

**Tishk International University**  
**Science Faculty**  
**IT Department**



# Computer Hardware

## Lecture 05: Motherboard

**2nd Grade – Spring Semester**

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# Lecture 05: Motherboard



# Agenda

- Introduction to Motherboards
- Motherboard Form Factors
  - AT Motherboard Form Factor
  - Modern Motherboard Form Factors (ATX vs Micro-ATX vs Mini-ITX)
  - Motherboard Form Factors: Selection Principles
  - Motherboard Form Factors: Advantages (Pros) & Disadvantages (Cons)
- Motherboard Components
  - Ports
  - Expansion Slots
    - ISA and EISA Slots
    - PCI Slots
    - PCI Express (PCIe) Slots
    - AGP Slot

# Agenda

- IOPs
  - CPU Socket
    - Intel CPU Sockets
    - CPU Socket Types: LGA vs PGA
    - How to Install a CPU
  - Power Supply and Power Connectors
  - Docking Station
- 
- BIOS vs. CMOS vs. UEFI
  - Differences Between BIOS and UEFI
  - Booting of BIOS and UEFI
  - Accessing The Legacy BIOS
  - Accessing The UEFI with Windows 10
  - Common BIOS Settings

# Introduction to Motherboards

- A **motherboard** (also called main board, or system board) is the main circuit board inside a computer that connects the different parts of a computer together. It has sockets for the CPU, RAM and expansion slots, hard drives, disc drives and built-in ports.
- A motherboard provides logistics for all elements so that they can work in coordination.
- In laptop, the motherboard is more compact and many components are integrated, and it takes the shape of the body of the laptop.



Laptop Motherboard



Desktop Motherboard

# Motherboard Form Factors

- The form factor refers to the physical dimensions (size and shape) as well as certain connector, screw hole, and other positions that dictate into which type of case the board will fit.
- Any motherboard size can fit into a larger case. Large cases can accommodate standard, medium, and small motherboards. From a visual standpoint, however, you might not want to put a small motherboard in a large case because the components will be put into one corner of the case.
- The opposite scenario is not possible. In other words, you cannot put large motherboards in small case.

# AT Motherboard Form Factor

- This is the first type of motherboard and it is obsolete now.
- AT form factor comprises the dimensions and layout (form factor) of the motherboard for the IBM AT with size of:  
13.8 × 12 inches
- Baby AT motherboards are a little smaller, measuring:  
8.5 x 13 inches



# Modern Motherboard Form Factors (ATX vs Micro-ATX vs Mini-ITX)

- **ATX (Advanced Technology Extended)** motherboards are larger in size, and this enables them to have more PCIe lanes. This trait means that ATX motherboards work best for multi-GPU setups or computers that use multiple PCIe input devices.
- **Micro-ATX** motherboards are similar to standard ATX motherboards, but micro-ATXs are a few inches shorter in length. The advantages of micro-ATXs is that these motherboards fit smaller form-factor cases if necessary.
- **Mini-ITXs** are even smaller motherboards with a length and height shorter than both micro-ATXs and standard-ATXs. The micro-ITXs usually have only one PCIe lane and are compatible with far more small form-factor cases. The item was first developed in the 2000s and is highly compact



# Motherboard Form Factors: Advantages (Pros) & Disadvantages (Cons)

Form	Pros	Cons
ATX	<ul style="list-style-type: none"><li>• Better-suited for overclocking</li><li>• More PCIe lanes</li><li>• Higher RAM capacity</li></ul>	<ul style="list-style-type: none"><li>• More expensive</li><li>• Won't fit inside most smaller cases</li></ul>
Micro-ATX	<ul style="list-style-type: none"><li>• The least expensive option</li><li>• Ideal for single-GPU PC builds</li><li>• Can fit into pretty much any case</li><li>• Higher RAM capacity than mini-ITX</li></ul>	<ul style="list-style-type: none"><li>• Not suitable for multi-GPU setups</li><li>• Not ideal for extreme overclocking</li></ul>
Mini-ITX	<ul style="list-style-type: none"><li>• Best option for smaller cases</li></ul>	<ul style="list-style-type: none"><li>• More expensive than micro-ATX</li><li>• Won't look right in larger cases</li><li>• Won't work for multi-GPU setups</li><li>• Not ideal for extreme overclocking</li><li>• Typically, only have two RAM slots</li></ul>

# Motherboard Form Factors

## Selection Principles

- **Building A High-Performance Gaming PC**
  - Most games can run on a Micro-ATX motherboard with its decent RAM capacity and ability to have 4 PCIe slots running simultaneously.
- **Building A Professional Work Computer**
  - If multiple GPU's are needed for mining then best selection is ATX motherboard.
  - For mass photo and video editing with numerous applications going at once best selection is ATX motherboard.
  - For classical office work the best selection is Micro-ATX motherboard form.
- **Building A Desktop Home PC**
  - Mini-ITX is absolutely the best selection due its small size.
  - Alternatively, if the size is not your main agenda then again the Micro-ATX is going to be most suitable.

# Motherboard Components



# Motherboard Components -Ports

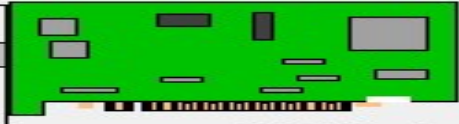

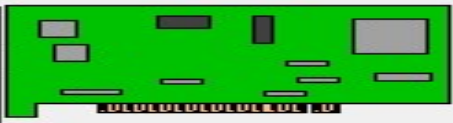

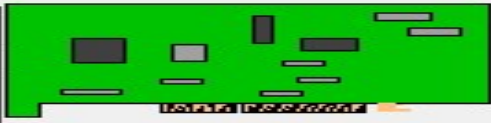

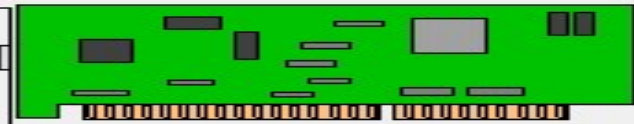

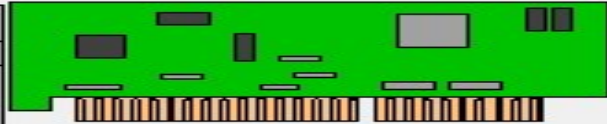

- Back Panel Connectors & Ports: Connectors and ports for connecting the computer to external devices such as display ports, audio ports, USB ports, Ethernet ports, PS/2 ports etc. See image below for a close-up view.



