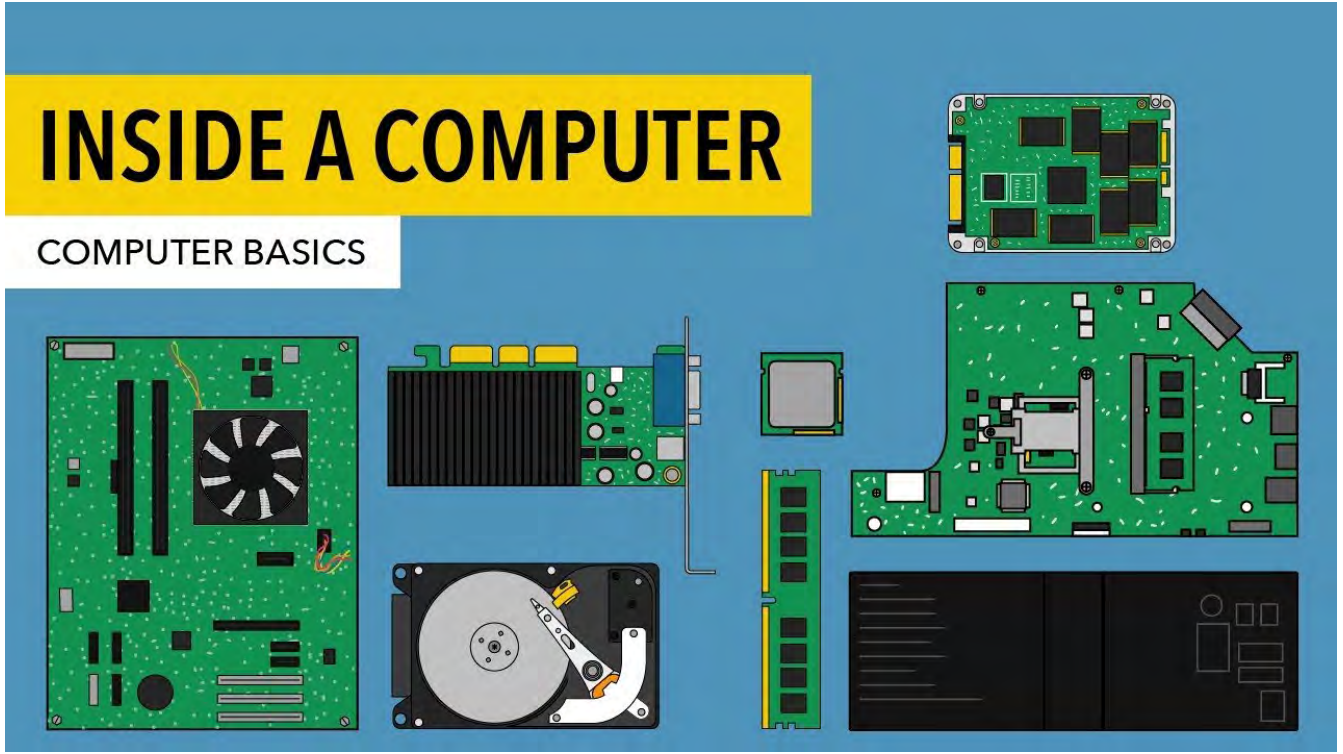
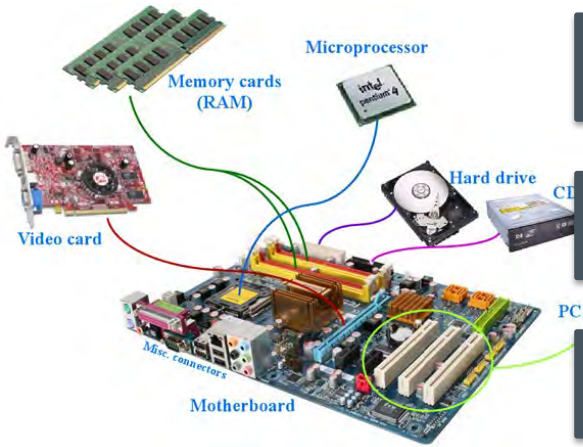
CH 4: Accounting for CPUs and Internal Components



Installing, Configuring, and Troubleshooting Internal System Components



Install and Upgrade	Install and Upgrade CPUs
Configure and Upgrade	Configure and Upgrade BIOS/UEFI
Install	Install Power Supplies
Troubleshoot	Troubleshoot Internal System Components
Configure	Configure a Custom PC

Topic A: Install and Upgrade CPUs

CPU

CPU: (central processing unit) The main chip on the system board, it performs software instructions and mathematical and logical calculations.

Operating system technologies

- Hardware drivers are specific to the OS version (32-bit / 64-bit)

32-bit (x86), 64-bit (x64)

- 32-bit OS cannot run 64-bit apps
- But 64-bit OS can run 32-bit apps

Apps in a 64-bit Windows OS

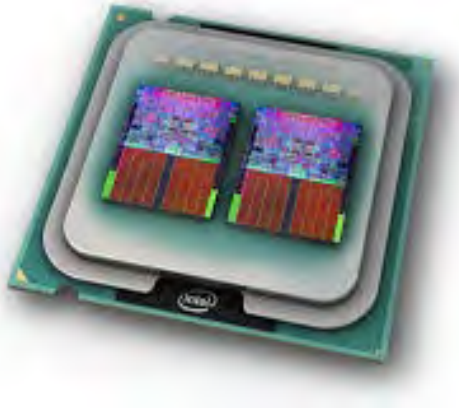
- – 32-bit apps: \Program Files (x86)
- – 64-bit apps: \Program Files

CPU

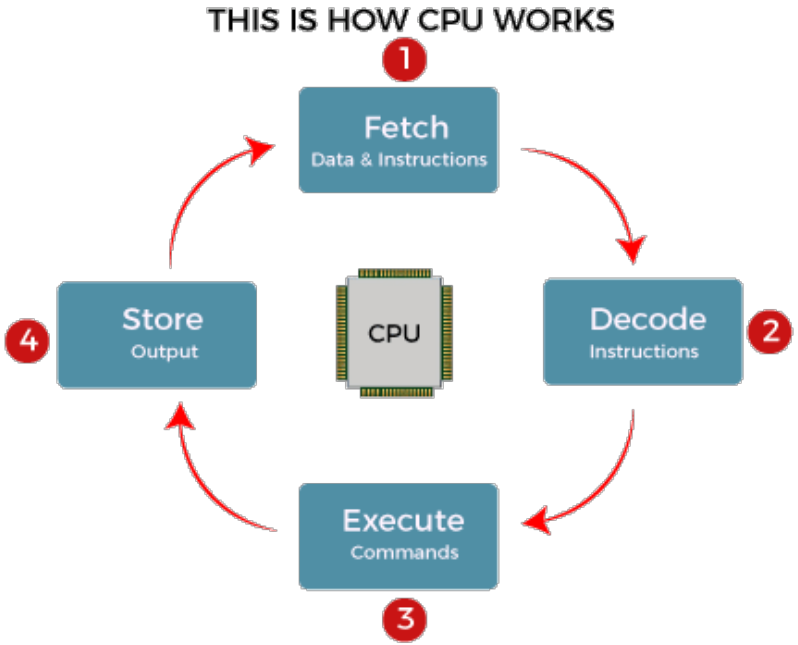
Processor cores: A CPU can have multiple cores.

A CPU With:

- 2 cores, a dual-core processor
- 4 cores, a quad-core
- six cores, hexa-core
- eight cores, octa-core.



CPU Architectures



- **Instruction set:** The machine language code and commands the CPU can process.
- **ALU:** (arithmetic logic unit) A CPU circuit that performs calculations
- **FPU:** (floating point unit) A math co-processor built into the CPU that performs calculations on floating point numbers.

