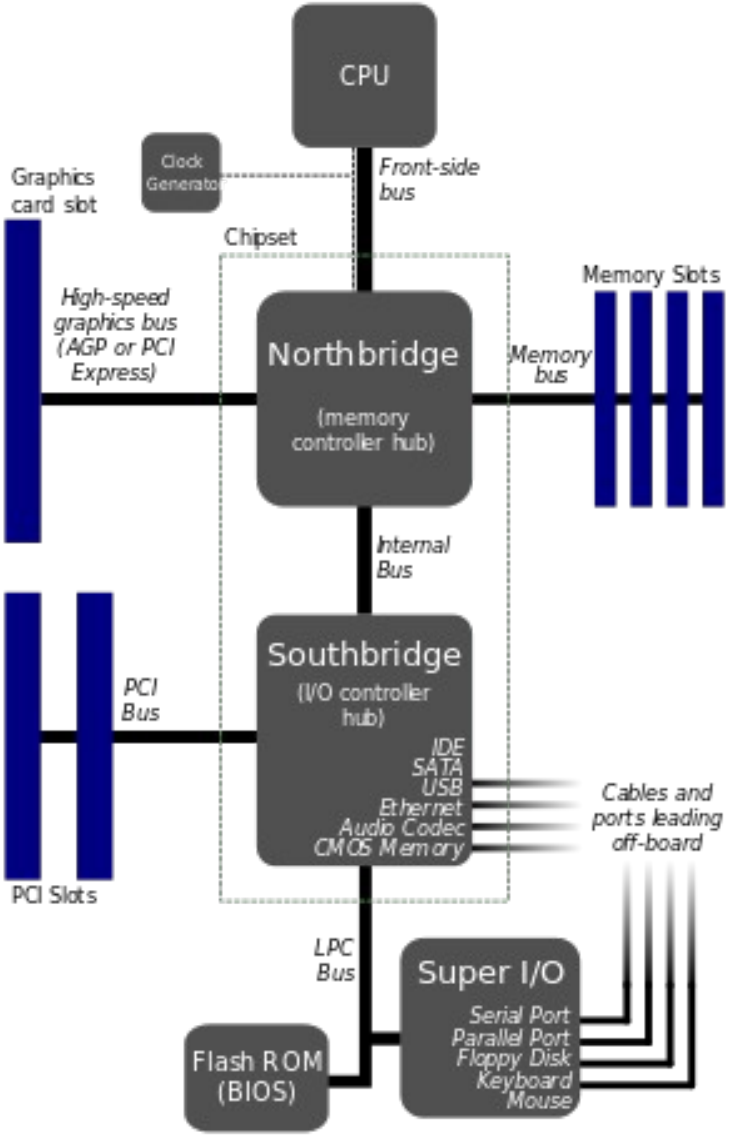
Chipset


LGA 1366 Socket
DDR3 Memory
ATX 2.0 Power 24pin
PCI Express
PCI Bus
P6T DELUXE V2
Chipset


ASUS
M4N82 DELUXE
Chipset

Chipsets

- Lookup Pro Z690-A and B550M-PLUS and answer the following:
  - Who manufactures the board?
  - What is its form factor?
  - What Processor type does it support?
  - What Memory type does it support?
  - Whats the maximum memory supported?
  - Does it support RAID?

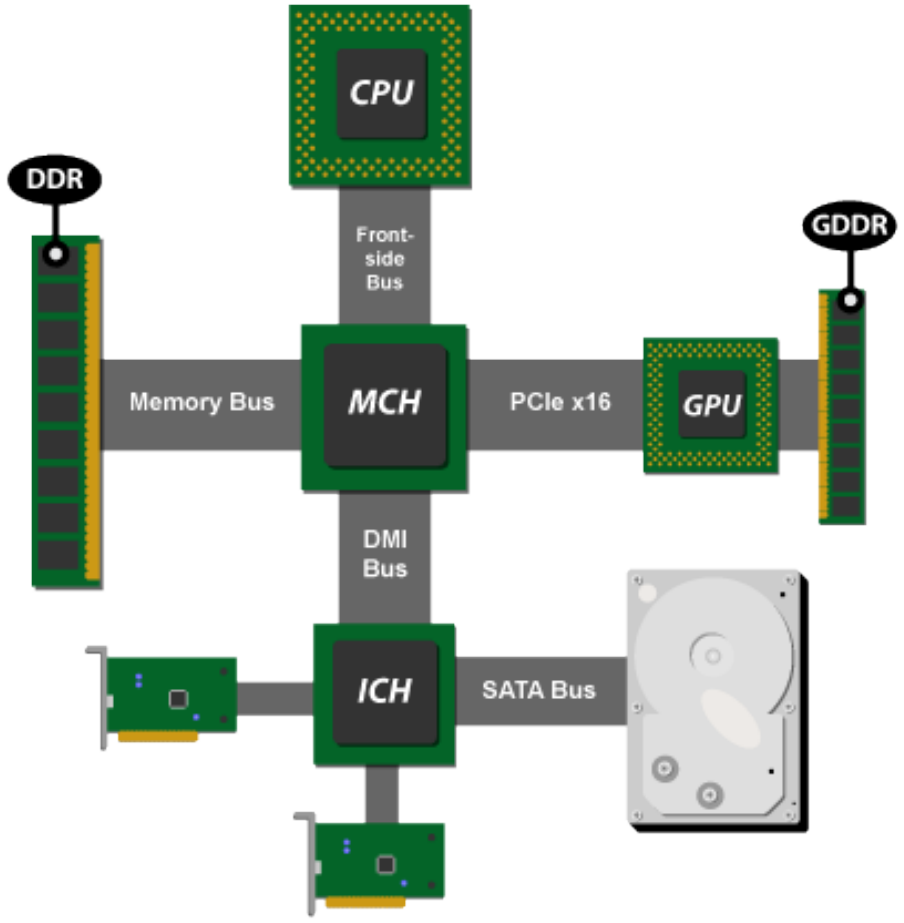

CPU
Clock Generator
Front-side bus
Graphics card slot
Chipset
Memory Slots
High-speed graphics bus (AGP or PCI Express)
Northbridge
(memory controller hub)
Memory bus
Internal Bus
Southbridge
(I/O controller hub)
PCI Bus
IDE
SATA
USB
Ethernet
Audio Codec
CMOS Memory
Cables and ports leading off-board
PCI Slots
LPC Bus
Super I/O
Serial Port
Parallel Port
Floppy Disk
Keyboard
Mouse
Flash ROM (BIOS)

Chipsets

- On Intel boards (and AMD) two sets
- Northbridge
  - Controls system memory and AGP video ports
  - Memory caching
  - Closer to processor
  - Communicates directly to PC with a 64 bit front side bus
  - True performance of PC relies on the Northbridge
- Southbridge
  - Controls input / output functions
  - System clock
  - Drives and buses
  - Advanced power management
  - Furthest from CPU
  - Interfaces to slower onboard peripherals
  - Uses PCI bus to communicate with Northbridge