- Front Panel USB 2.0/3.0 Connectors: Connects to USB 2.0/3.0 ports at the front or top of a computer case.



# Motherboard Components - Expansion Slots

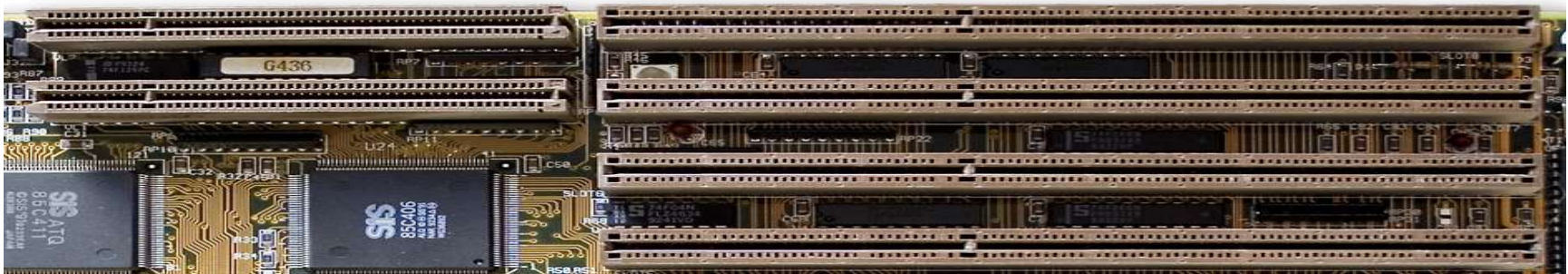
EXPANSION CARDS	Bandwidth	
	Bits	Speed
<b>PCI Express</b>  x16 PCIe Configuration 	2 4 8 16 32	2-16 Gbps
<b>PCI</b>  	32 64	33-66 MHz
<b>AGP</b>  	32	66-533 MHz
<b>ISA</b>  	8 16	8-10 MHz
<b>EISA</b>  	32	8-10 MHz

# ISA and EISA Slots

**ISA expansion** slots are the oldest types of slots on the motherboard. ISA stands for 'Industry Standard Architecture' because no other slots were invented at that time. The components designed to install on ISA slot were huge in size and among the first slots to be used in personal computers.

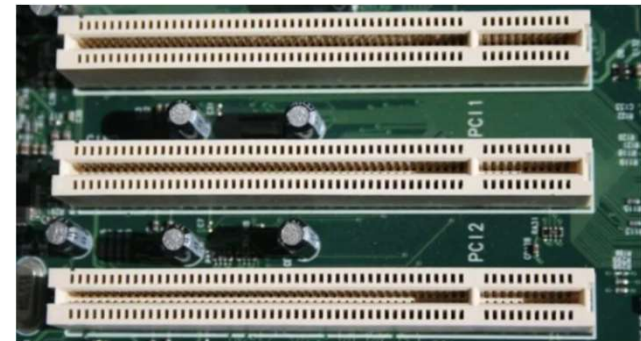
Today, Modern motherboards no longer have ISA slots. These slots were included until the first models of the Pentium III microprocessor, then it was replaced in 2000 by the PCI slot.

**Extended ISA** extended to 32 bits and provided bus mastering. ISA cards could plug into an EISA slot



# PCI Slots

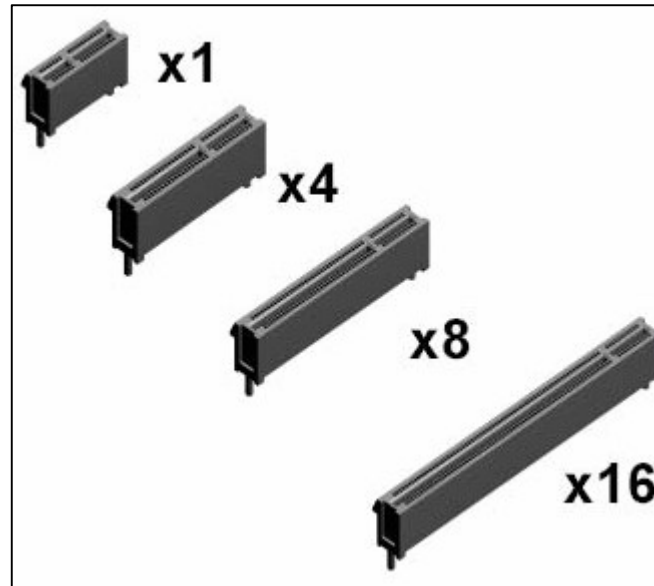
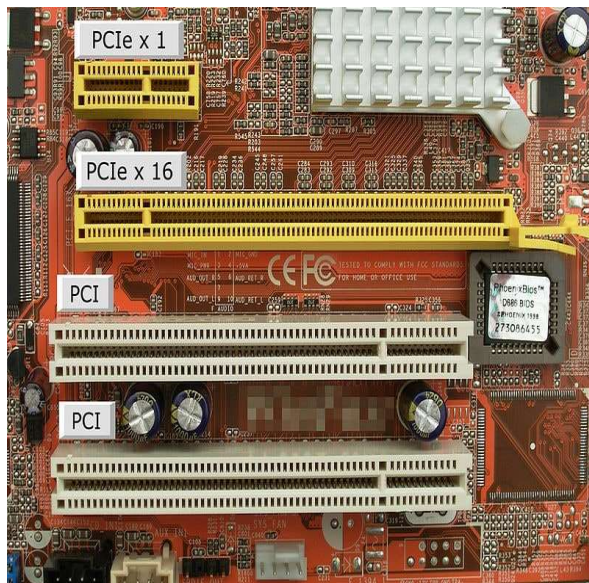
PCI Slots: Peripheral Component Interconnect Slot for older expansion cards such as sound cards, network cards, connector cards.