Addressing

- System bus between CPU and memory consists of:
  - Data bus determines how much data can be transferred per clock cycle.
  - Address bus determines how many memory locations the PC can access.

- On modern PCs, the data bus is 64 bits wide.

- Address bus for 32-bit CPUs is 32 or 36 bits wide.
  - 32-bit bus can access 4 GB of address space.
  - 36-bit bus can access 64 GB of address space.

- Address bus for 64-bit CPUs is usually 48 bits wide.
  - 48-bit bus can access 256 TB of address space.
  - Done to reduce complexity in compatibility with 32-bit software.
  - Theoretically could be 64-bits wide and access 16 Exabytes of address space.

ARM Advanced RISC Machine

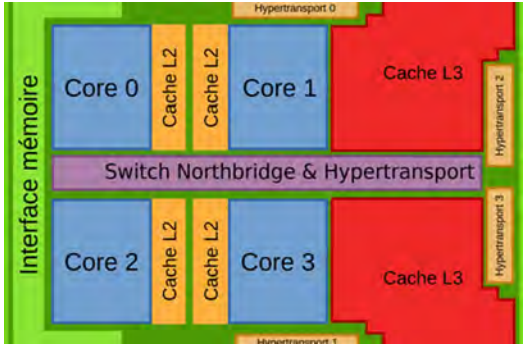
Advanced RISC Machine (ARM) is a CPU architecture based on a 32-bit reduced instruction set (RISC) computer. ARM architecture is implemented on Windows, Unix, OS including Apple iOS, Android (Licensed worldwide).

- They design the chip; others license and build
- Simplified instruction set
- Efficient and fast processing
- Less power Less heat
- Traditionally used for Mobile and IoT devices
- The lines are constantly blurring between Arm 32bit, and 64bit architecture

Cache

Cache: A small block of high-speed memory that enhances performance by preloading instructions and data from system RAM that the CPU uses regularly.

- Levels
  - Level 1 On-Die cache is closest to CPU and is smallest and fastest.
  - Level 2 cache is a bit larger, and a bit slower than Level 1.
  - Levels 3 and 4 are larger and possibly slower than Level 2.

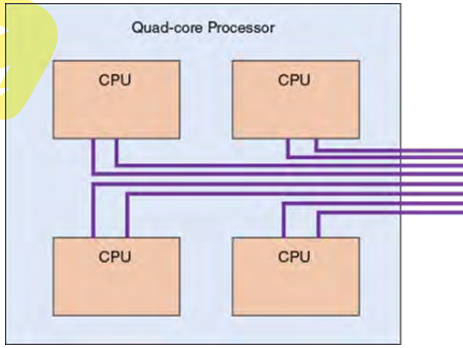


Hyperthreading

Multitasking: The ability of an operating system to run multiple programs, or tasks, at one time.

Thread: A stream of instructions generated by a software application. Most applications run a single process in a single thread.

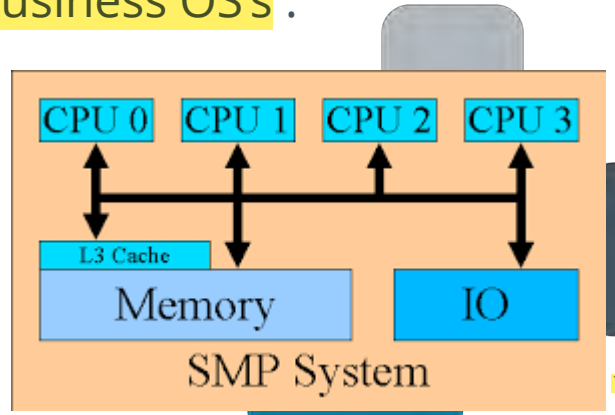
- Multithreading:
  - Also known as SMT, HT, or HTT.
  - Allows multiple threads to run through the CPU at the same time.
  - Reduces amount of CPU idle time.
  - The OS thinks more CPUs are installed.
  - Works best with multithreaded software (usually runs on servers).



Multiprocessing and Multicore Processors

SMP: (symmetric multiprocessing) A condition where two or more physical CPUs that share a common OS simultaneously.

- Two or more physical processors installed for SMP.
- SMP-aware OS makes efficient use of processing resources.
- Servers and high-end workstations running Win business OS's .



Clock Speed

- A key performance indicator.
- 3.5G - 4.2GHz, 4.8-5GHz

- Some run slower but provide better performance.

Core clock speed:

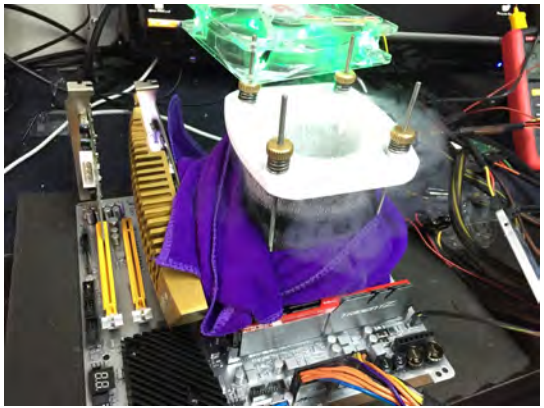
- 3.5G - 4.2GHz or 4.8-5GHz
  - Speed at which the CPU runs internal processes and accesses L1, L2 and L3 cache.

- Front Side Bus speed is the speed of the interface between the CPU and system memory.

Overclocking

Overclocking: Increasing the clock speed over the optimum speed determined by the manufacturer.

- Manufacturer sets optimum clock speed where damage is not likely.
- Overclocking is configured through system setup firmware .
  - Increasing clock speed generates more heat.
  - Requires a suitable power supply and sufficient cooling.
  - Monitor the temperature of the room as well.



Power Management (Throttling)

Throttling: Technology that allows the CPU to adjust speed to improve power performance.

- CPUs can implement power management to enter lower power states.
  - Helps conserve energy and reduce heat production.
  - CPUs that run too hot can become unstable or damaged.

CPU Virtualization support

VM: (Virtualization support)

Run other operating systems within a single hardware platform

Microsoft Hyper-V, Vmware No need to dule boot!

- This can be enabled in the UEFI setting VT or AMD-V
- Multiple operating systems share physical hardware components

Virtualization added to the processor

- – Hardware is faster and easier to manage
- – Intel Virtualization Technology (VT)
- – AMD Virtualization (AMD-V)

CPU Packaging

CPU form factor: CPU packaging and how it connects to the motherboard.

LGA: (Land Grid Array) Intel technology in which pins are located on the socket.

- Intel CPU ranges: LGA socket type only
  - Core -high-end gaming, intensive image editing work and video editing.
  - Pentium- productivity for home use and for office work. (not gaming)
  - Celeron -small business and personal use less cache
  - Atom -is a good fit for tablets sub for ARM cpu's
  - Xeon -Industrial servers and workstations.

CPU Packaging

PGA: (Pin Grid Array) Technology in which pins are on the processor.

ZIF: (Zero Insertion Force) A processor socket type allowing for as little risk of damaging the pins on the processor chip as possible.

AMD CPU ranges: PGA socket types only

- EPYC - Server/datacenter platform
- Threadripper -animation, coding, and graphic design.
- Ryzen I series - gaming performance, multi-threaded performance
- Ryzen Mobile - Tablets

Cooling Mechanisms

Heat sink: A passive heat exchanger that dissipates heat from a source such as a CPU and transfers it, normally via an enlarged surface area, to another medium such as air or water.