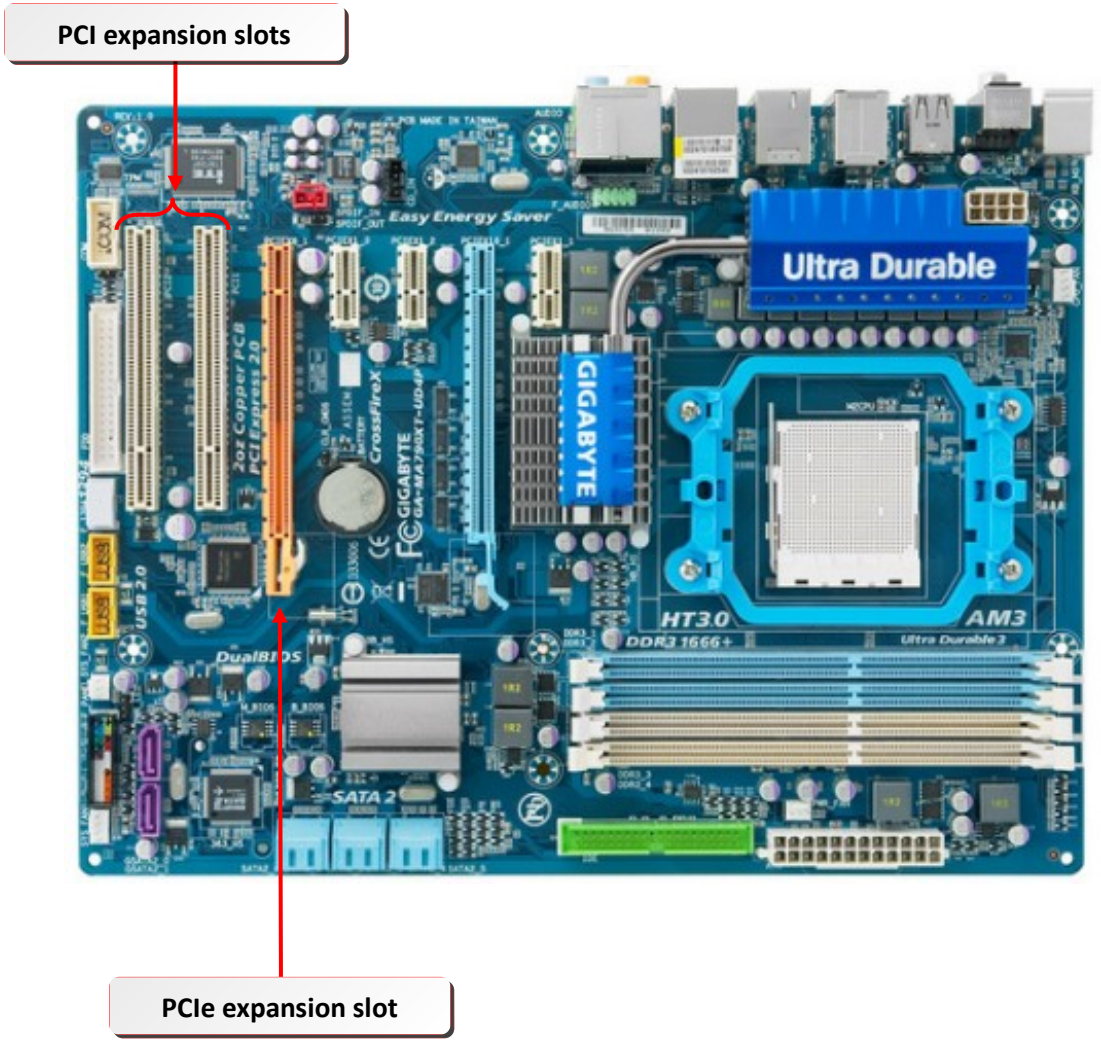
Intel Hub Architecture (IHA)

- Newer systems
- Two chips
  - Graphics Memory Controller (GMC)
  - I/O Controller Hub (ICH)
  - Faster than North and South bridges



Expansion Slots

- Allows addition of expansion cards
- Extend PC capability


PCI expansion slots
Easy Energy Saver
Ultra Durable
GIGABYTE
2oz Copper PCB
PCI Express 2.0
CrossFireX
GIGABYTE
GA-MA790X-UD4P
USB 2.0
DualBIOS
SATA 2
HT3.0
AM3
DDR3 1666+
Ultra Durable 3
PCIe expansion slot

Units of Data

- “b” = “bit”.
- “B” = “byte.”
- 8 bits in a byte
- 1 megabit is 1,000,000 bits
- 1 megabyte is 1,000,000 bytes.

PCI – Peripheral Component Interconnect

- Most common expansion slot
- Cards operate at 33 or 66MHz
- Up to 8 functions per slot
  - 32bit @ 33MHz – 133MBps throughput
  - 32bit @ 66 MHz – 266MBps throughput
  - 64bit @ 33MHz – 266MBps throughput
  - 64bit @ 66MHz – 533MBps throughput
- 5 cards per bus and a system can have two PCI buses

PCI-X (PCI-eXtended)

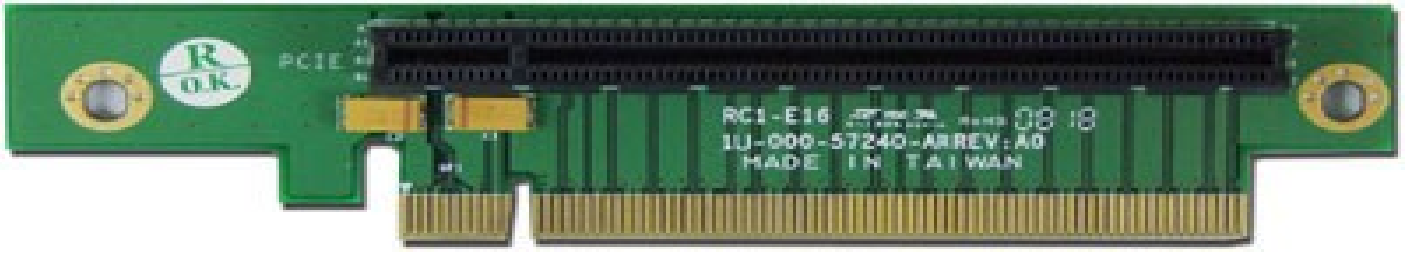
- Improves PCI expansion capabilities
- Increased bandwidt and faster speeds by doubling the bus width from 32bits to 64bits
- PCI-X 1.0 speeds 66MHz to 133MHz
  - 64bit @ 66MHz – 533MBps throughput
  - 64bit @ 133MHz – 1.06GBps throughput
- PCI-x 2.0 speeds 266MHz or 533MHz
  - 64bit @ 266MHz – 2.13GBps (using double data rate technology)
  - 64bit @ 533MHz – 4.26GBps (using quad data rate technology)
- PCI and PCI-X also called “Parallel PCI”. PCI Express uses a serial lane based architecture

PCI Express (PCIe)

- Not compatible with PCI
- Replacement for AGP
- Full Duplex
- Serial Bus
- Uses the concept of Lanes
  - More lanes, more bandwidth
  - Eight lanes in x8
- Latest version is 3.x
  - 1 GBps per lane
  - PCIeX16 – 16 Gbpbs
- Next version 4.x
  - 16 GTs (Gigatransfers per second)
  - X16 slot (16 lanes) will handle 64 GBps in one direction
- Excellent for high speed graphics or network cards
- Local serial interconnection

Riser Cards

- Provides additional expansion slots
- Plugs into motherboard
- Changes slot orientation
- Often in rackmount servers