# PCI Express (PCIe) Slots

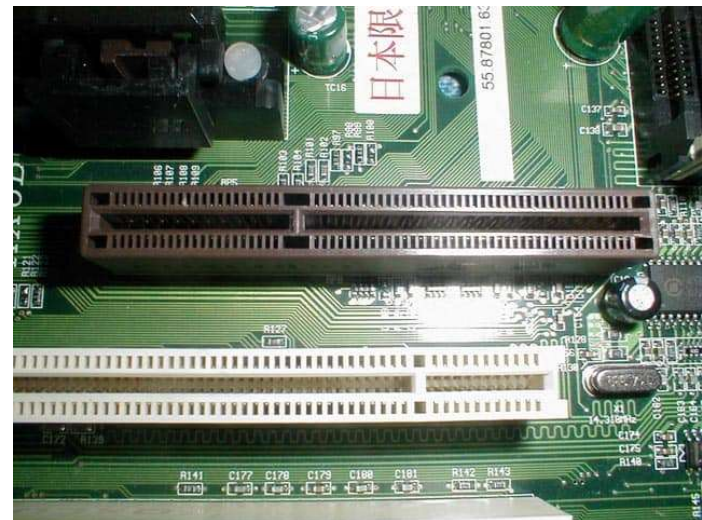
PCI Express (x1, x4, x8) Slots: each X number is the amount of lanes the slot provides. Those slots are for modern expansion cards such as sound cards, network cards (Wi-Fi, Ethernet, Bluetooth), connector cards (USB, FireWire, eSATA) and certain low-end graphics cards.

PCI Express x16 Slot: optimum slot for discrete graphic cards and high bandwidth devices such as top-end solid state drives.



# AGP Slot

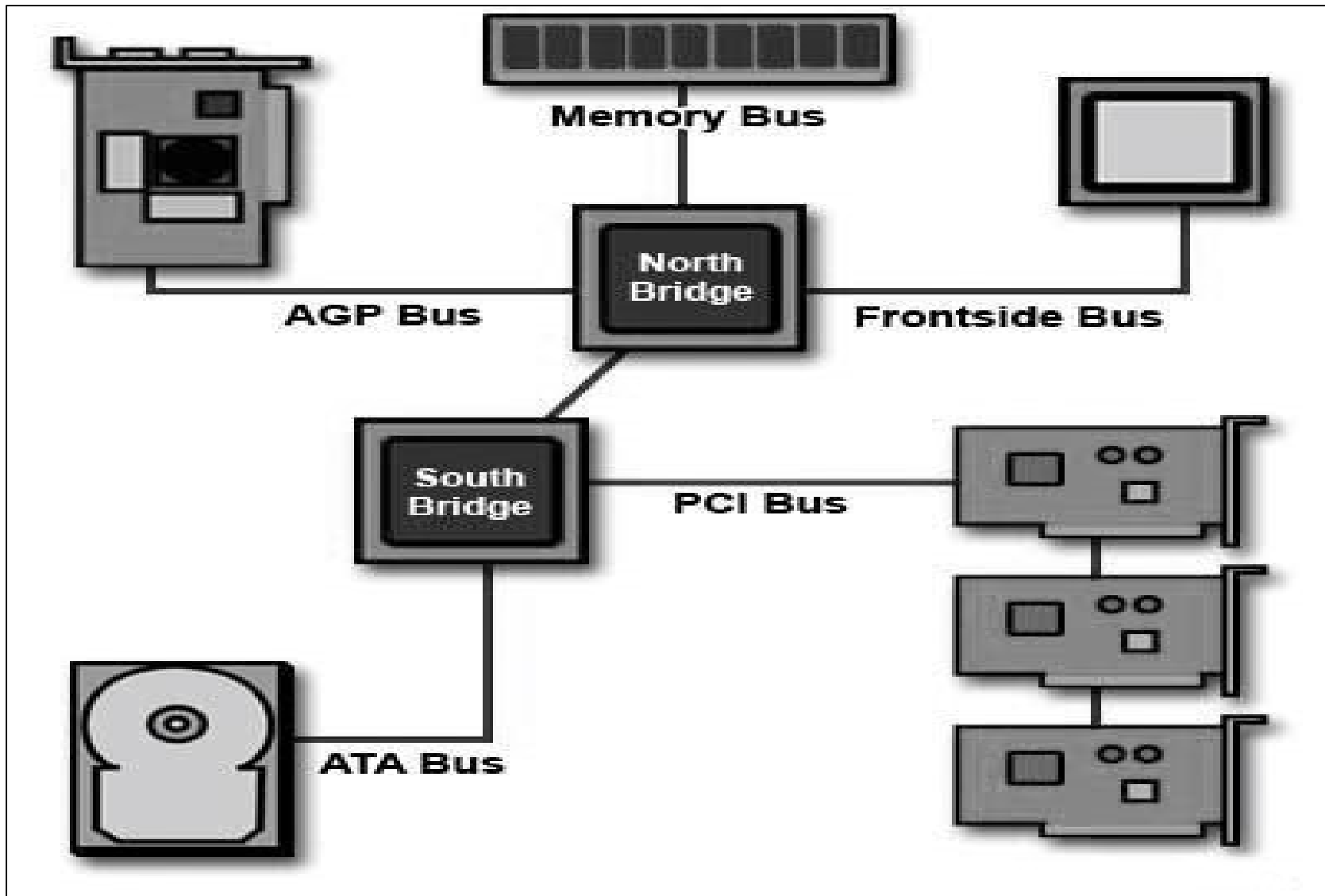
This type of expansion slot was specifically designed to deal with graphics adapters. In fact, AGP stands for Accelerated Graphics Port. Older PCs may support this expansion slot, but the best video cards use PCI Express.