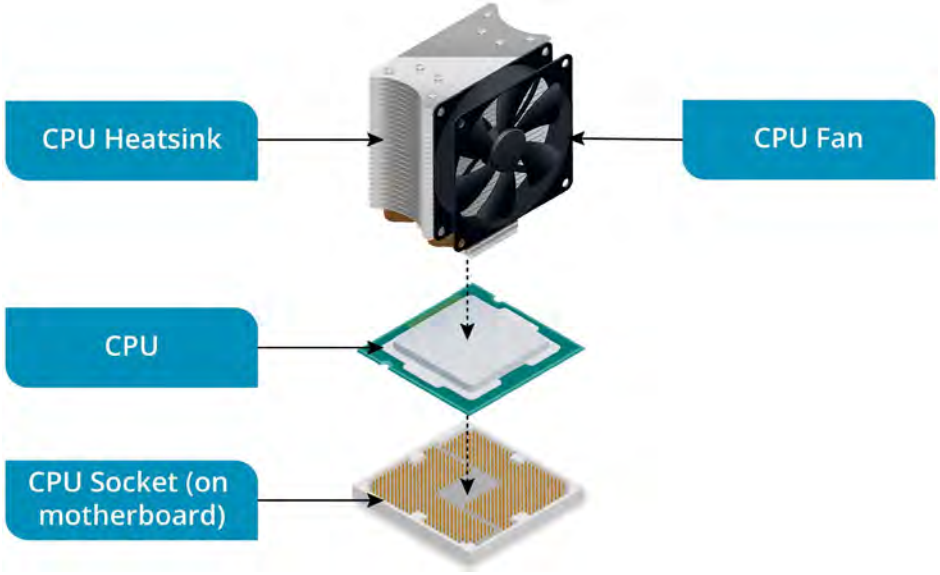
Thermal paste: A medium used to connect a heat sink to a CPU that fills any gaps between the CPU and the heat sink to permit a more efficient transference of heat from the CPU to the heat sink.

Passive cooling device: Cooling systems that work without electricity.

Cooling Mechanisms

- CPU heat sink and fan assembly called a COOLER
- Case fans
- GPU fans

the heat sink and a fan that sit on top the cpu called cooler they can not be seprTED



Cooling Mechanisms

Heat pipe: A sealed tube containing water or ethanol coolant.

Heat spreader: Similar to a heat pipe except it is a flat container rather than a pipe.

- Liquid-based cooling systems
- OR
- Laptops

CPU Installation Considerations

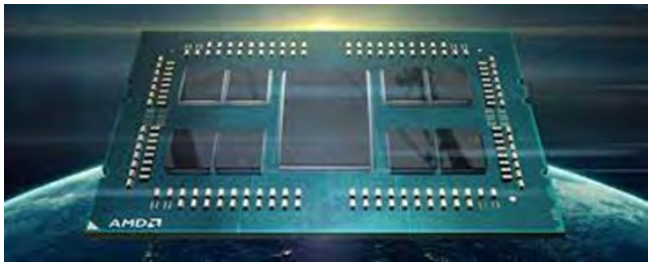
- Make sure processor matches the type of socket LGA orPGA on the system board.

- When upgrading the CPU, model is supported by the motherboard.

- On a processor, Pin 1 may be indicated with:
  - A beveled corner or a white dot
  - A square
  - A "spur"

CPU Installation Considerations

- On a processor socket, Pin 1 may be indicated with:



Discussing CPU Upgrades

- **Why can cache improve performance?**

- **ANSWER:**
  - If routines are stored in fast cache RAM, they can be accessed more quickly than instructions and data stored in system memory.

Discussing CPU Upgrades

- **What limits upgrade potential for the system processor?**

- **ANSWER:**
  - The type of CPU socket and chipset provided on the motherboard.

Discussing CPU Upgrades

- **What does SMP mean?**

- **ANSWER:**
  - Symmetric Multiprocessing: More than one CPU.

Discussing CPU Upgrades

- **How can CPU performance be improved?**

- **ANSWER:**
  - Overclocking

Discussing CPU Upgrades

- **What must you check when inserting a PGA CPU chip?**

- **ANSWER:**
  - That pin 1 is aligned properly in the socket.
  - Otherwise, you risk damaging the pins when the ZIF lever is lowered.

Discussing CPU Upgrades

- **What is the difference between a heat sink and a heat pipe?**

- **ANSWER:**
  - A heat sink uses solid metal fins to dissipate heat
  - A heat pipe contains fluid that evaporates in the area over the CPU

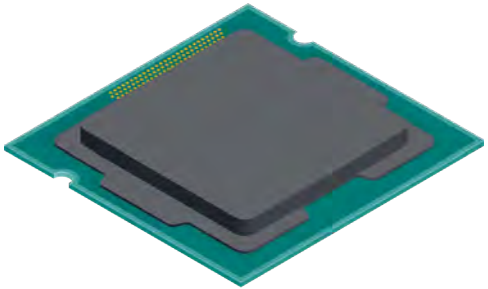
Topic B: Configure and Update BIOS/UEFI

System Firmware

Firmware: Software stored in nonvolatile memory chips.

System firmware: Provides low-level code that allows computer components to be initialized and load the main OS software.

Hardware



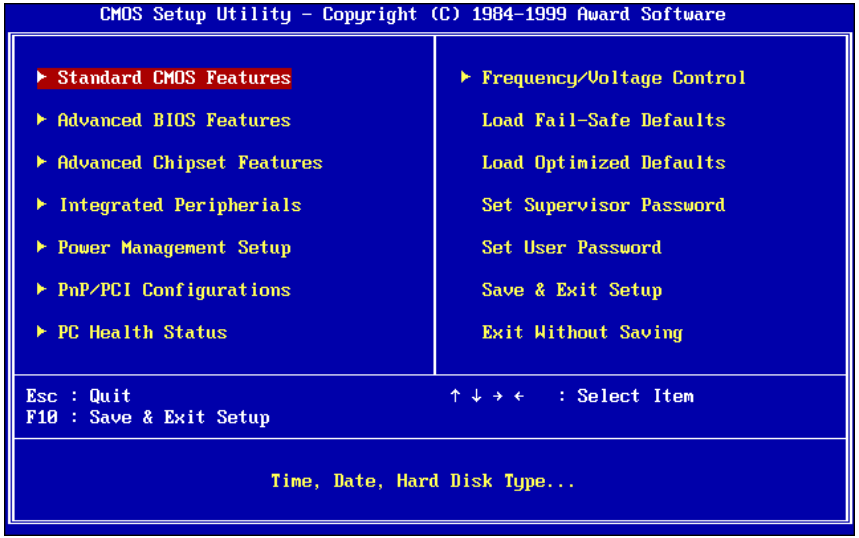
Firmware

Software

BIOS

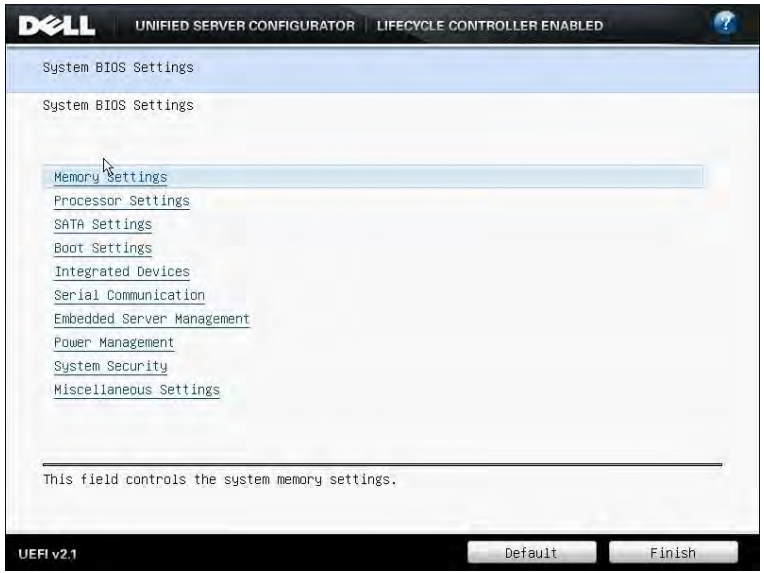
BIOS: (basic input/output system) A set of instructions that is stored in ROM Chip on prior to 2012.