Memory

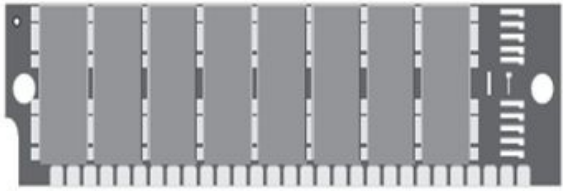
- RAM – Random Access Memory
  - Volatile
  - Easily Modified
  - Requires constant voltage to retain data
- ROM – Read Only Memory
  - Non Volatile
  - Not easily modified
  - Data retained during power cycles

RAM Slots

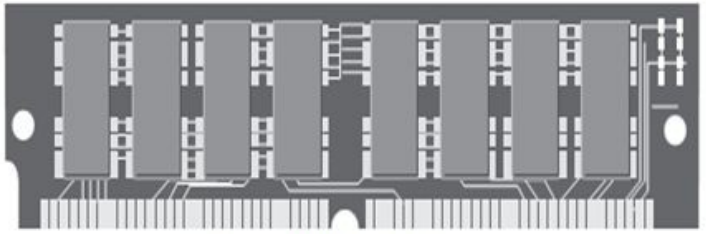
- DIMM (Dual In-Line Memory Module)
  - Solves the issue of requiring pairs of memory sticks
  - Pairs do optimise performance though
  - Use a 64bit data path (contacts on both sides)
  - Original DIMMs had a 168 pin connector
  - Normally black slots on Motherboard
- RIMM (Rambus Inline Memory Module)
  - Packaging for Rambus DRAM (RDRAM)
  - For high speed applications
  - First to have metal cover as heatsink
  - Same number of pins as DIMM, but different settings mean not interchangeable with DIMM

RAM Slots

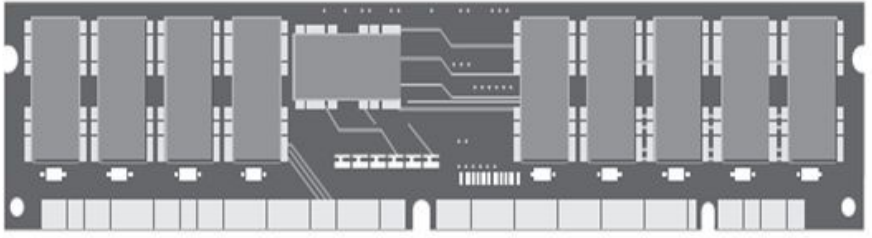
- SODIMM (Smal Outline Dual In-Line Memory Module)
  - 144pin or 72pin
- SIMM (Single Inline Memory Module)
  - Older format



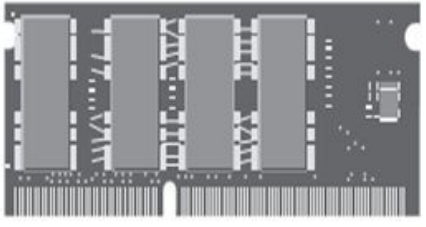
30-pin SIMM (3.5 × .75″)



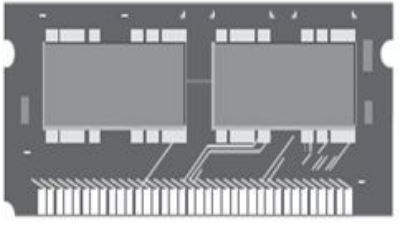
72-pin SIMM (4.25 × 1″)



168-pin DIMM (5.375 × 1″)



144-pin SODIMM (2.625 × 1″)



72-pin SODIMM (2.375 × 1″)

Memory

- If not enough, possible “Out of Memory” errors
- Paging
  - Using hard drive as RAM
  - Also called virtual memory
  - PAGEFILE.SYS
  - Not direct access, info paged into and out of RAM
  - Degrades PC performance

Memory

- Caching
  - Small fast memory between CPU and RAM
  - Three Levels
    - Level 1
      - Smallest and fastest
      - On processor (one per core)
    - Level 2
      - Larger and Slower than L1
    - Level 3
      - Larger and slower than L2

Memory

- General rule: the further from the processor, the slower and larger memory becomes.
- Various utilities will show details.
  e.g. CPU-Z from www.cpuid.com

Memory

- Non Parity memory
- Parity Checking
  - Error checking but without data correction
  - 9th bit added
  - Even Parity – add bit to make number of 1’s even
  - Not common

Memory

- ECC - Error Checking and Correction
  - Error checking with data correction
  - Check bits calculated and stored
  - Algorithm is run to check the data when it is accessed
  - Can detect single and double bit errors
  - Can correct single bit errors

Memory

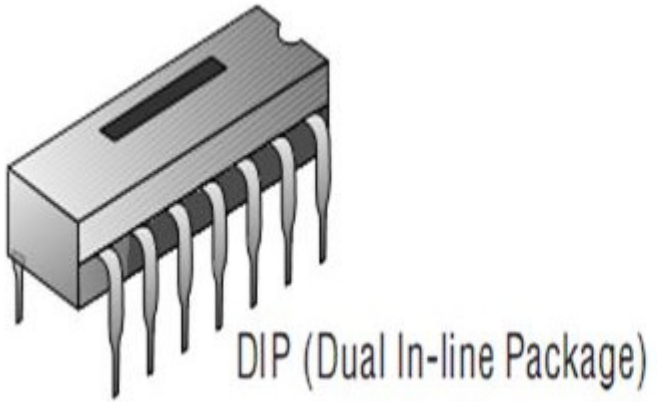
- DRAM – Dynamic RAM
  - Cheapest type of RAM
  - Needs refresh signal
- Asynchronous DRAM
  - Uses independent clock from the CPU
  - No longer used
- Synchronous DRAM
  - Shares the CPU clock
  - Same speed of FSB
- SRAM – Static RAM
  - No refresh signal required
  - Complex and more expensive
  - Cache memory

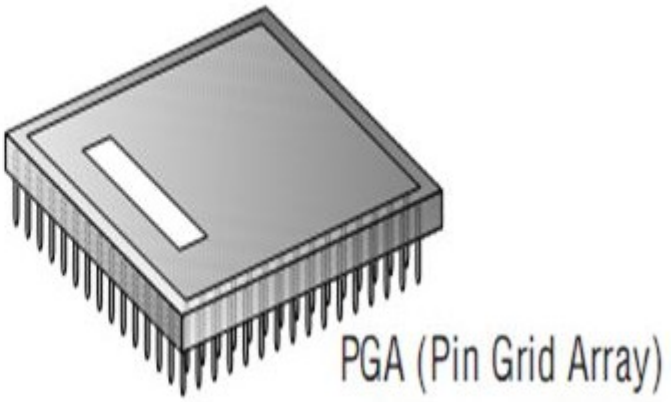
Memory

- https://youtu.be/DjSC2J7hvH4
- https://youtu.be/W7sIU8UoTpA
- ROM – Read Only Memory
  - Normally only written to once
  - PROM (Programmable ROM)
  - EPROM (Erasable Programable ROM)

CPU

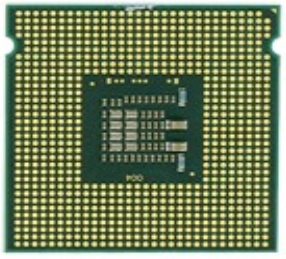
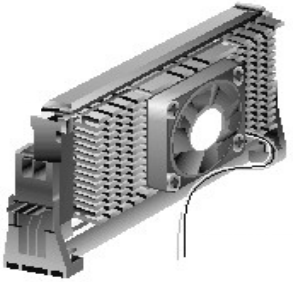
- Central Processing Unit
- Hidden by heatsink, an essential component
- Different sockets