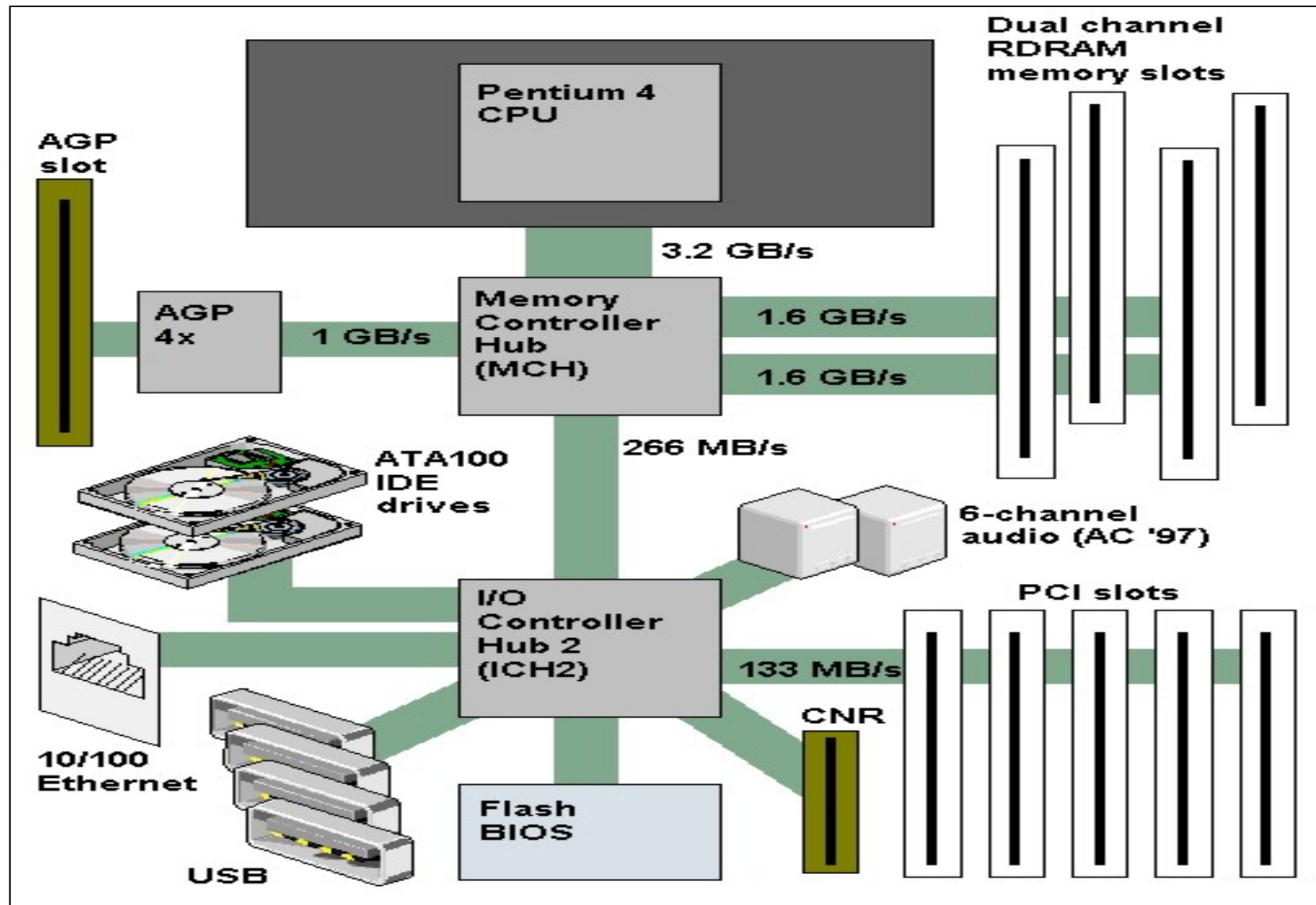
# Motherboard Components - IOPs

1. Northbridge: Memory Controller Hub (MCH): Chipset that allows the CPU to communicate with the RAM and graphics card. Beginning from Intel Sandy Bridge in 2011, this motherboard component is no longer present as it has been integrated within the CPU itself
2. Southbridge: Also known as the Input/Output Controller Hub (ICH). Chipset that allows the CPU to communicate with PCI slots, PCI-Express x 1 slots (expansion cards), SATA connectors (hard drives, optical drives), USB ports (USB devices), Ethernet ports and on-board audio.

