# **Chapter 2**

**All About Motherboards**

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| **At a Glance** |

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# **Overview**

This chapter covers the different features and types of motherboards commonly available. Students will learn about the motherboard BIOS and how to navigate through settings available within the BIOS. Proper maintenance and motherboard installation / replacement procedures are covered also.

# **Objectives**

After completing this chapter, students will be able to:

* Describe and contrast various types and features of motherboards
* Configure a motherboard using BIOS/UEFI firmware
* Maintain a motherboard by updating drivers and firmware, using jumpers to clear BIOS/UEFI settings, and replacing the CMOS battery
* Select, install, and replace a desktop motherboard or laptop system board

# **Teaching Tips**

## Motherboard Types and Features

1. Mention that when selecting a motherboard, students should pay attention to the form factor, processor socket, chipset, expansion slots, and other connectors, slots, and ports.

#### Motherboard Form Factors

1. Review the types of motherboard form factors that are available:
   1. ATX
   2. MicroATX
   3. MiniITX (commonly referred to as an ITX board
2. Students should be aware of the intended use of the individual motherboard form factor designs. For example, ITX is typically used in smaller computers, while ATX is designed for larger, full-size computers. Use Table 2-1 in your discussion.

#### Intel And AMD Chipsets and Processor Sockets

1. Define the chipset as chips that exist on the motherboard that control various system resources such as memory, buses, and peripherals.
2. Explain that a socket is rectangular with pins or pads to connect the processor to the motherboard and a mechanism to hold the processor in place. Point out that the chipset and socket determine which processors a board can support.
3. Review the following Intel chipsets with your students:
   1. Coffee Lake
   2. Kaby Lake
   3. Skylake
   4. Broadwell and Haswell
4. Mention to students that since the release of the 2nd generation Intel Core family of processors, you can know which generation a processor fits in by the four digits in the model number. Example: the Core i5-6200U processor is a 6th generation processor.
5. Explain that the Intel name for a socket includes the number of pins the socket has. Further mention that Intel uses a land grid array (LGA) for all its current sockets.
6. Review and compare the following Intel sockets:
   1. LGA1151
   2. LGA1150
   3. LGA1155
   4. LGA2066
   5. LGA2011
   6. LGA1366
7. Emphasize the importance of caution when handling a processor during install, and explain how to use a zero insertion force (ZIF) socket.
8. Discuss the four chipset and socket categories currently offered by AMD:
   1. TR4 (Threadripper 4)
   2. AM4
   3. AM3+
   4. FM2+
9. Stress the importance of checking documentation when building a computer or replacing processors on an existing computer. Students should understand that the processor and motherboard socket must match, and the motherboard should also list compatibility with the processor.

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| ***Teaching***  ***Tip*** | At one point, Intel and AMD processors used the same socket (such as Socket 5) and were interchangeable. |

#### Buses and Expansion Slots

1. Familiarize students with how a motherboard physically facilitates access to devices connected to it, via traces.
2. Define a bus as a system of pathways used for communication throughout a computer, and describe how protocols dictate the way communication will take place.
3. Use Table 2-2 to discuss details of some of the expansion slots found on today’s motherboards.
4. Introduce students to the PCI Express (PCIe) expansion slot. Discuss how the PCIe slots use lanes to transfer data. Discuss the characteristics of the following slots:
   1. PCIe x1
   2. PCIe x4
   3. PCIe x8
   4. PCIe x16
5. Discuss the possible power connection options that are needed for the various expansion slots. Use Figure 2-14 to illustrate the difference between a Molex-style connector and a SATA-style power connector.
6. Point out that conventional PCI slots are slower than those of PCI Express, but they are still found on most motherboards to support Ethernet network cards, wireless cards, and sound cards.
7. Explain how a riser card allows PCI cards to be installed at a right angle to the motherboard.

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| ***Teaching Tip*** | Many electrical components and motherboards include test points on the motherboard itself, connected by traces. A multimeter can be used with these points to determine continuity or system voltages. |

#### On-Board Ports and Connectors

1. On-board ports should be explained as components that exist directly on the motherboard, such as USB ports, network or video ports, or eSATA ports.
2. Explain the purpose of the I/O shield in covering up excess space around the on-board ports exposed at the back of a computer case.
3. List some common internal connectors that might exist on the motherboard, and stress that the motherboard’s documentation is the best source for identifying the connectors.