Used to start the most basic services of a computer system.



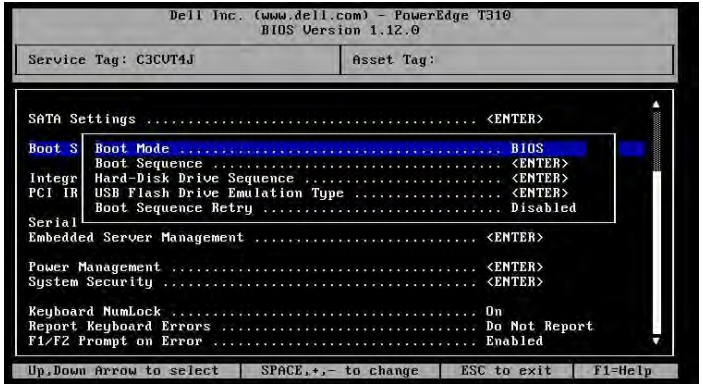
UEFI

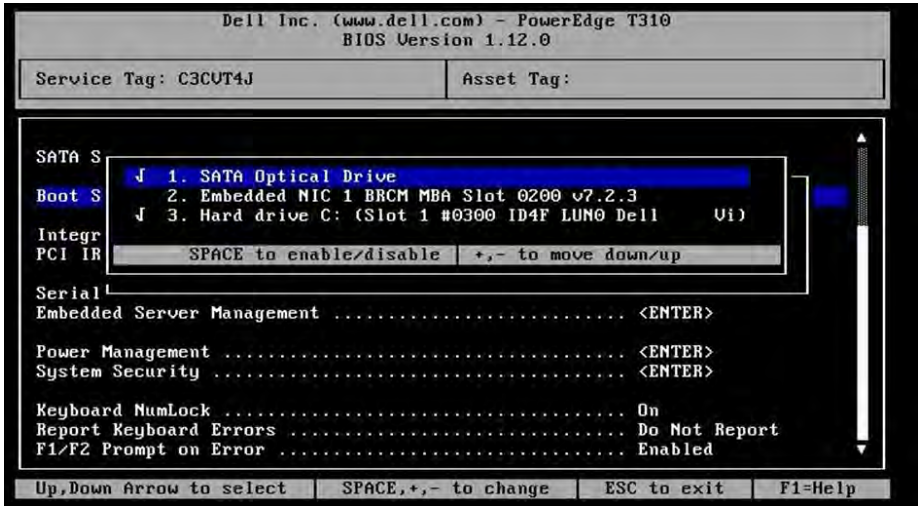
UEFI: (Unified Extensible Firmware Interface) A newer standard firmware to interface with PCs. designed for improvement over BIOSs.



Boot Order Options

- Hard drive
- Floppy drive
- Optical drive
- USB
- Network/PXE





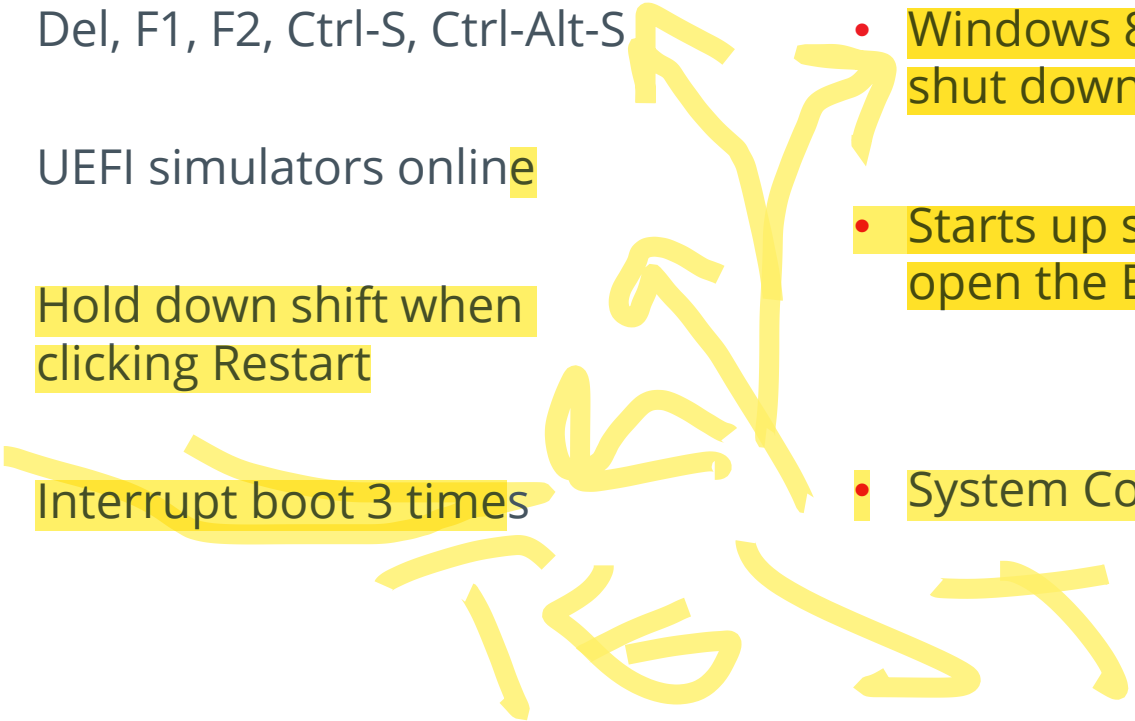
Boot Options

The Secret Button(s)

- Del, F1, F2, Ctrl-S, Ctrl-Alt-S
- UEFI simulators online
- Hold down shift when clicking Restart
- Interrupt boot 3 times

Fast startup

- Windows 8, 10, and 11 Doesn't shut down all the way
- Starts up so quickly, you can't open the BIOS
- System Configuration (msconfig)



BIOS

The Secret Button(s)

- Make a backup of your BIOS configuration
- Write detailed notes or Take a picture
- Don’t make a change unless you’re certain of the setting

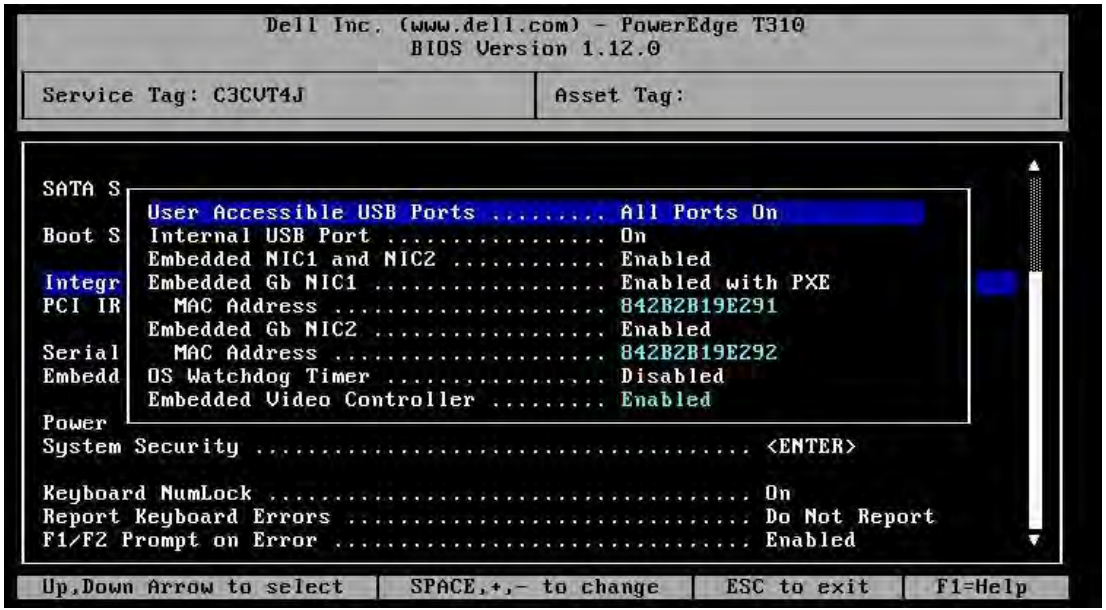
Fast startup

- Windows 8, 10, and 11 Doesn’t shut down all the way
- Starts up so quickly, you can’t open the BIOS
- System Configuration (msconfig)