# Legacy Motherboard Architecture



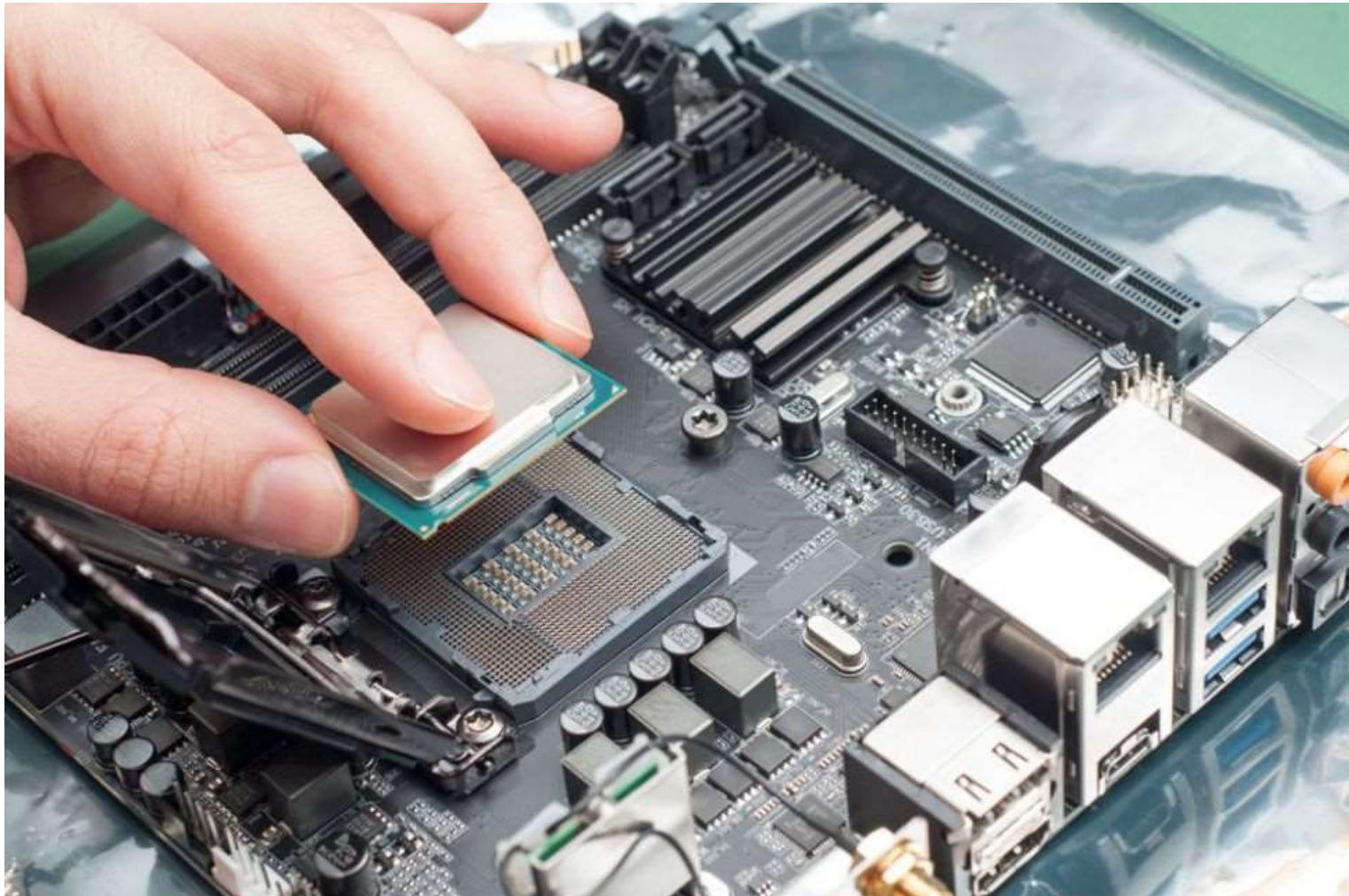
# Modern Motherboard Architecture



# Motherboard Components - CPU Socket

- A **CPU socket** is a place on the motherboard plate of the computer where the processor is inserted, and it acts as a connector between the CPU and the motherboard.
- For laptops, **surface-mounted** processors are used instead of socket processors to save space on the laptop motherboard.
- CPU socket is almost the most important characteristic of motherboard.
- Sockets differ in the number of pins, which usually grows with the power and complexity of the processors.

# CPU Socket



# Intel CPU Sockets

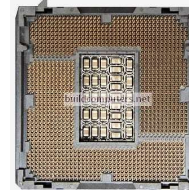
1. LGA1156 (*Socket H1*)



2. LGA1366 (*Socket B*)



3. LGA1155 (Socket H2)



4. LGA2011 (Socket R):

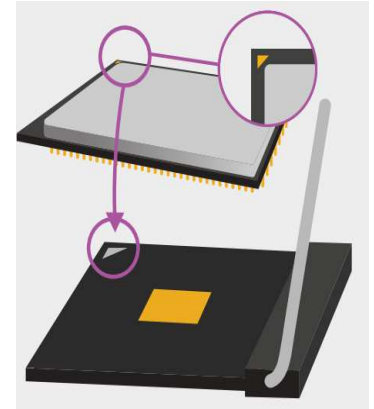


5. LGA1150 (Socket H3)

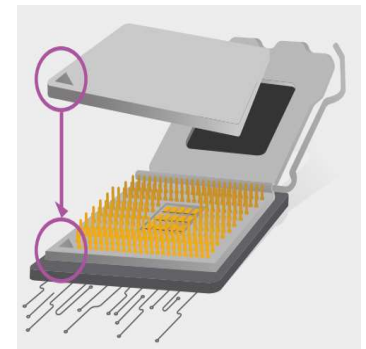


# CPU Socket Types: LGA vs PGA

1. For Pin Grid Array (PGA), the contact pins are on the CPU, while the socket on the motherboard contains holes to secure the CPU. This kind of socket is known as Zero Insertion Force (ZIF) socket, which means the CPU will be able to drop in without any pressure.



2. The Land Grid Array (LGA) contains pins in the motherboard. The socket itself rests in the motherboard and has an enclosure at its top end, and the CPU is placed inside the enclosure and secured using a pressure lever. The CPU rests in the enclosure through a series of grooves, and communicates through electronic signals transmitted through transmission surfaces inside the socket.



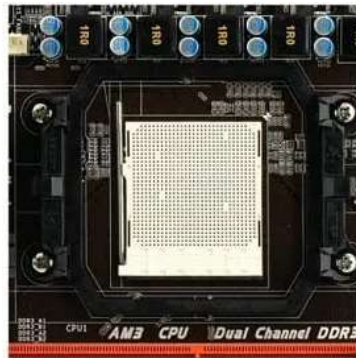
# Comparison – LGA vs PGA

## 1. Advantages of LGA socket:

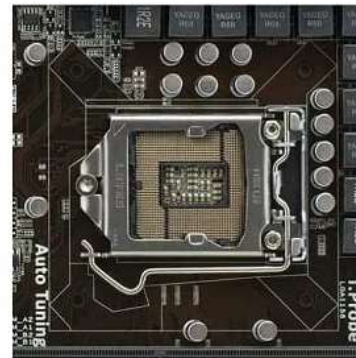
- **More Durable CPU:** The processors are less likely to be damaged by mishandling and drops, because of no fragile pins.
- **More Space Efficient:** LGA pins are smaller in physical size, allowing for more pins in the same amount of space.