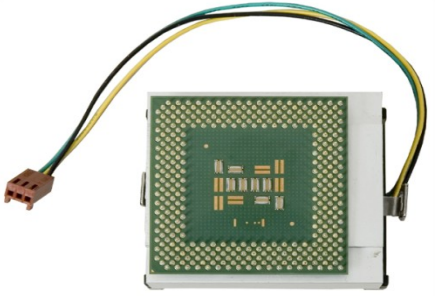

DIP (Dual In-line Package)


PGA (Pin Grid Array)

CPU

- Modern Processors use LGA (Land Grid Array) packaging
  - LGA Pins are not on processor.
    better than PGA (Pin Grid Array)
  - Processor contacts on processor, called lands
- Held in place by a ZIF (Zero Insertion Force) socket



Processors

- Intel and AMD dominate market
- Use msinfo32.exe to get information on your processor set up
- Server Processors
  - Intel Xeon
  - AMD Opteron
- Non Server Processors
  - (Intel) Pentium, Core 2, Celeron, Core i3, Core i5, Core i9
  - (AMD) Phenom, Athlon, Semperon, Duron, Turion
- Virtualisation Support
  - (Intel) VT-x
  - (AMD) AMD-V

Processors

- CISC – Complex Instruction Set Computing
  - Intel and AMD
- RISC – Reduced Instruction Set Computing
  - Not inferior to RISC
  - Smaller than CISC
  - Less heat
- ARM – Advanced RISC Machine
- Not Compatible
  - Code has to be developed for each platform
- x64/x86
  - Bus size

CPU Characteristics

Characteristic or Technology	Description
Architecture	A description of the width of the CPU's front-side bus, which is either 32 or 64 bits.
Clock speed	The number of processing cycles a microprocessor can perform in one second. Also referred to as processor performance.
Overclocking	Configuring the CPU to run faster than it is rated to handle.
CPU speed	The overall rate at which instructions are processed. Factors that contribute are core clock speed and bus clock speed.
Throttling	Adjusting CPU speed to slow down during idle time or when hardware problems occur. Common in mobile devices.
Hyperthreading	A feature of some Intel CPUs that enable one physical CPU to be recognized as two logical CPUs, increasing performance by up to 30%.

CPU Characteristics

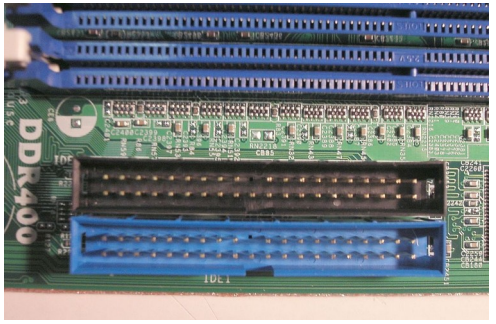
Characteristic or Technology	Description
Integrated GPU	Graphics processing unit included on the CPU instead of dedicated graphics card.
Virtualization support	Virtualization software built into CPU's chipset, enabling fast and efficient processing of instructions from multiple operating systems.
Cores	The computational heart of the PC. A CPU that contains multiple cores can be faster and more efficient than a single-core CPU.
Cache	Dedicated high-speed memory for storing recently used instructions and data.
VRM	Voltage regulator module, provides the CPU with the appropriate voltage.
MMX	Multimedia extensions, additional instructions that support sound, video, and graphics.
EDB (Execute Disable Bit)	A hardware-based security feature that allows the processor to classify and separate memory areas where application code can and cannot run. Intel: XD bit; AMD: Enhanced Virus Protection. The OS must support the NX bit to use this feature.

32 bit & 64 bit

- How many bits of data a processor can handle.
- 64bit uses memory more efficiently
- 64bit can handle more memory
- 64bit reduces caching to disk
- 32bit software can run on 64bit systems
- x86 refers to 32 bit systems (historic reasons not x32)
- x64 refers to 64 bit systems

Disk Drive Connectors

- IDE (Integrated Drive Electronics)
  - Originally most common
  - Called PATA
  - Legacy technology



- SATA (Serial Advanced Technology Attachment)

Storage Devices

- HDD (Hard Disk Drive)
  - Platters
  - Memory Chips (SSD)
- Disk Controller
  - Circuit to allow CPU to communicate with the HDD
- Hard Drive Speeds
  - The speed the disk spins to retrieve the data
  - Measured in rpm
- Hot swappable
  - Allows replacement whilst the system remains powered on
  - Cant just pull out of slot though!

Storage Devices

- SATA
  - Serial Advanced Technology Attachment
  - One device per channel
  - Supports hot swapping
  - External SATA ports on some PC’s

Storage Devices

Version	Characteristics
SATA 1.5Gb/s	• Transfer speed: 1.5 Gb/s • Interface throughput: 150 MB/s
SATA 3Gb/s	• Transfer speed: 3.0 Gb/s • Interface throughput: 300 MB/s • Backwards-compatible with SATA 1.5Gb/s
SATA 6Gb/s	• Transfer speed: 6.0 Gb/s • Interface throughput: 600 MB/s • Backwards-compatible with SATA 1.5Gb/s and SATA 3Gb/s
SATA 16Gb/s	• Transfer speed: 16.0 Gb/s • Interface throughput: 1969 MB/s • Backwards-compatible with SATA 1.5Gb/s and SATA 3Gb/s
eSATA	• External SATA connectivity • Transfer speed: 3.0 Gb/s • Interface throughput: 30 MB/s

Storage Devices

- SSD
  - Uses non-volatile memory
  - Faster and more reliable than mechanical storage
  - Can be removable or internally installed
  - Can be divided into three categories:
    - USB flash drives
    - Memory cards
    - Solid state drives