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| ***Teaching***  ***Tip*** | Many different form factors exist, all with different intended uses. MiniITX motherboards, for example, are designed to be extremely low power, and are typically used in small form factor computers. |

1. Discuss the SATA (Serial Advanced Technology Attachment or Serial ATA) interface standard that is used mostly by storage devices. Discuss the following versions of SATA:
   1. SATA Express (SATAe)
   2. SATA3
   3. SATA2
2. Introduce students to the M.2 connector, formerly known as the Next Generation Form Factor (NGFF). Point out that the M.2 connector was first used in laptops but is now common on desktop motherboards.
3. Be sure to point out that there are multiple M.2 standards and M.2 slots and students should make sure an M.2 card matches the M.2 slot and uses an interface standard the slot supports.
4. Explain to students that years ago, the IDE (Integrated Drive Electronics) standard was used to interface storage device with the motherboard. Students will need to be able to recognize an IDE connector.
5. Use Figure 2-23 to discuss USB connectors.

**Quick Quiz 1**

1. Which socket has pins on the motherboard that make physical contact with pads on the bottom of the processor?

Answer: land grid array (LGA)

1. True or False: A MicroATX motherboard will fit inside of a MiniITX case.

Answer: False

1. Select the socket below that is not an AMD socket:
   1. FM2
   2. AM3+
   3. Socket 940
   4. LGA1151

Answer: D

1. Which Intel processor was the first to use the LGA1151 socket?
   1. Coffee Lake
   2. Kaby Lake
   3. Skylake
   4. Broadwell and Haswell

Answer: C

1. Which of the following is used to provide another slot at a right angle?
   1. onboard port
   2. riser card
   3. M.2 connector
   4. PCI slot

Answer: B

## Using BIOS/UEFI Setup to Configure a Motherboard

1. Discuss how firmware on the motherboard is used to:

* Enable or disable a connector, port, or component
* Control the frequency of the CPU
* Manage security features
* Control what happens when the PC first boots
* Monitor various activities of the board

1. Point out that motherboards made after 2012 use BIOS/UEFI firmware and prior to 2012 all motherboards used BIOS firmware.
2. Explain that UEFI (Unified Extensible Firmware Interface) improves on BIOS but includes BIOS for backward compatibility with older devices. Discuss the facts that students should know about UEFI that are found in the text.

#### Accessing the BIOS/UEFI Setup Program

1. Demonstrate how to access the BIOS/UEFI setup program, and list some of the more common keystrokes necessary for gaining access at computer startup.

#### Viewing and Monitoring Information

1. Familiarize students with navigation and changing settings within the BIOS/UEFI setup screen, pointing out what options are available. Students should understand that different BIOS/UEFI versions will have different capabilities and settings available for change.
2. Use Figure 2-27 to illustrate a BIOS/UEFI screen with a graphical interface.

#### Changing Boot Options

1. Explain how to change a computer’s BIOS boot sequence, then demonstrate how this is done.
2. Discuss some examples of where students might want to change the boot priority order.
3. Introduce students to Secure Boot, which was invented to help prevent malware from launching before the OS and anti-malware software are launched.
4. Explain to students that the Platform Key (PK) is a digital signature that belongs to the motherboard or computer manufacturer and that it authorizes turning Secure boot on or off.
5. Review how Secure boot operates when it is enabled.
6. Introduce students to CSM (Compatibility Support Module), also called Legacy Support. Point out that CSM should be used for backward compatibility with older BIOS devices and drivers and MBR hard drives.

#### Configuring Onboard Devices

1. Show how on-board devices such as built in audio, USB, or network ports can be configured using BIOS/UEFI setup.
2. Discuss the practice of overclocking a computer’s components, and note how this can be done within some BIOS/UEFI setup screens.

