Chapter 3: System Configuration

Complete CompTIA A+ Guide to PCs, 6e
Chapter Objectives

- How to make configuration changes to a computer
- The importance of BIOS and UEFI BIOS
- How to replace a motherboard battery
- What system resources are and how to view/change them
CompTIA A+ Exam Objectives Covered in This Chapter

801-1.1: Configure and apply BIOS settings.
801-1.2: Differentiate between motherboard components, their purposes, and properties.
801-1.4: Install and configure expansion cards.
802-1.4: Given a scenario, use appropriate operating system features and tools.
802-4.2: Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU, and power with appropriate tools.
CMOS: (Complementary Metal-Oxide Semiconductor) Memory

- Requires power, provided by a small coin-sized lithium battery
  - Battery dies $\rightarrow$ data lost
  - CR2032 common battery
- BIOS settings
- Data about supposedly installed hardware
- Incorrect data $\rightarrow$ POST errors
BIOS
(Basic Input/Output System)

- Contains Firmware
  - POST (power-on self-test):
    - identifies, tests, and initializes basic hardware components
  - Bootstrap program/loader:
    - locates an operating system and allows it to load
  - Setup (BIOS setup, system setup, and CMOS setup):
    - allows settings to be viewed and managed
    - See Configuration Settings: pgs. 98 & 99
The BIOS Controls the Beginning of the Boot

- Successful boot
  - Hardware, BIOS, operating system all perform without errors (beeps, text or voice messages)
- Boot functions
  - BIOS runs POST and assigns system resources
  - BIOS program searches for and loads an OS
  - OS configures system and completes its own loading
  - Application software is loaded and executed
BIOS
(Basic Input/Output System)

- Access Setup:
  - Keystrokes to access CMOS setup.
  - F1, F2, ESC key, Del key
  - Motherboard documentation

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**BIOS**: (Basic Input/Output System)

- Flash BIOS (“flash the BIOS”; most common today):
  - allows changing/upgrading the BIOS without installing a new chip or chips.
  - Write protection (motherboard jumpers, switch or BIOS setting)
  - Download upgrade from website (manufacturer or 3rd party)
  - Upgrade/flash:
    - New/upgraded hardware (larger hard drive)
    - Increased virus protection
    - Optional password protection
    - Patches/fixes
    - Corruption/failure
- Always see motherboard doc. for details
- Always use AC adapter when flashing BIOS
Step 1: POST and Assignment of System Resources

- Turn on PC power
- Processor begins the boot by initializing itself
- Startup BIOS first performs POST

1. System clock begins to “tick”
2. Processor resets internal values
3. Processor finds first instruction in ROM BIOS at memory address FFFF0h
4. Instruction tells processor to run POST
5. POST test CMOS (Complementary Metal Oxide Semiconductor) RAM
6. Test battery
7. Hardware interrupts disabled so that input devices (keyboard, mouse, etc.) cannot interrupt startup process.
8. Processor tested
9. If “cold boot” then first 16K of RAM tested
10. Hardware devices tested
11. Video card tested and configured.
12. RAM tested
13. Keyboard tested
14. Secondary storage tested against data in CMOS
15. DMA and interrupt controllers checked
16. BIOS begins search for Bootstrap Loader to load OS
For a successful boot, a hard drive must contain a healthy Master Boot Record (MBR) and a healthy OS boot record.
Boot/Startup Process

Step 1
1. Where do I find an OS?
2. First look on drive C and then drive E.
   - BIOS
   - RAM on CMOS chip

Step 2
3. MBR, can you start the OS boot?
   - BIOS
   - Master Boot Record
   - Drive C starts here
   - OS boot record
   - BootMgr

Step 3
4. Only if I can find the OS boot record.
5. Only if I can find BootMgr.
6. I'm the beginning of the OS. I'll take it from here.
   - MBR
   - OS boot record
   - BootMgr

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Boot/Startup Process

Startup Bios Finds and Loads the OS (cont’d)

• Tracks: concentric circles on drive
• Sectors (segments): portion of a track
  • Holds up to 512 bytes of data
• Master Boot Record (MBR)
  • Contains master boot program and partition table
• OS boot record
  • 512-byte sector
  • Second sector on drive behind MBR
  • Contains small program pointing to a larger OS program file (BootMgr or Ntldr)
**UEFI:** Unified Extensible Firmware Interface (EFI)

- Interface (environment) between OS and BIOS firmware
- May provide:
  - Mouse use
  - Internet connection
  - Run apps./utilities
  - Virus scan
  - GUI
  - Backup/restore

*Figure 3.3* Sample UEFI main menu

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BIOS Configuration Settings (stored in CMOS)

• **System Information**: General information

• **General Optimization**: Boot faster, disable feature, e.g. memory checking, network booting, removable drive booting.

• **Date/Time**: configure system data and time

• **Boot Sequence**: Prioritize devices to search for the OS.