Interface Configuration Settings

Onboard device configuration

- Storage adapters
- USB Permissions
- Network adapters
- Graphics adapters
- Sound adapters
- Fan Speeds
- Temp 105-150 degress



Security Settings

- Authentication:
  - Boot Password
  - Supervisor/Administrator/Setup
  - User/System

- BIOS Secure Boot :
  - Helps a computer resist attacks and infection from malware.
  - Drivers are Authenticated
  - Digital signed operating system

Security Settings

Trusted Platform Module **(TPM)**

- A specification for Full Disk Encryption
- Hardware to help with, Bit-Locker
- Random number generator, key generators
- Persistent memory comes with unique keys burned into a chip

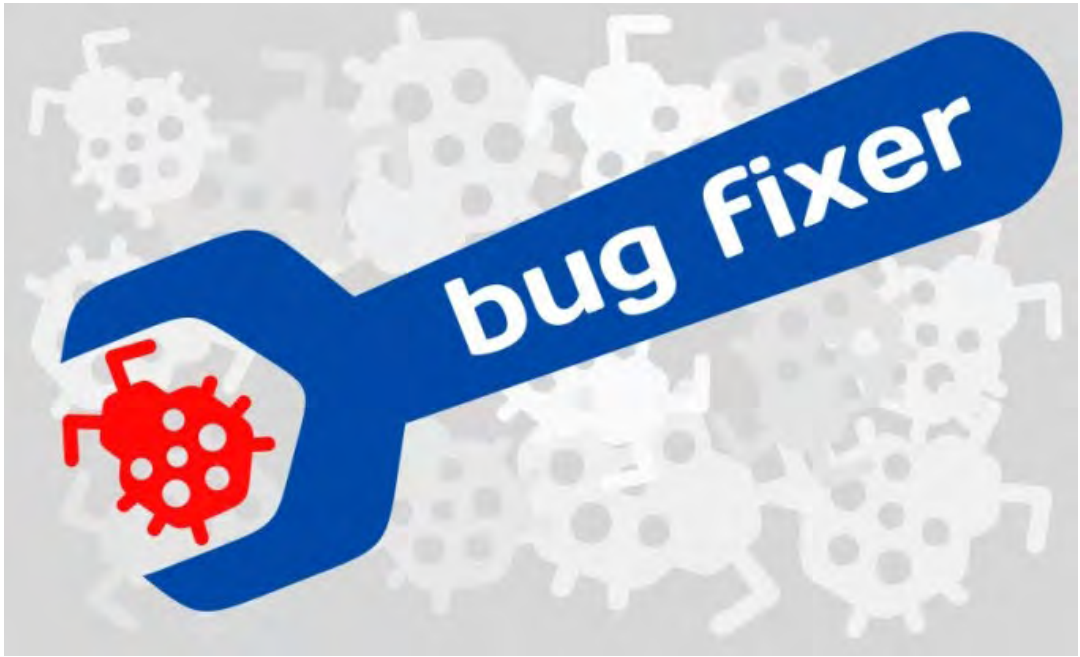
Hardware Security Module **(HSM)**

- Used in large environments
- Clusters, redundant power
- High-end cryptographic hardware
  - Plug-in card or separate hardware device
- Key backup
- Secured storage for servers
- Cryptographic accelerators
- Offload that CPU overhead from other devices

Firmware Updates

Flashing the BIOS

- Fix bugs.
- Solve incompatibilities.
- Only apply to resolve specific issues.
- Install critical updates.



Discussing BIOS/UEFI Configuration and Updates

- **What widely supported boot method is missing from the following list? HDD, FDD, Optical, USB.**

- **ANSWER:**
  - Network/PXE (Pre-eXecution Environment)

Discussing BIOS/UEFI Configuration and Updates

- **True or false? Processor extensions such as VT are set by the vendor depending on the CPU model and cannot be enabled or disabled by the user.**

- **ANSWER:**
  - False. The user can choose whether it is enabled or disabled.

Discussing BIOS/UEFI Configuration and Updates

- **Name three keys commonly used to run a PC's BIOS/UEFI system setup program.**

- **ANSWER:**
  - Esc, Del, F1, F2, F10.

Discussing BIOS/UEFI Configuration and Updates

- **If you want to enforce TPM system security, what other BIOS feature should you enable?**

- **ANSWER:**
  - A supervisor password to prevent the TPM keys from being accessed or cleared.

Discussing BIOS/UEFI Configuration and Updates

- **What advantages does UEFI have over BIOS?**

- **ANSWER:**
  - UEFI supports 64-bit CPU operation and better hardware support at boot.
  - UEFI allows for full GUI
  - Startup security options (Secure boot Drives and OS authentication).

Discussing BIOS/UEFI Configuration and Updates

- **When you are configuring BIOS security, what is the difference between a supervisor password and a user password?**

- **ANSWER:**
  - The user password allows the boot sequence to continue.
  - A supervisor password controls access to the firmware setup program.

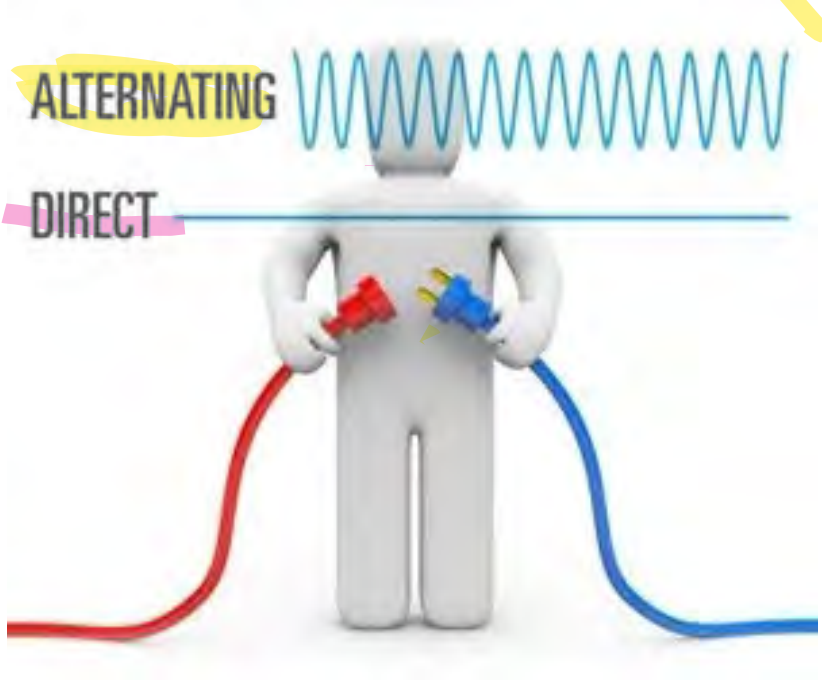
Discussing BIOS/UEFI Configuration and Updates