## 2. Advantages of PGA socket:

- **More Durable Motherboard:** The motherboard can hardly be damaged by CPU misalignment.
- **Slightly Better Reparability:** It is much easier to repair bent pins on a PGA processor than on a LGA motherboard.



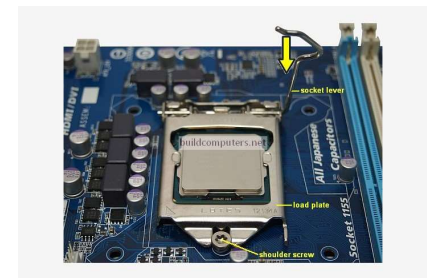
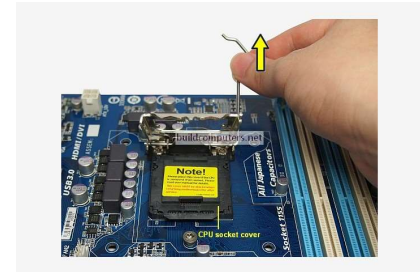
AMD



intel

# How to Install a CPU

1. Lift up the socket lever and the load plate will pop up
2. Remove the CPU from its plastic tab and insert it into the motherboard's CPU socket.
3. Gently align the two CPU notches (circled in yellow above) with the two protruding socket keys (circled in yellow below). Gently set the CPU onto the socket.
4. Lower the load plate and slide it under the shoulder screw. Once this is done, lower the socket lever under it touches the motherboard and slide it left to lock it into place.



# Power Supply and Power Connectors

- CMOS Battery: Supplies power to store BIOS settings and keep the real-time clock running.
- Power & Reset Button: Onboard button to turn on, turn off and reboot the computer. This motherboard component is more common among high end boards.
- ATX Main Power Connector: Connects to the 24-pin ATX power cable of a power supply unit which supplies power to the motherboard.
- ATX 12V Power Connector: Connects to the 4-pin power cable of a power supply unit which supplies power to the CPU.

# Docking Station

- Docking stations and port replicators add connectivity and expansion capability to laptop computers. A docking station allows a laptop computer to be more like a desktop system. A docking station can have connections for a full-size monitor, printer, keyboard, mouse, and printer.
- In addition, a docking station can have expansion slots or cards and storage bays.
- To install a laptop into a docking station, close the laptop and slide the laptop into the docking station. Optionally (depending on the model), secure the laptop with locking tabs.