#### Configuring Security Features

1. Power-on passwords should be explained as a way to limit or prevent a computer’s ability to boot without providing a password during the startup process. Note that this can be reset using a jumper on the motherboard.
2. Detail security mechanisms such as LoJack that are embedded into a device’s BIOS, and describe how this can help secure data.
3. Explain that some laptop BIOS/UEFI utilities offer the option to set a hard drive password, which does not encrypt all the data on the drive but encrypts only a few organizational sectors.
4. Discuss options for hard drive encryption and password protection. Note that the Trusted Platform Module (TPM) chip can help secure data in the event that a device is stolen by preventing the use of a hard drive in a different computer. Point out that the BitLocker Encryption tool in Windows 10/8/7 is designed to work with the TPM chip.
5. Review how to initialize a TPM chip in Windows.

#### BIOS Support for Virtualization

1. Explain the use of virtualization technology, and show what settings (if available) in the BIOS/UEFI enable built-in virtualization.

#### Exiting the BIOS/UEFI Setup Menus

1. Demonstrate how to exit the BIOS screen and save any changes that have been made, or discard changes.

## Updating Motherboard Drivers and BIOS/UEFI

#### Installing or Updating Motherboard Drivers

1. Describe device drivers as small programs stored on the hard drive that an OS uses to communicate with a specific hardware device. Further explain that motherboards typically come with a CD or DVD containing drivers for using on-board devices.
2. Use Figure 2-36 to illustrate to show students how to obtain updated drivers from a manufacturer’s website.

#### Updating Firmware

1. Provide information on what might warrant updating, or flashing the BIOS/UEFI, such as system issues or malfunctioning motherboard features.
2. List the different methods for updating the BIOS/UEFI:
   1. Download and update from within BIOS.UEFI setup
   2. Update from USB drive using BIOS/UEFI setup
   3. Express BIOS/UEFI update
3. Discuss the potential cautions involved when updating the motherboard BIOS/UEFI software. Students should be aware that interrupted updates could result in motherboard failure.
4. Review the possible options if the BIOS update is interrupted or creates errors:
   1. Back flash
   2. Bootable media and restore defaults

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| *Teaching* *Tip* | Some motherboards have a recovery BIOS/UEFI that can be used in the event that a BIOS/UEFI update fails. This is typically a feature present on mid-range to high-end motherboards. |

#### Using Jumpers to Clear BIOS/UEFI Settings

1. Define a jumper as two small posts or metal pins that stick up on the motherboard that is used to hold configuration information.
2. Demonstrate how to use jumpers to clear BIOS settings or forgotten passwords.

#### Replacing the CMOS Battery

1. The purpose of the CMOS battery should be covered, as well as how to determine if the battery requires replacement.
2. Discuss the steps that should be followed when replacing the CMOS battery.

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| Teaching  Tip | CMOS batteries can often be found in drug stores. However, students should be aware that they should match the battery specifications of the currently installed battery. Server motherboards sometimes use different type of CMOS battery than standard desktop motherboards. |

## Installing or Replacing a Motherboard

#### How to Select a Desktop Motherboard

1. Discuss with students how to select a motherboard. Make students aware of the different factors involved in motherboard selection, such as form factor, chipset, and processors supported.
2. Because motherboards may have integrated components, explain to students what benefits or drawbacks motherboards with integrated components may have.
3. Demonstrate how to disable an integrated component within the BIOS setup screen.

#### How to Install or Replace a Motherboard

1. Review information from Chapter 1 regarding safety when working inside of a computer case.
2. List steps involved in the replacement of a motherboard, starting with making sure that the replacement motherboard will work with the case, uses the correct socket, and is compatible with the same RAM.
3. Elaborate on how students can test to see if a motherboard replacement is functioning properly after install by entering the BIOS setup and verifying settings.

#### Replacing a Laptop System Board

1. Point out that due to the complexity in replacing a motherboard on a laptop, alternatives should be considered before tackling the job.
2. Go over the steps necessary for replacing the system board in a laptop.

**Quick Quiz 2**

1. Which of the following terms is used to describe a set of small posts or pins on the motherboard that are used to set or clear motherboard settings?
2. CMOS battery
3. Jumper
4. BIOS
5. socket

Answer: B

1. True or False: A TPM chip can be cleared without causing loss of data.

Answer: False

1. Which of the following can be used to encrypt all the contents on a hard drive?
2. BitLocker
3. LoJack
4. Power-on passwords
5. Virtualization

Answer: A

1. Which of the following is NOT a good reason to flash a motherboard’s BIOS?
   1. Issues with system during the boot sequence
   2. Motherboard features are no longer working properly
   3. Computer case has been replaced
   4. New processor support provided by update