- **What security system allows system boot to be disabled if the computer is reported stolen?**

- **ANSWER:**
  - LoJack for Laptops Service Subscription is needed

Topic C: Install Power Supplies

Electrical Circuits

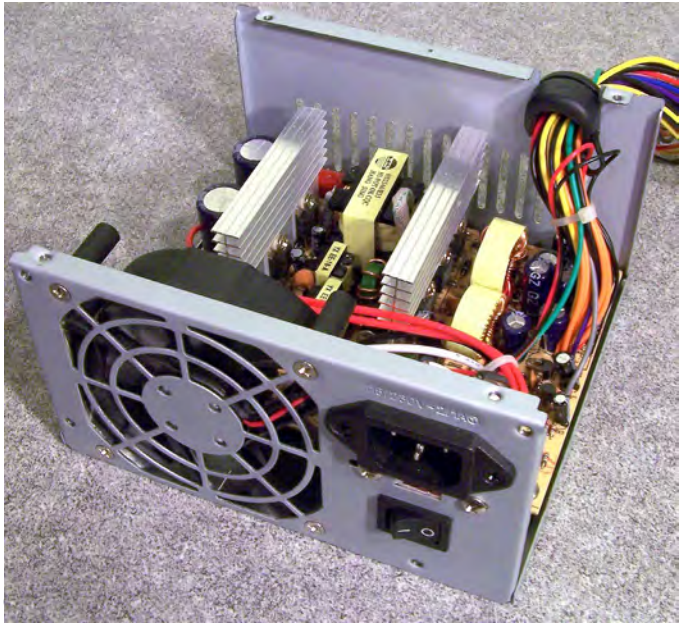


- **DC:** (Direct Current) The charge flows in one direction and power source at a constant voltage.
- **3.3v 5.v 12v**
- **AC:** (Alternating Current) The current flows in both directions and the voltage alternates between low and high values. **120v**

PSU

PSU: (Power Supply Unit) Delivers Direct Current **(DC)** low voltage power to the PC components.

- Contains:
  - Transformers
  - Filters
  - Regulators
  - Fan



PSU Form Factors

- ATX
  - Most common

- EPS12V
  - Server class

- Micro-ATX
  - SFX12V
  - TFX12V

PSU Modular power supplies

- Modular power supplies are simply power supply units with detachable cables

- Benefits:
- Less overheating, Avoiding damage to the comp - components.
- Only the power cables that your PC will need.
- Better Organization

Input Voltage

Input voltage: A PSU setting to Switch between set America 115 V to UK 240 V. Some are Manual or Automatic.

PSU Wattage rating

Power rating: The maximum power output available from a PC power supply, measured in watts.

- Laptops require a 19V DC input and offer a 5V DC output via USB ports
- Desktop PC typically 200-300 W
- Slimline Desktop PC typically 100-200 W
- Tower systems and servers often over 300 W
- Gaming PCs often over 500 W

Output Voltages

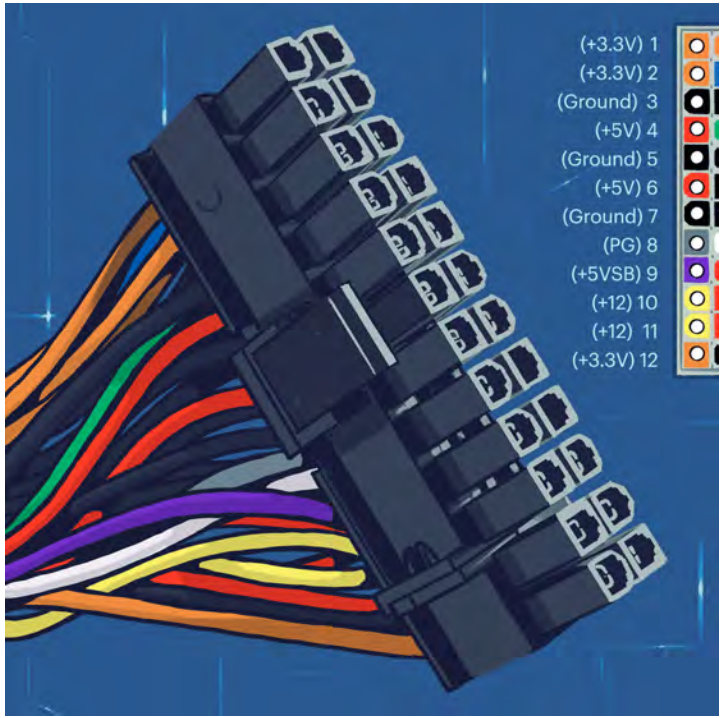
OCP: (Overcurrent Protection) A power supply rail safety feature that cuts the circuit if the power exceeds a safe limit.

Output Rail (V)	Maximum Load (A)	Maximum Output (W)
+3.3	20	130
+5	20	130
+12	33	396
-12	0.8	9.6
+5 (standby)	2.5	12.5

PSU Adapter Types

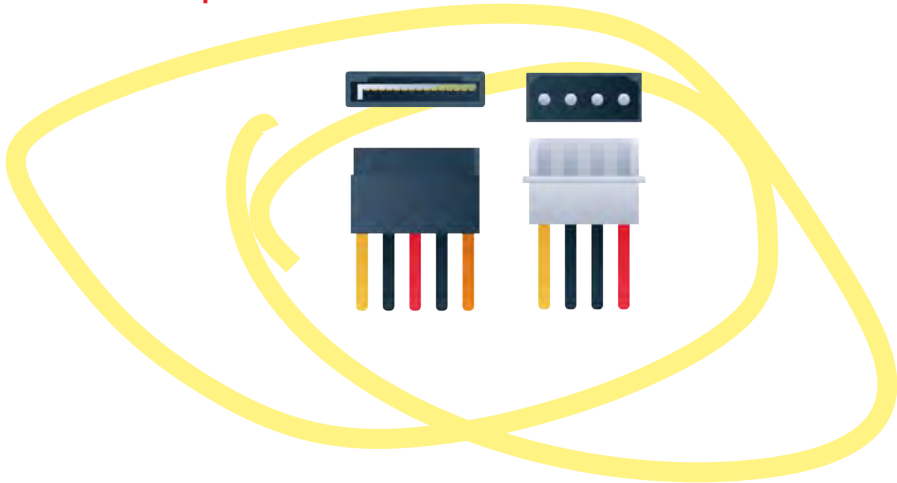
- **Voltage regulator:** A module that ensures the motherboard delivers the voltage required by the CPU.

- **Main connector P1: 20 pin or 24pin - forPCIe**
- The Main power plug that supplies power to the motherboard.



PSU Adapter Types

Molex connector: A older power connector that is used to supply power to (PATA) drives, optical drives, and SCSI drives.



- PCIe connectors: 6-pin
- P4 and EPS connectors: 8-pin

PSU Adapter Types

- PCIe connectors: 6-pin
- P4- CPU, and 8-Pin for Graphics connectors:

PSU Redundant power supply

- During normal operation, the dual redundant power supplies power the load 50/50.
- For example, your server pulls 500W total and you have two 750W power supplies
- If one 750W power supply fails, the other 750W power supply can provide enough power to keep the 500W server running

Power Needs Calculation

1. List the devices that need to have power served by the PSU. Be sure to include the following:
   - Motherboard
   - CPU
   - RAM
   - Hard drives
   - CD drives
   - DVD drives
   - Floppy drives (if any)
   - Expansion cards

Power Needs Calculation (Slide 2 of 2)

2. Determine the power requirements for each device.

3. Add up the power requirements for the existing total power load.

4. Consider adding a buffer of **50 percent** for future power needs.

5. Examine the details on the PSU currently installed, paying particular attention to the maximum output.
   - If you have not exceeded the power available, you do not need to upgrade the PSU.
   - If you have, you will need to obtain a PSU with a higher output and install it.