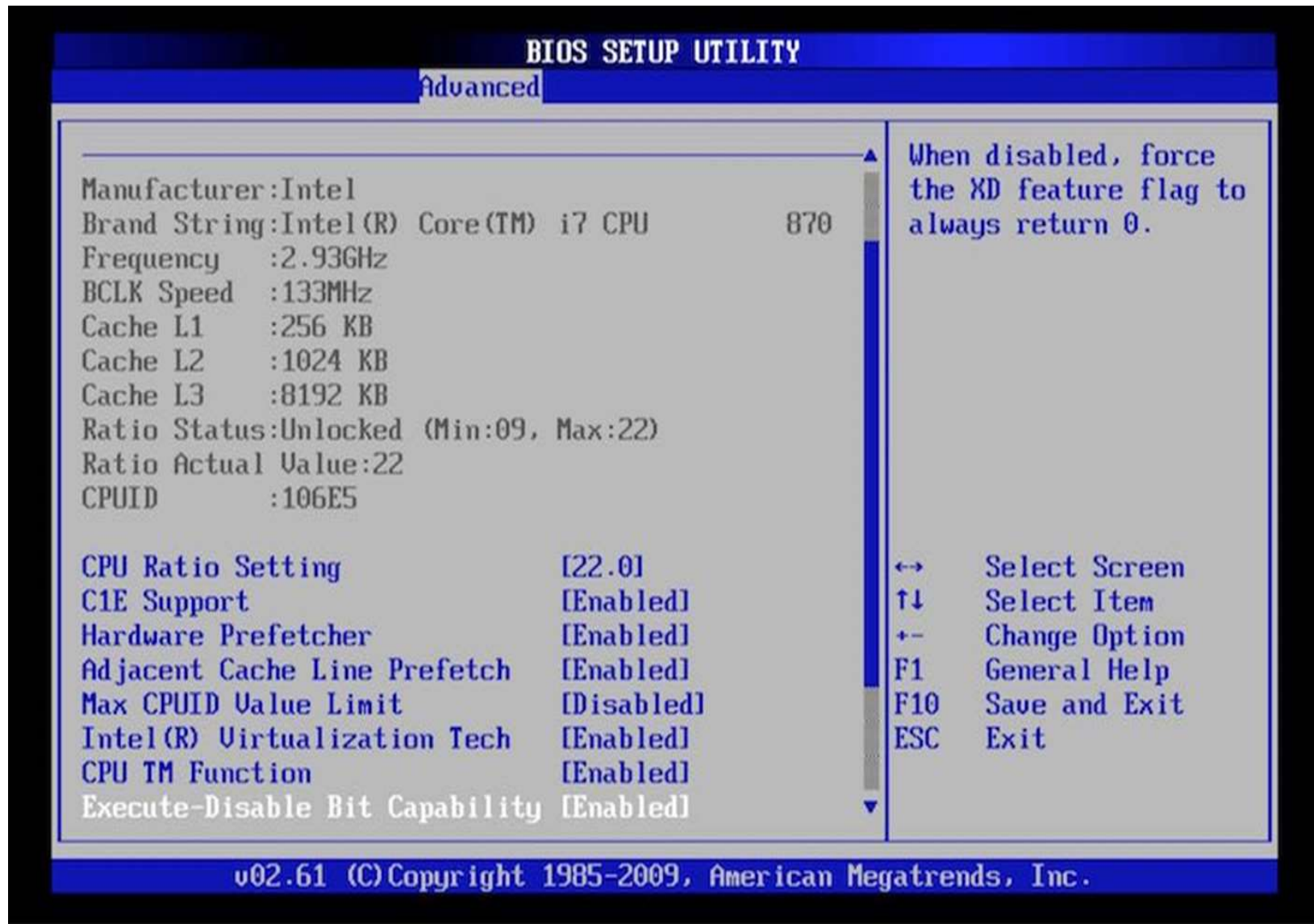
# Docking Station and Port Replicator



# BIOS vs. CMOS vs. UEFI

- There are significant differences between BIOS (Basic Input/Output System) and CMOS (Complementary Metal Oxide Semiconductor). Generally, the terms BIOS and CMOS are used interchangeably.
- A **BIOS chip** in a motherboard contains the program (firmware) to start the booting of the computer.
- A **CMOS chip** stores the settings like date & time, fan speed, and booting sequence.
- **UEFI (Unified Extensible Firmware Interface)** to extend a better user experience and provide a new secured BIOS.
- The bootloader is a tiny software that loads the operating system (OS). One of the advantages of UEFI is the secure booting process using a safe boot loader. This feature prevents malicious access, allows remote monitoring and control during the booting process.