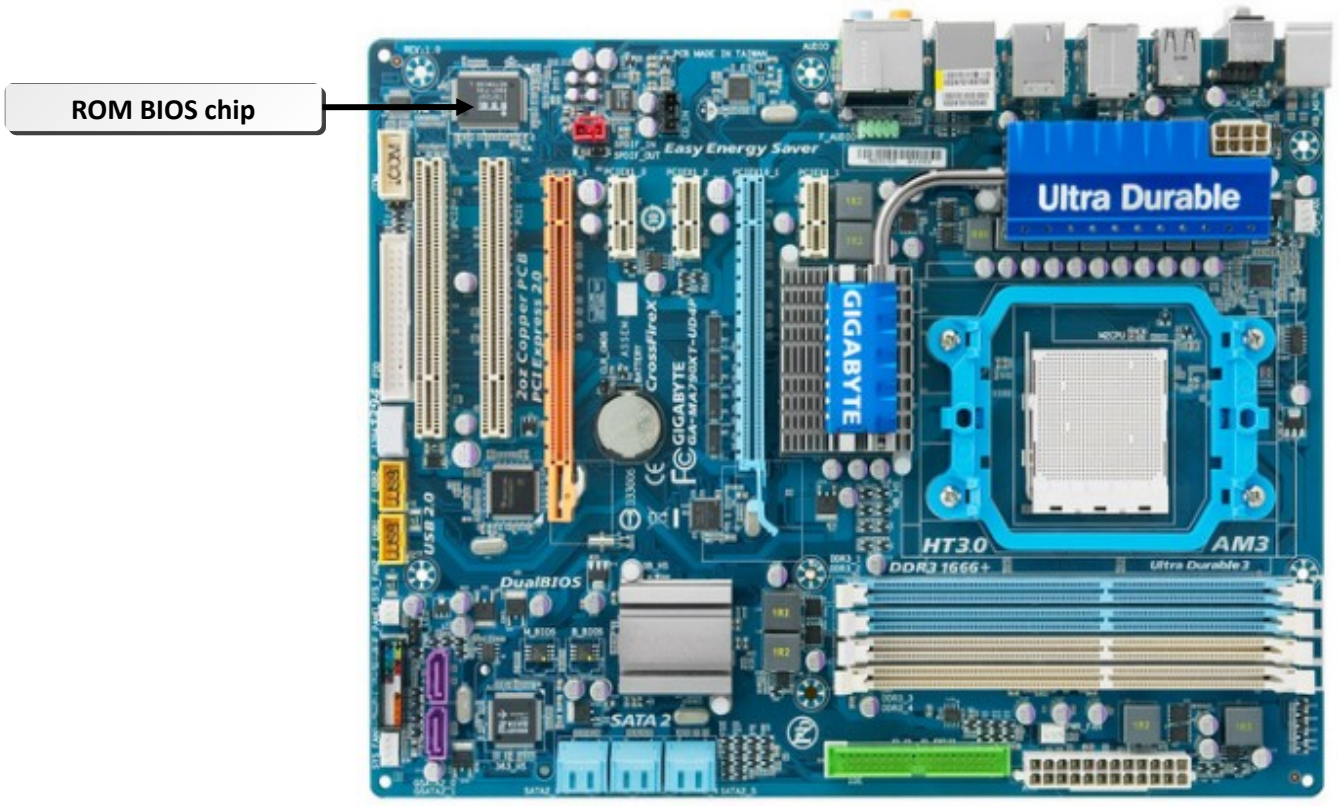
M.2

- M dot 2
- Primarily used for Hard Drives
- Also
  - Wi-Fi
  - Bluetooth
  - GPS
  - NFC
- Form factor not a bus standard
  - Connect a SATA device (using correct adapter), the speed is defined by the SATA device

Firmware

- Specialised Software
- Stored in ROM that can be updated
  - Updating sometimes called flashing
- Best example - BIOS

System BIOS


ROM BIOS chip
Easy Energy Saver
Ultra Durable
GIGABYTE
2oz Copper PCB
PCI Express 2.0
CrossFireX
USB 2.0
DualBIOS
SATA 2
HT3.0
AM3
DDR3 1666+
Ultra Durable 3

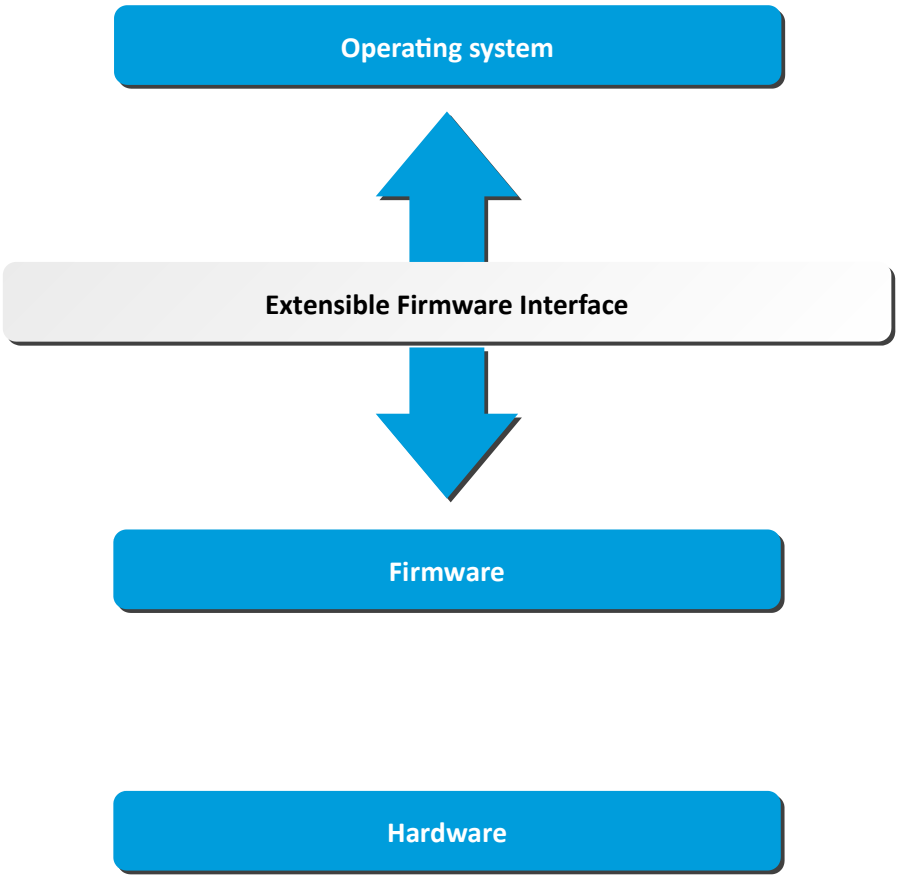
System BIOS

- Basic Input/Output System
- Stored in ROM
- Starts basic services of the computer
- Every PC has a BIOS
- Devices can have own BIOS
- Sometimes integrated onto Southbridge

UEFI

- Unified Extensible Firmware Interface
- Replacement for BIOS
  - Improves user interface
  - Supports remote diagnostics
  - Legacy support for BIOS services
- Advantages over BIOS
  - Can boot from larger disks (2TB+) with a GUID partition table (GPT)
  - CPU independent architecture and drivers
  - Flexible pre-OS environment with networking abilities
  - Modular design
- Some systems allow a choice between BIOS and UEFI

UEFI


Operating system
Extensible Firmware Interface
Firmware
Hardware

BIOS/UEFI Security and Encryption

- BIOS Password
  - User (boot) password
  - Administrator
- Now has closer integration with OS
  - TPM (Trusted Platform Module)
    - BIOS configured to boot after authenticating boot device
    - Process is called “sealing”
      - Devices can’t be used if removed from the system
    - Start → Settings → Update & Security → Windows Security → Device Security
    - Modern Motherboards have a TPM chip on them
    - Secure Boot

The POST

- Power-On Self Test
- Built in diagnostic program
- Runs on computer start up
- Checks hardware before OS boot
- Audible beep (manufacturer implemented)