Discussing Power Supply Installation

- **Are you able to use a standard ATX12V PSU with a Mini-ITX motherboard?**

- **ANSWER:**
  - Yes (assuming it fits in the case you have chosen).

Discussing Power Supply Installation

- **What is the significance of a PSU's power output when you are designing a custom build PC?**

- **ANSWER:**
  - It determines the number of drives, expansion cards, and peripherals that the PC can support (assuming the peripherals do not have their own power supplies).

Discussing Power Supply Installation

- **You are connecting a new PSU. The PSU has a square 4-pin P4 cable but there is no square 4-pin receptacle on the motherboard. Should you leave the cable disconnected?**

- **ANSWER:**
  - No; it will plug into an 8-pin EPS12V receptacle near the CPU. You should check the motherboard documentation for advice about which pins to plug the cable into.

Discussing Power Supply Installation

- **What setting should you check before installing a PSU?**

- **ANSWER:**
  - That the voltage selector is set to the correct voltage

Discussing Power Supply Installation

- **You have a power supply with an 8-pin connector on it. What is this for?**

- **ANSWER:**
  - It supplies power to a PCI Express graphics card.

Activity 4-4: Discussing Power Supply Installation

- **Another technician replaced the PSU on a PC. Later the same day the PC's owner contacts you to say that the system has been displaying numerous alerts about high temperature. What do you think might be the cause?**

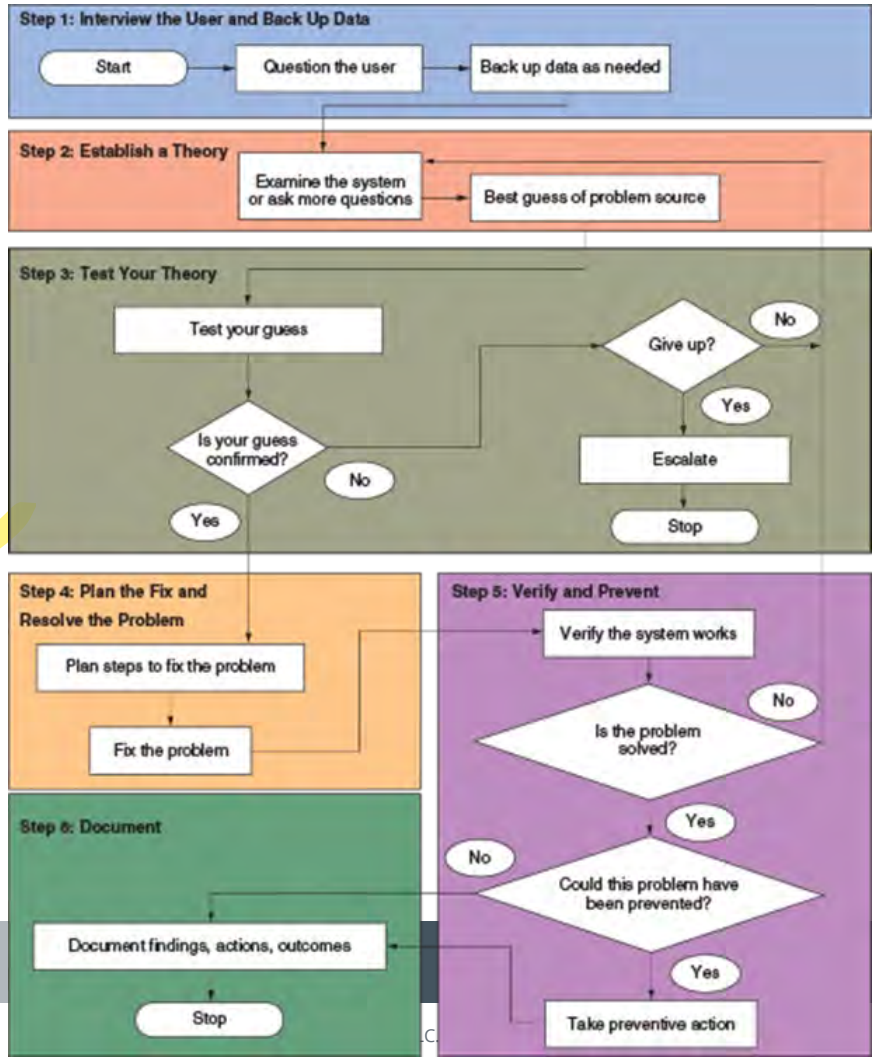
- **ANSWER:**
  - You would need to open the case to investigate the problem. Perhaps when the upgrade was performed, one of the fan power connectors was not attached properly. If the PSU cabling was not secured with cable ties, it could disrupt air flow within the case, reducing the effectiveness of fans. There could be a fault with the fan on the new PSU.

Topic D: Troubleshoot Internal System Components

Basic Hardware Problems

- Look for simple solutions first.
  - Find out if anything has changed.
  - Eliminate hardware issues as a cause first.
  - Try one thing at a time.
  - Ensure that a user's data is backed up first!

- Observable symptoms
  - Indicator lights.
  - Alerts.
  - Overheating.
  - Loud noises.
  - Visible damage.



Multimeter Use

Multimeter: An electrical meter capable of measuring voltage, resistance, and current.

- To test a fuse, set the multimeter to measure resistance and touch the probes to each end of the fuse.

- PC power supplies are NOT user-serviceable.
  - Do NOT attempt any maintenance beyond the simple tests described.
  - Never remove the cover of a power supply.

Multimeter Use

Supply Line	Color Code	Tolerance	Min. Voltage	Max. Voltage
+5 V	Red	±5%	+4.75 V	+5.25 V
+12 V	Yellow	±5%	+11.4 V	+12.6 V
-12 V	Blue	±10%	-10.8 V	-13.2 V
+3.3 V	Orange	±5%	+3.135 V	+3.465 V
+5 V Standby	Purple	±5%	+4.75 V	+5.25 V
PSU On	Green	Higher than +3 V when PC is off; less than 0.9 V when the PC is on.		
Power Good	Gray	Less than 0.9 V when the PC is off; higher than 2.5 V when the PC is on.		
Ground	Black	-	-	-

Power Supply Tester

Power Supply Tester: A type of meter designed specifically to test PSUs.

- Typically include ports for:
  - 20/24-pin P1
  - Molex
  - SATA
  - 8-pin connectors
  - 6-pin connectors
  - 4-pin connectors

Power-On Self-Test (POST): A hardware checking routine built into the PC firmware.

This test sequentially monitors the state of the memory chips, the processor, system clock, display, and firmware itself.

1. POST locates video card firmware at memory address C000.
   - If found, card is initialized from its own firmware.

2. Startup screen is displayed.
   - More tests are performed, including RAM.
   - Any errors are indicated by displaying text messages.

3. If desired, access system setup routine at this point. (**Press F2**)

4. Most computers boot silently, but some may emit a single beep to indicate system checks have been successfully completed.

POST and Boot Problems

5. PC searches for interfaces with additional firmware chips.
6. Firmware may display system configuration summary screen.
7. Operating system load sequence starts.

POST Not Running

- If you ensure power is available but computer does not start, screen remains black, and there are no beeps, POST likely is not executing.
  - If possible, try another monitor if there is still no image.
  - Check for faulty cables, damaged or mismatched CPU, or motherboard issues.

POST and Boot Problems

POST Not Running (continued):

- Try these tests and solutions:
  - If the system firmware has been flashed and the PC has not booted since, the system firmware update may have failed. Use the reset procedure.
  - Check cabling and connections. Correct any errors, reset adapter cards, and then reboot the PC.
  - Check for faulty interfaces and devices. Try removing one device at a time to see if this solves the problem.
  - Check the PSU for a fault that is preventing the Power Good signal from being sent to the CPU, preventing POST.
  - Check for logic errors—POST test adapter cards can interpret the debug codes given by the firmware
  - Check for a faulty CPU or system firmware.
  - Check motherboard jumper settings.