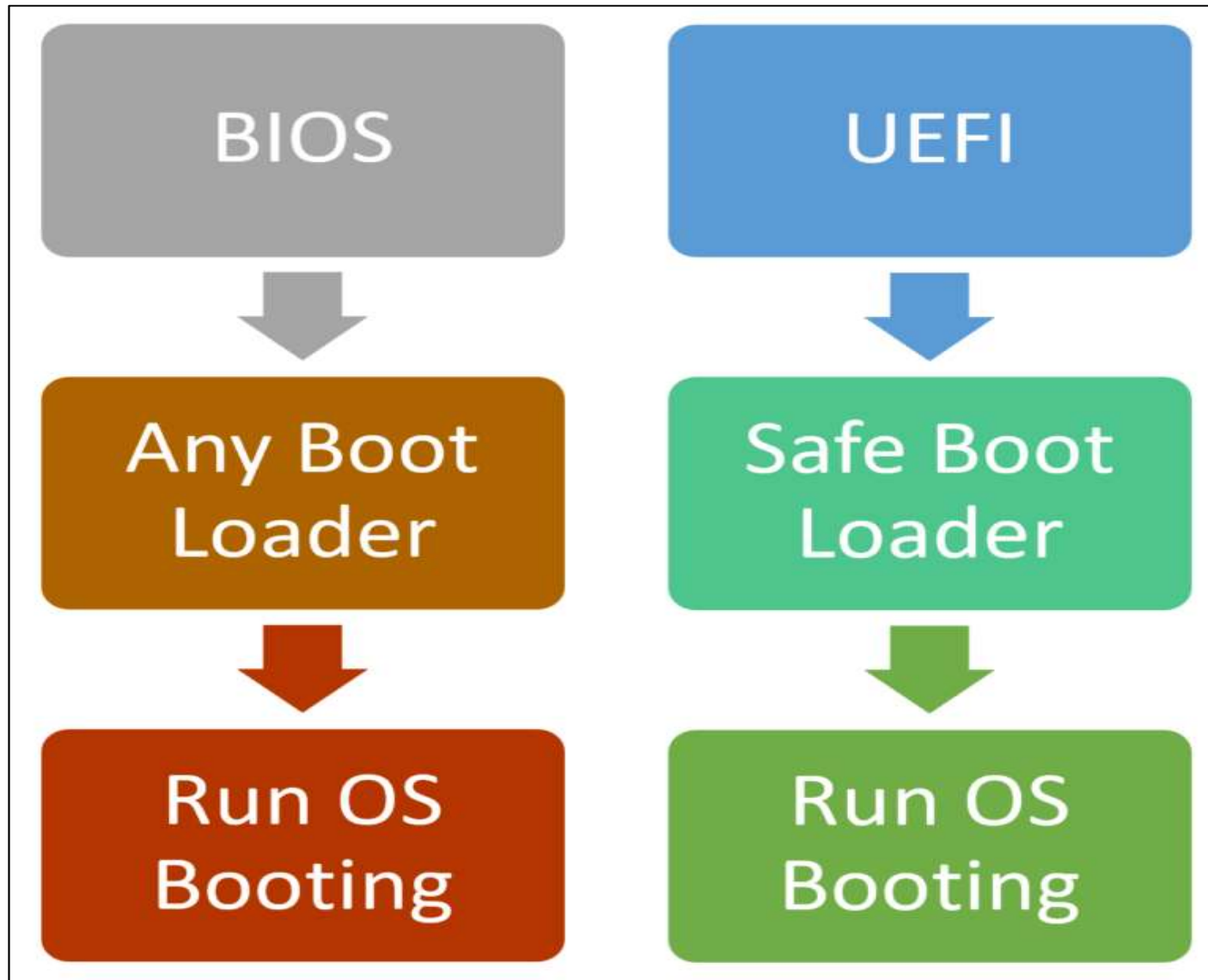
# BIOS vs. CMOS vs. UEFI



# Differences Between BIOS and UEFI

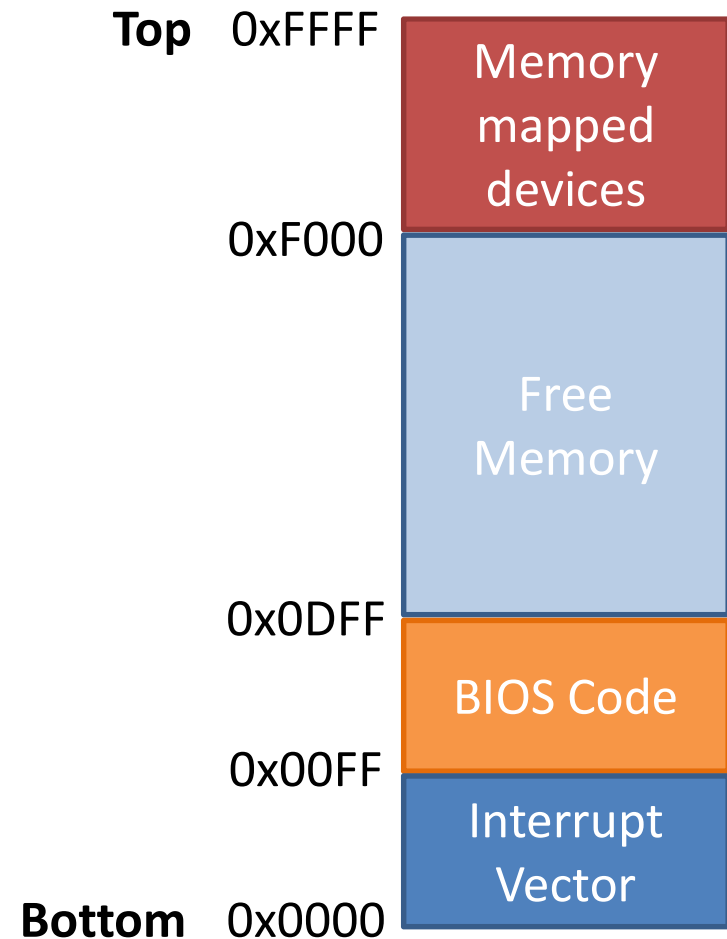
BIOS	UEFI
Windows blue screen	User-friendly graphical user interface
No Animation	Multi colored with Animations
Can't recognize Ethernet, Wi-Fi and Bluetooth	Support Ethernet, Wi-Fi and Bluetooth connectivity
No remote diagnosis and repair support	Support remote diagnosis and repair if the OS won't boot.
No mouse support, keyboard only	Keyboard and mouse support
No secure booting option	Secure boot facility to stops loading malicious softwares.
Firmware program in 16-bit assembly language	Firmware program in 64-bit C language
Supports 2.2 terabytes	Supports drive sizes upto 9 zettabytes

# Booting of BIOS and UEFI



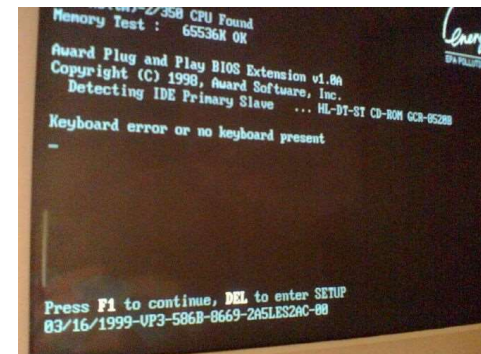
# Typical Memory Layout

- Example: 64KB of memory
  - $2^{16}$  bytes
  - Addresses from 0 to 65535
- Not all memory is free
  - Specific ranges get used by devices, system services, the BIOS, etc.



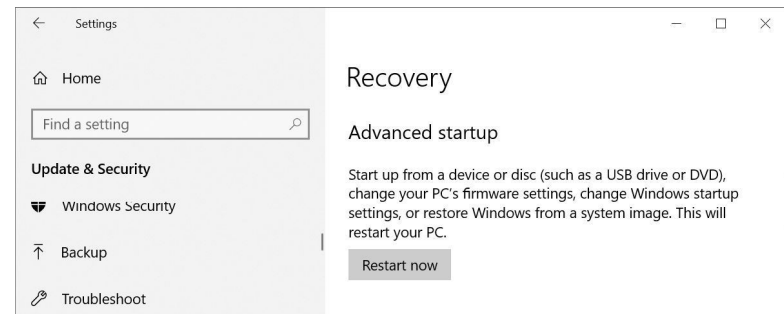
# Accessing The Legacy BIOS

- To access the Legacy BIOS screen, first restart the computer, and then press the appropriate key between powering on the computer and before the operating system is launched.
- If no keyboard is attached to the PC, BIOS cannot be accessed.
- Common keys to enter the BIOS are F1, F2, F10, Delete, Esc. The exact key or key combination depends on your computer manufacturer and model and should appear on-screen at the start of the boot process.



# Accessing The UEFI with Windows 10

- Go to Settings > Update & Security > Recovery
- Under Advanced startup click Restart now. Note that this will actually restart your computer.



- On the screen that comes up, go to Troubleshoot > Advanced options > UEFI Firmware Settings and click Restart, which will boot straight into your UEFI BIOS from Windows 10.



# Common BIOS Settings

- **CPU Clock**: used for overclocking the processor.
- **Memory Timings**: Allows to adjust the memory timings.
- **Boot Order**: determines the order in which the computer will boot to each device to look for an operating system or installer. The options typically include the hard drive, optical disk drive, USB and network.
- **Display Settings**: can prioritize the GPUs so user can select the graphics card for the boot process.
- **Virtualization Settings**: used to enable hardware support for virtualization manually before any virtualization software like VirtualBox will run properly. On Intel motherboards, virtualization settings may be called “VT-d.” The equivalent for AMD motherboards is called “AMD-V.”
- **Walk-on LAN** allows the computer to wake up from sleep when it receives a packet from the local area network (LAN), It is recommended to turn it off unless it is really need functionality.
- **The supervisor password** protects the system information stored in the setup program. If you have set a supervisor password, no one can change the configuration of the computer without the password.
- **Power-On Password**: to protect the computer against access by unauthorized users. then password prompt is displayed on the screen whenever the computer is turned on.