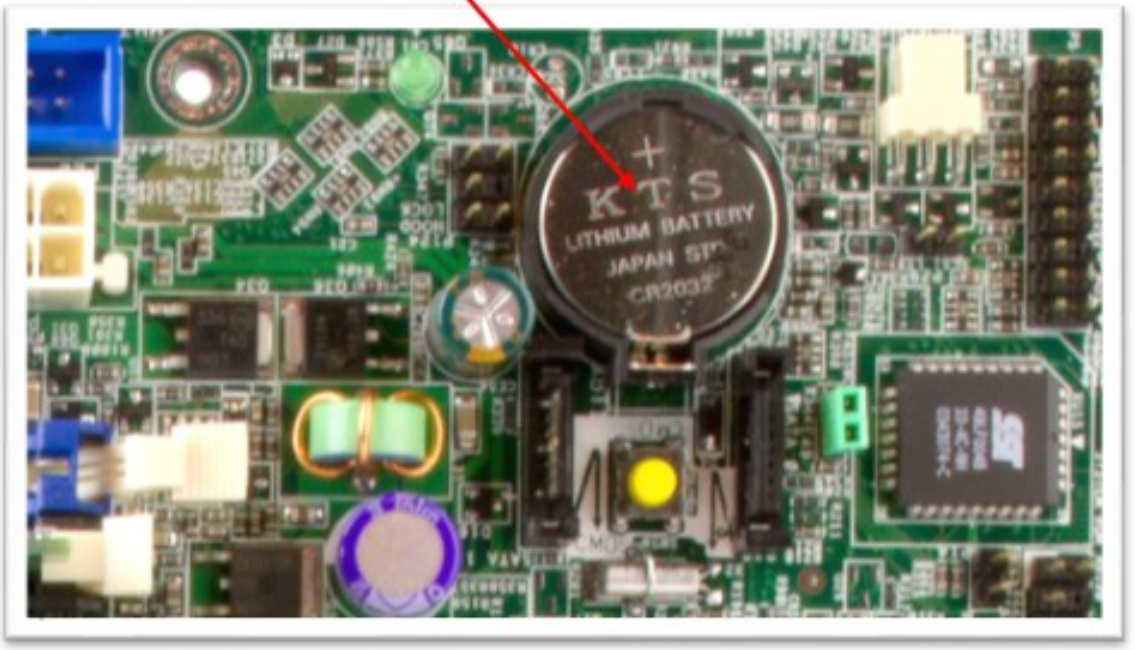
POST Steps

Hardware Component	POST Test Criteria
Power supply	• Must be turned on • Must supply “power good” signal
CPU	• Must exit **Reset status** mode • Must be able to execute instructions
BIOS	Must be readable
BIOS memory	Must be readable
Memory	• Must be able to be read by the CPU • First 64 KB must be able to hold the POST code
Input/output (I/O) bus or I/O controller	• Must be accessible • Must be able to communicate with the video subsystem

CMOS Batteries

- Complementary metal-oxide-semiconductor
- Small battery to provide power for realtime clock and other critical settings when power switched off
  - CMOS Read Error or CMOS Battery Failure
- Other system settings stored
- When replacing, write down settings in BIOS

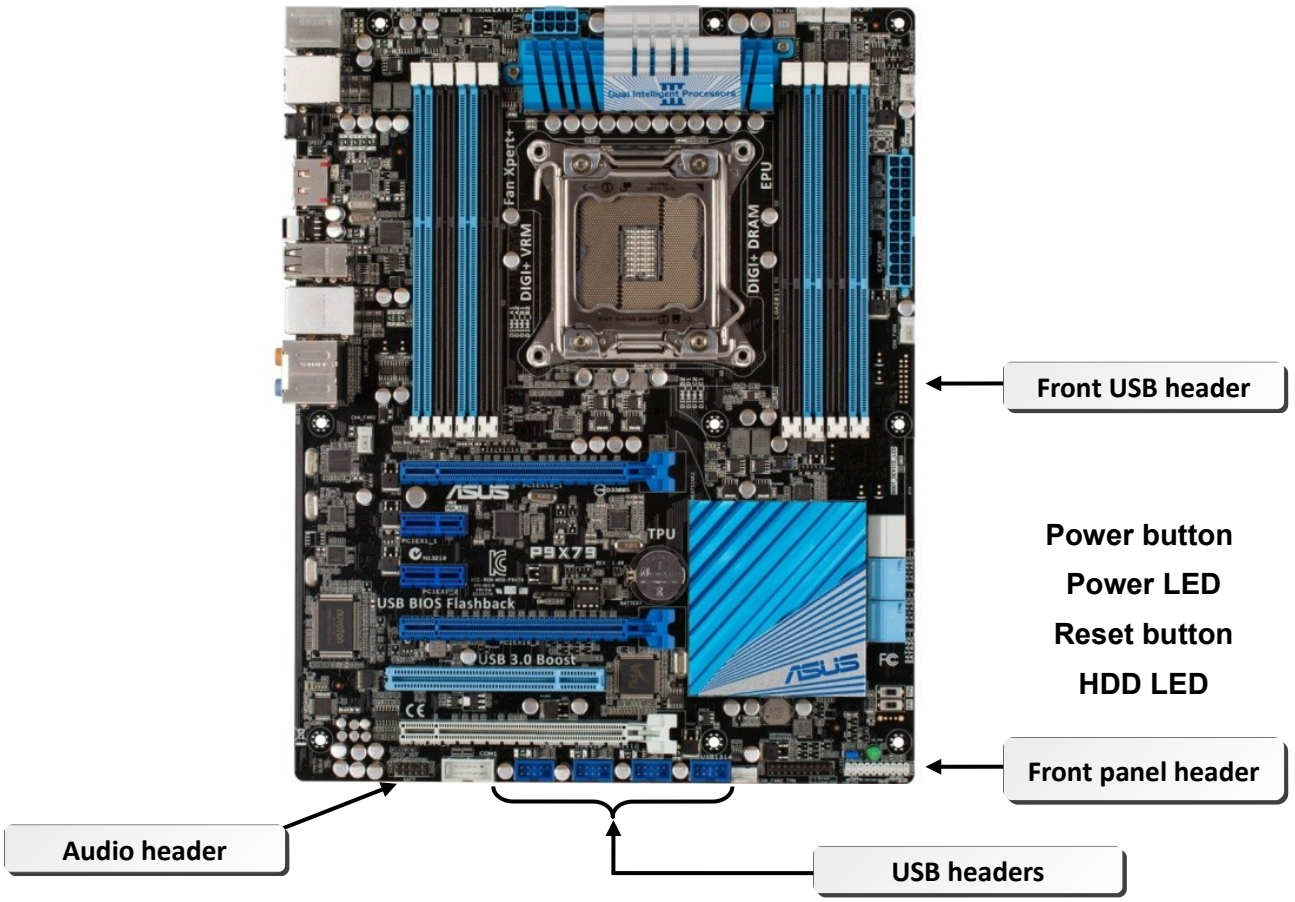
CMOS battery



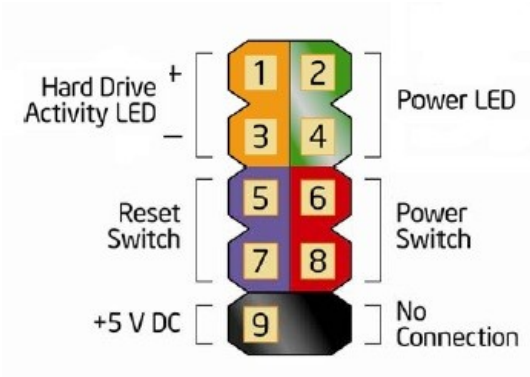
CMOS Settings

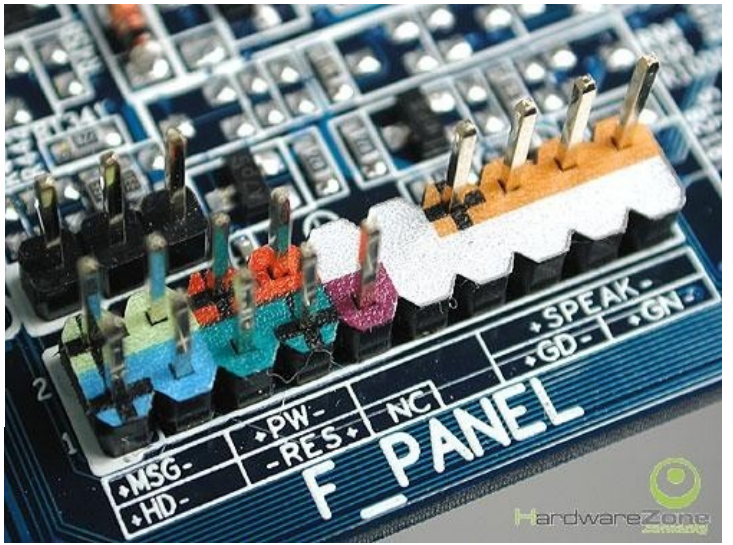
- System Date and Time
- Password
- Boot Sequence
- Memory installed (modern systems will now automatically detect)
- Hard Drive attached
- Display
- Power management settings