POST and Boot Problems

POST Not Running (continued):

- Try these tests and solutions:
  - If the system firmware has been flashed and the PC has not booted since, the system firmware update may have failed. Use the reset procedure.
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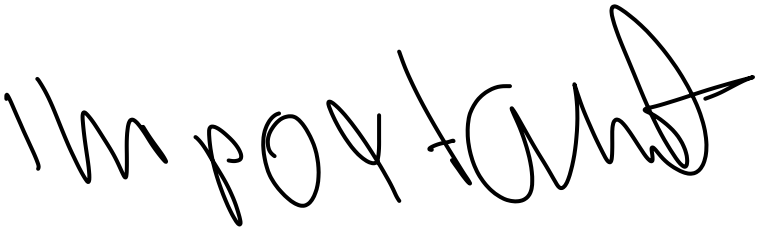
POST and Boot Problems



POST Beep Codes

Code	Meaning
1 short beep	Normal POST—System is OK
2 short beeps	POST error—Error code is shown on screen
No beep	Power supply or motherboard problem
Continuous beep	Power supply, motherboard, or system memory problem
Repeating short beeps	Power supply, motherboard, or keyboard problem
1 long, 1 short beep	Motherboard problem
1 long, 2 or 3 short beeps	Display adapter error
3 long beeps	3270 keyboard card

POST and Boot Problems

BIOS Time and Settings Reset

- Modern computers don't rely on CMOS battery to store settings.

- Computers that lose the correct time might have a failed Real Time Clock battery.

CMOS Battery

ComputerHope.com

POST and Boot Problems

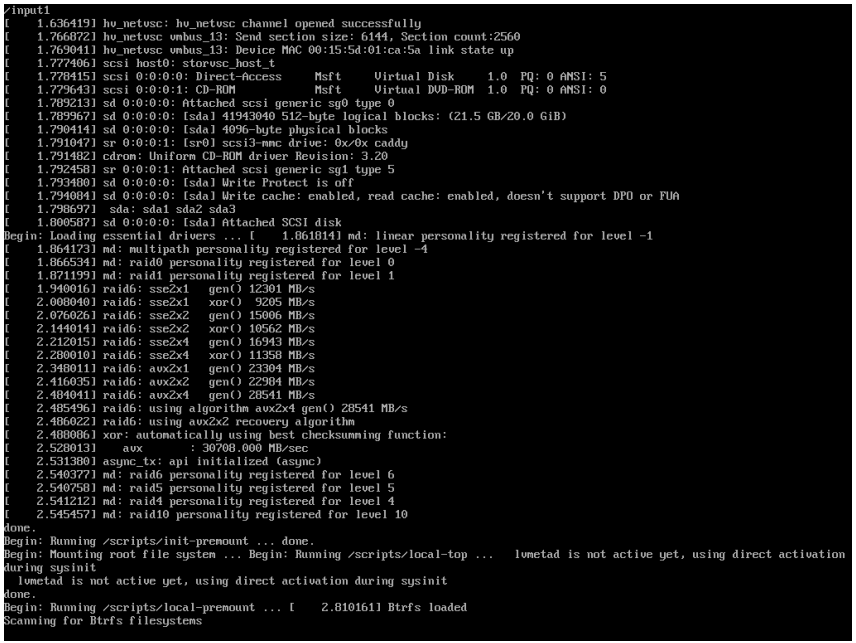
Operating System Search/Boots to Incorrect Device

- After POST tests, firmware searches devices in specified boot sequence.
- If first drive is not found, it moves to the next drive.
- If no disk-based boot device is found, it might try to boot from a network.
- If no boot device is found, an error message is displayed, and the boot process is halted.

OS Boot Troubleshooting and Log Entries

- When boot device is located, code from boot sector is loaded into memory.
- Code from boot sectors takes over from system firmware to load the rest of the OS into system memory.
- Error messages after this point are usually software or driver problems.

OS Boot Troubleshooting and Log Entries



If system tries to boot to the wrong device.

- Verify boot device order is correctly configured.

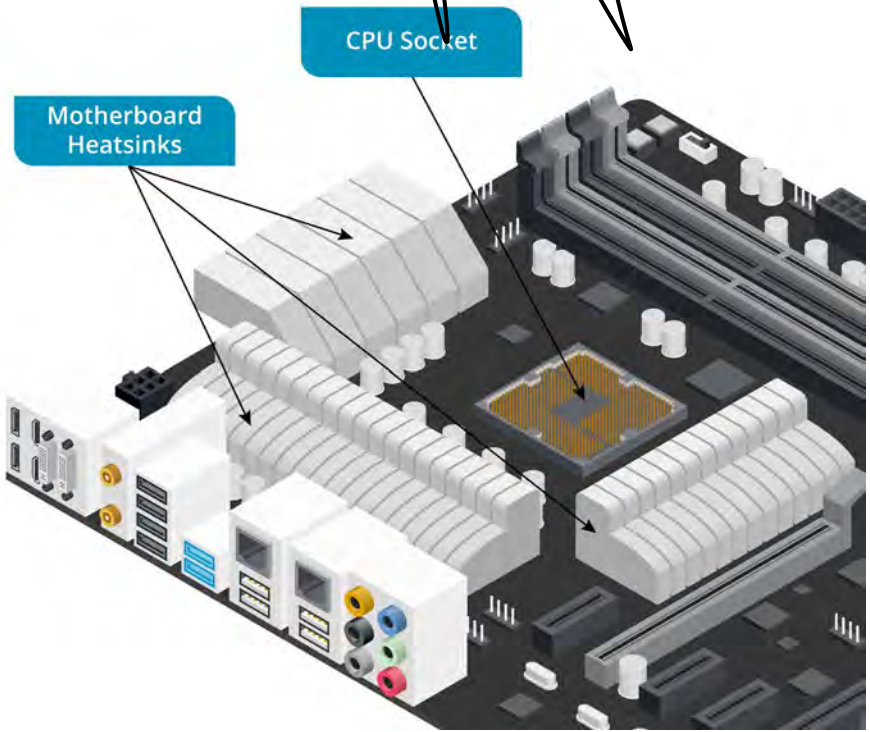
Examine log entries:

- In Windows, use Event Viewer to analyze System and Applications logs.
- In Linux, review boot messages using dmesg | less command.

Motherboard Component Problems

Visually inspect for physical damage.

- Pins are not bent.
- Dirty contacts on connectors.
- Chips and boards are properly seated.
- Scorch marks and distended capacitors.



Motherboard Component Problems

Determine	Determine if intermittent problems have a pattern.
Verify	Verify power supply provides stable voltages to the computer.
Check	Check for overheating issues. Ensure that: • CPU fan is working. • Heatsink is properly fitted. • Empty slots have blanking plates installed. • Processor is running at the correct speed.

Activity

Discussing System Component Troubleshooting

Discussing System Component Troubleshooting

- **What cause might you suspect if a PC experiences intermittent lockups?**

- **ANSWER:**
  - Thermal or power problems are most likely.
  - Loose connections or faulty memory or CPU are also possibilities.

Discussing System Component Troubleshooting

- **What measurement would you expect from a multimeter if a fuse is good?**

- **ANSWER:**
  - Zero ohms.

Discussing System Component Troubleshooting

- **What might stop a POST from executing?**
- **ANSWER:**
  - Faulty cabling and connections, poorly-seated chips, faulty interfaces and devices, logic errors, faulty CPU, motherboard, or PSU.