Answer: C

1. A small amount of memory stored on the motherboard that retains data even when the computer is turned off is known as which of the following?
   1. BIOS
   2. jumper
   3. I/O shield
   4. CMOS RAM

Answer: D

# **Class Discussion Topics**

1. Motherboards that have integrated components such as wireless and video capabilities can keep the cost of building a new system down. Have students discuss why a high-end motherboard might have less or more of these integrated features, especially in the case of gaming motherboards.
2. Start a discussion on the use of encryption for protecting documents and files on a computer, and then have students evaluate whether the benefits of BitLocker encryption with TPM are worth the risks to data in the event of motherboard failure or TPM chip failure.

# **Additional Projects**

Task students with picking and choosing parts for a fictitious computer build. Students should use an online site such as Newegg to research what motherboards are available, and then research what processors are compatible with those motherboards.

A motherboard can often be identified without having to open up a case. Task students with trying different software capable of providing information about the motherboard installed in a system. One example of such software is the AIDA64 software from FinalWire.

# **Additional Resources**

1. Gigabyte Factory Tour – How Motherboards are Made

<https://www.youtube.com/watch?v=kwdQhv6WOfM>

1. We Built the CHEAPEST PC on Amazon! (But are the parts compatible?)

<https://www.youtube.com/watch?v=AkK_n5Q8M38>

1. How Motherboards Work

<http://computer.howstuffworks.com/motherboard1.htm>

1. How to Choose a Motherboard

<https://www.tomshardware.com/reviews/motherboard-buying-guide,5682.html>

1. How to Enter BIOS/UEFI Utility on all PCs

<https://fossbytes.com/enter-bios-utility-uefi-settings-all-pc-boot-from-usb/>

1. What is UEFI, and How is It Different from BIOS?

<https://www.howtogeek.com/56958/htg-explains-how-uefi-will-replace-the-bios/>

1. How to Update Your BIOS

<https://www.techadvisor.co.uk/how-to/pc-upgrades/how-update-bios-3428662/>

1. Boot to UEFI Mode or Legacy BIOS Mode

<https://docs.microsoft.com/en-us/windows-hardware/manufacture/desktop/boot-to-uefi-mode-or-legacy-bios-mode>

1. BIOS/UEFI Flashing

<https://www.pcworld.com/article/187437/how-to-update-your-bios.html>

1. PXE Booting

[[https://www.howtogeek.com/57601/what-is-network-booting-pxe-and-how-can-you-use-it/](https://technet.microsoft.com/en-us/windows/dn938339%28v=vs.60%29?f=255&MSPPError=-2147217396)](https://www.howtogeek.com/57601/what-is-network-booting-pxe-and-how-can-you-use-it/)

**Key Terms**

For explanations of key terms, see the Glossary for this text.

* AM3+
* AM4
* ATX
* back flash
* BitLocker Encryption
* bus
* chipset
* CMOS (complementary metal-oxide semiconductor)
* CMOS battery
* CMOS RAM
* Compatibility Support Module (CSM)
* device drivers
* flashing BIOS
* flashing BIOS/UEFI
* FPC (flexible printed circuit) connectors
* GUID Partition Table (GPT)
* header
* IDE (Integrated Drive Electronics)
* I/O shield
* ITX
* jumper
* land grid array (LGA)
* LGA1150
* LGA1151
* LoJack
* M.2 connector
* Master Boot Record (MBR)
* mATX
* microATX
* Mini-ITX
* mITX
* Molex connector
* onboard ports
* overclocking
* PCI (Peripheral Component Interconnect)
* PCI Express (PCIe)
* pin grid array (PGA)
* Platform Key (PK)
* Preboot eXecution Environment or Pre- Execution Environment (PXE)
* protocol
* riser card
* SATA (Serial Advanced Technology Attachment or Serial ATA)
* Secure boot
* small form factor (SFF)
* S.M.A.R.T. (Self-Monitoring Analysis and Reporting Technology)
* socket
* TPM (Trusted Platform Module) chip
* TR4 (Threadripper 4)
* traces
* UEFI (Unified Extensible Firmware Interface)
* USB (Universal Serial Bus)
* virtualization
* virtual machine (VM)
* zero insertion force (ZIF) sockets