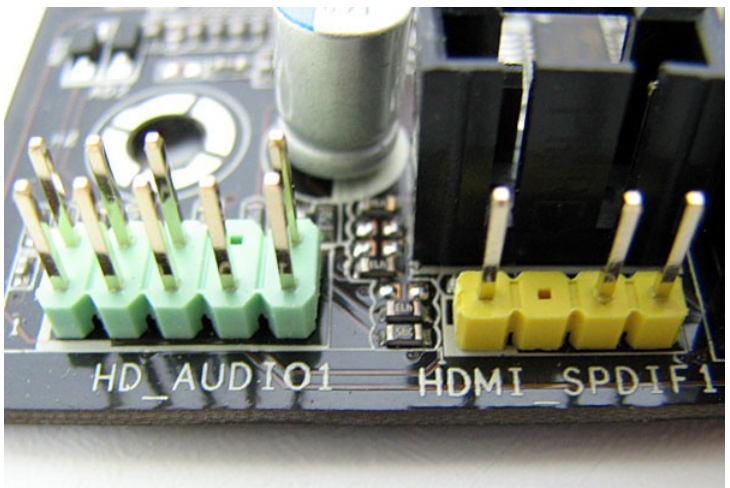
Front and Top Panel Connectors



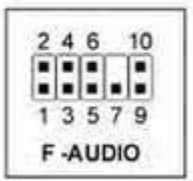
Panel and Audio Header







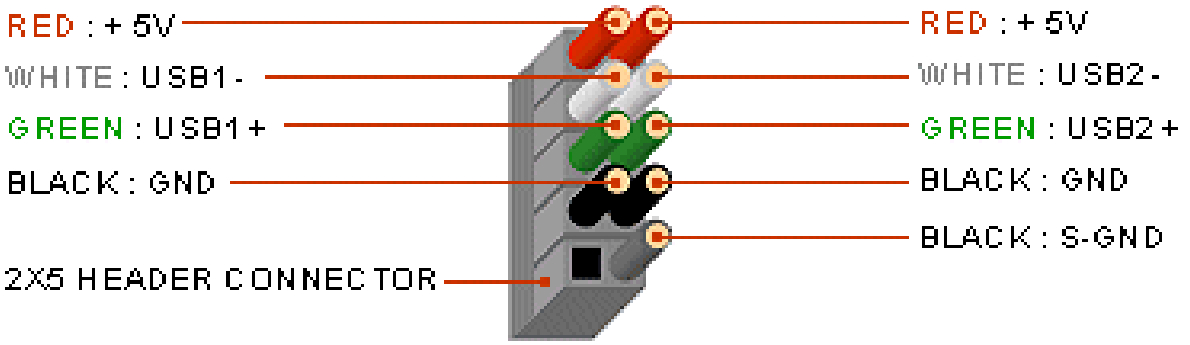
High Definition Audio



Pin	Pin Assignment	Pin	Pin Assignment
1	MIC2 L (Microphone 2 Left)	2	AGND (Analog Ground)
3	MIC2 R (Microphone 2 Right)	4	AVCC (Analog VCC Power)
5	FRO-R (Front Right)	6	MIC2_JD (Microphone 2 Jack Detect)
7	F_IO_SEN (Front I/O Sensor)		
9	FRO-L (Front Left)	10	LINE2_JD (Line 2 Jack Detect)

USB Header


F_USB1
F_USB2
CLR_CMOS

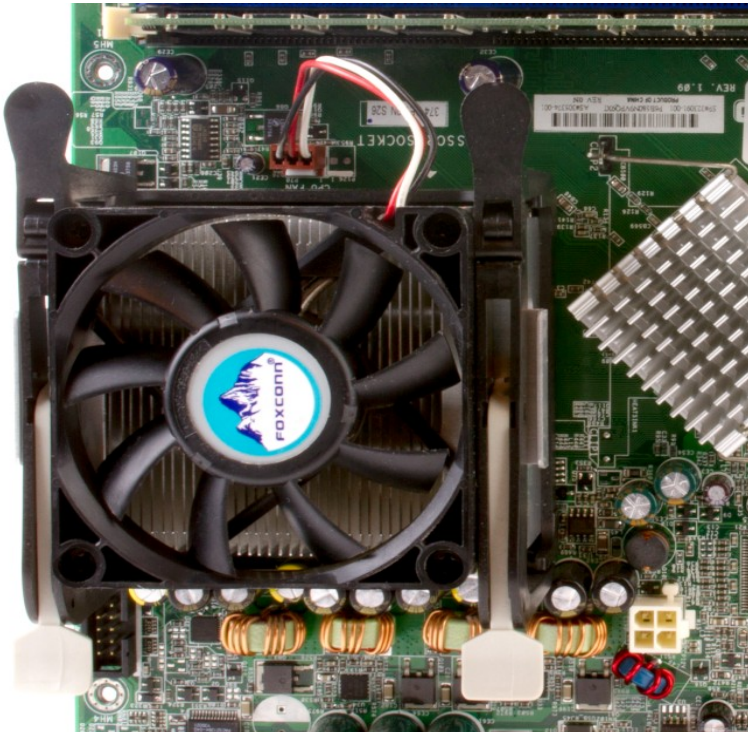

RED : + 5V
WHITE : USB1 -
GREEN : USB1 +
BLACK : GND
2X5 HEADER CONNECTOR
RED : + 5V
WHITE : USB2 -
GREEN : USB2 +
BLACK : GND
BLACK : S-GND

Cooling Systems

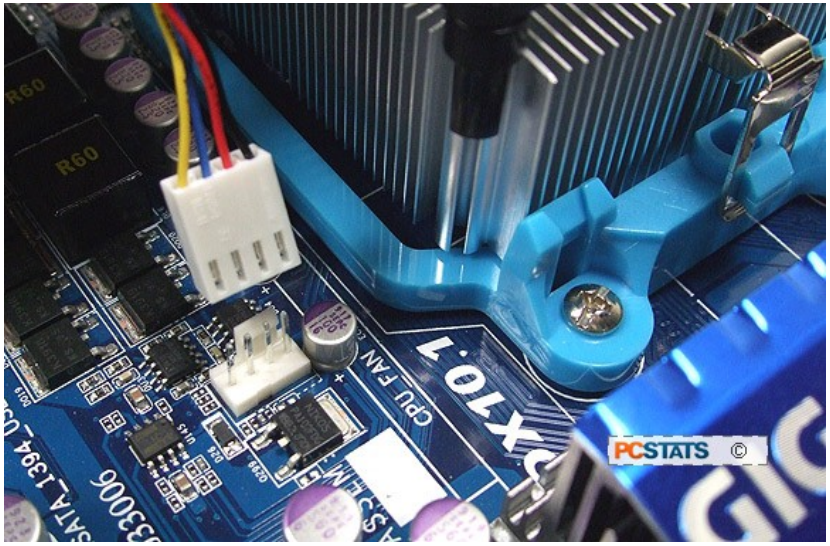
- Cooling the temperature of processor allows optimum performance
- Cooling systems are directly connected to the processor