• **CPU Configuration**:
  • Throttle management to slow CPU when overheated
  • Clock speed: may not be changeable
  • Platform Environmental Control Interface (PECI)
    • Affects how thermal sensors report CPU core temperature
  • Virtualization
BIOS Configuration Settings

- Video Options:
  - Dynamic Video Memory Technology (DVMT)
    - Control video memory
    - Aperture size: amount of RAM for video adapter use
    - Primary and secondary video controller

- Onboard Device Configuration
  - Modify devices built into the motherboard
  - Audio, Bluetooth, network, USB, video ports

- Password management
- Virus Protection
- Numlock On/Off
- USB configuration
BIOS Configuration Settings

- Hyperthreading
- Integrated Peripherals: manage/configure motherboard controlled devices
  - PATA/SATA, USB, audio & network ports
  - RAM for AGP adapters
- HD audio controller
- Advanced BIOS Options
  - CPU, front side bus, north & south bridge, chipset and memory voltage levels
- IDE device configuration
  - PATA, hard drive, optical drive
- SATA configuration
BIOS Configuration Settings

- PCI/PnP Configuration
- PCIe Configuration
- Virtual Machine
- Advanced Configuration & Power Interface (ACPI)
- Hardware monitor: view CPU & Motherboard temps., status of CPU, voltages, clock speed, bus speeds, chassis intrusion, power supply fan(s)
- Execute Disable: prevent executable code
- Drive encryption: password required to boot
- Lojack
- Intrusion Detection
Motherboard Batteries

- Small coin-sized lithium battery
- Lasts several years (3 – 8 yrs.?)
- When the battery dies, all configuration information in CMOS is lost and must be re-entered after the battery is replaced.
**System resources used by hardware and software**

<table>
<thead>
<tr>
<th>System Resource</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRQ numbers</td>
<td>A line of a motherboard bus that a hardware device or expansion slot can use to signal the CPU that the device needs attention. Some lines have a higher priority for attention than others. Each IRQ line is assigned a number (0 to 15) to identify it.</td>
</tr>
<tr>
<td>I/O addresses</td>
<td>Numbers assigned to hardware devices that software uses to send a command to a device. Each device “listens” for these numbers and responds to the ones assigned to it. I/O addresses are communicated on the address bus.</td>
</tr>
<tr>
<td>Memory addresses</td>
<td>Numbers assigned to physical memory located either in RAM or ROM chips. Software can access this memory by using these addresses. Memory addresses are communicated on the address bus.</td>
</tr>
<tr>
<td>DMA channels</td>
<td>A number designating a channel on which the device can pass data to memory without involving the CPU. Think of a DMA channel as a shortcut for data moving to and from the device and memory.</td>
</tr>
</tbody>
</table>
Configuration Parameters: Interrupt Requests (IRQ’s)

- Number assigned to expansion adapter or port
- System to prioritize device requests for CPU time
- **APIC**: Advanced Programmable Interrupt Controller
  - More flexible than older systems
  - Allows sharing of interrupts
- **LAPIC** (Local APIC): in CPU
- **I/O APIC**:
  - for peripheral I/O buses
  - in Chipset
IRAQ Resource Conflicts

• Install a new device and then already installed device no longer works.
• Computer locks up or restarts when preforming specific operation
• Computer hangs up during boot or shutdown
• A device does not work/fails
• May need to update device driver
• See device error codes: page 105
PCI (Peripheral Component Interconnect) Interrupts

- Assigned by OS during boot for peripherals
- Peripheral ROM BIOS allowed to run during boot
- May use shared interrupts INTA, INTB…
- Dynamic assignment after boot
- IRQ (PCI) Steering
  - Allows multiply adapters to be mapped to the same IRQ
  - Multiple adapters mapped/assigned to IRQ 9, 10, 11 and 12
- MSI / MSI-X (Message Signaled Interrupt)
  - Interrupts sent to CPU using software and memory space
I/O Addresses

• aka Port addresses
• Allow devices and CPU to exchange data
  • Device places data in memory with specified I/O address
  • CPU picks up data from memory using same address
• Allows CPU to distinguish between devices
• Devices assigned range of addresses
  • Provides multiple memory locations depending on device needs
Memory Addresses

• Unique range of addresses assigned to memory chips
  • e.g. C8000h – C8FFFh (may be listed as just C8000h)
• Used by CPU to access data in chip
• Memory addresses should not overlap
• Some are preset and cannot be changed
• ROM Shadowing
  • Contents of device ROM BIOS copied to RAM for faster access
Adapter Configuration

- Documentation and drivers available on Internet
- **ESCD**: Extended System Configuration Data
  - Data area in CMOS
  - Holds info about installed adapters and resources assigned to the adapters
- BIOS checks saved settings for startup sequence
- **PnP**: Plug and Play
  - Automated configuration of adapters
- **Registry**:
  - Database of adapter configuration data
  - Apps access for configuration data
Soft Skills - A Good Technician Quality: One Thing at a Time

- Make a list of symptoms.
- Try the simplest solutions first.
- Document each step.
A lot of questions from both exams can come from this chapter, especially in the troubleshooting areas. Review the troubleshooting bullets. Go to at least one computer and go through the BIOS menus. Review what types of things can be configured through BIOS.

Review the difference between a BIOS and a UEFI BIOS.

Review different sections of Device Manager. Device Manager is a critical tool for troubleshooting computer issues. Know how to determine what driver is installed. Practice finding drivers on Internet sites.

Know what issues look like in Device Manager. Trying to get Windows or BIOS to show an error within Device Manager on a machine that works properly is difficult, so use a search engine such as Google Images and type Device Manager conflicts as your search string. The resulting images are examples of Device Manager conflicts.
The system flash BIOS is used to enable/disable, configure, and troubleshoot motherboard components, expansion slots, and ports. When the computer is off, a motherboard battery holds saved settings in CMOS.

An updated type of BIOS is UEFI BIOS, which allows the use of a mouse and a graphical environment. Security options, support for larger hard drives, antivirus software, and utilities may also be included.

Each port and card uses system resources such as interrupts, I/O addresses, and memory addresses.

PCIe cards can use traditional interrupts or software interrupts known as MSI or MSI-X.

System resources can be viewed and changed using Device Manager. Specific Device Manager codes and messages help in troubleshooting conflicts.

A good computer technician should methodically troubleshoot a problem by making only one change at a time and reverting the change if the change did not solve the problem. Furthermore, the technician documents the issue and its resolution for future problems.