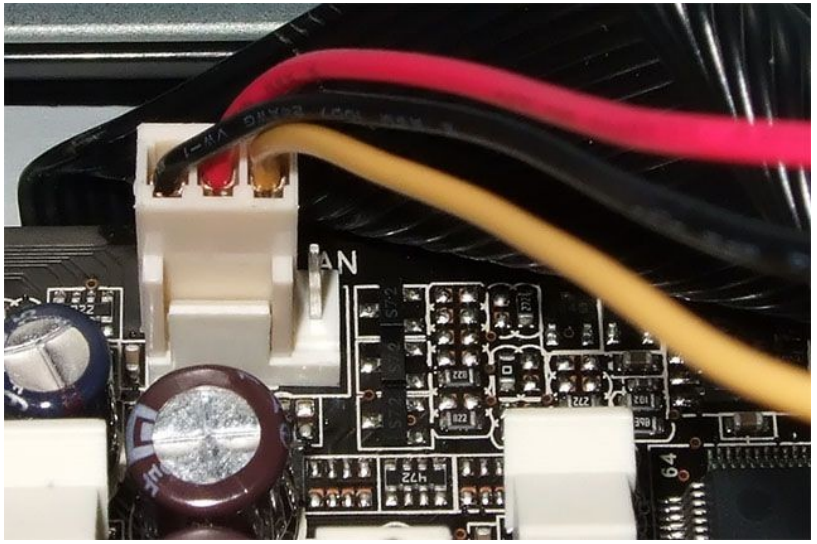
Cooling Systems

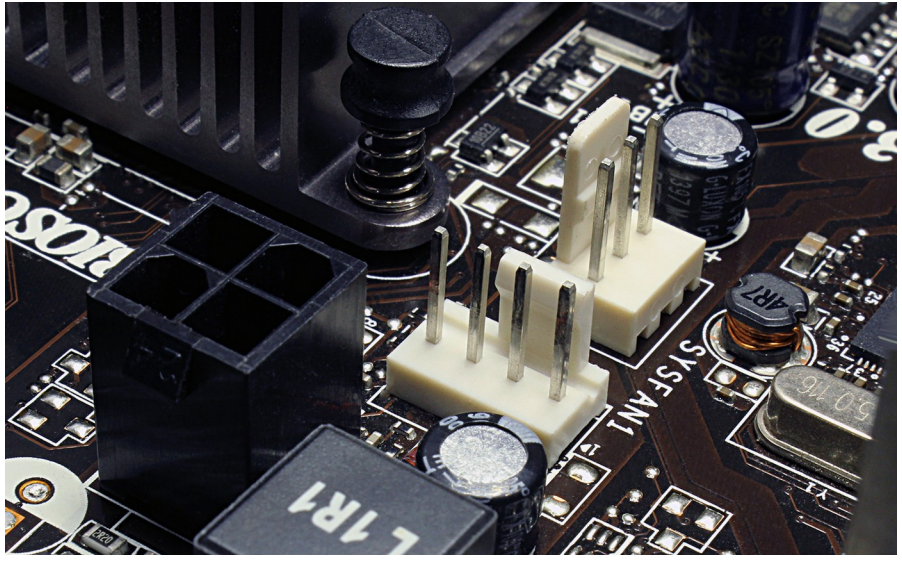
- Dissipates heat generated by components
- Normally fans
- Liquid cooling sometimes
- Attached to heatsinks

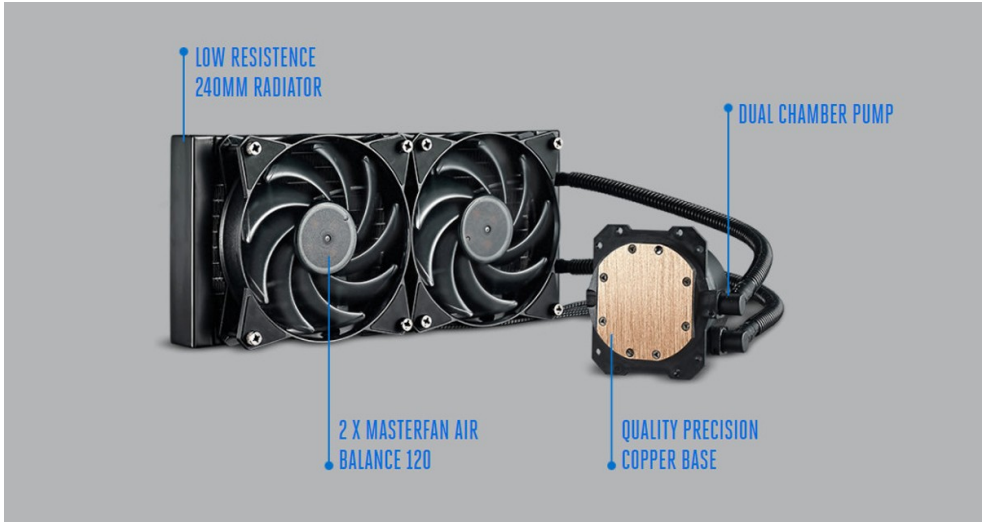


Cooling System	Description
Fans	Computer fans provide cooling by blowing regular air across heated components. It is common to see case fans, power supply fans, adapter card fans, and CPU fans.
Vents	Computer cases are designed with vents to facilitate airflow through the case and across all components. A common implementation is to include air vents near the bottom of the front of the case and to place a fan near the top of the rear of the case to pull cooler air through the system.
Heat sinks	A heat sink is designed to provide direct cooling to a system's CPU. Heat sinks have metal fins to increase their surface area to aid in heat dissipation. Cool air is blown past it by a fan, removing the heat from the processor.
Thermal paste	Thermal paste connects a heat sink to a CPU. At the microscopic level, when two solids touch, there are air gaps that act as insulation; the liquid thermally conductive compound gel fills these gaps to permit a more efficient transference of heat from the processor to the heat sink.
Fanless/passive	A fanless CPU cooler passively transfers heat through convection to the area surrounding the CPU. This ensures that hot air can move out of the CPU chassis without the assistance of loud, dust-accumulating fans. The fanless cooler is therefore more silent and efficient than traditional heat sinks.
Liquid-based	CPUs can also be kept cool by circulating a liquid or liquefied gas past the CPU. Like an air conditioner or car radiator, heat from the CPU is absorbed by the cooler liquid, and the heated liquid is circulated away from the CPU so it can disperse the heat into the air outside the computer. Also quieter than using fans. Not as prevalent as heat sinks in most desktop systems or low-end servers, but you might encounter them if your organization has deployed computers with hexa-core or octa-core processors.


CPU_FAN
PCSTATS




SYSFAN1


LOW RESISTENCE
240MM RADIATOR
DUAL CHAMBER PUMP
2 X MASTERFAN AIR
BALANCE 120
QUALITY PRECISION
COPPER BASE

Cooling

- https://www.youtube.com/watch?v=xXTadDEf1F0

Exam Essentials

- Know the different types of motherboards
- Know the major components on a motherboard
- Understand about processors
  - Hyperthreading, cores, cache speed, virtualization support, integrated GPU
- Understand memory
  - DRAM, SDRAM, DIMM, SODIMM
- Understand cooling systems