COURSE TECHNOLOGY
CENGAGE Learning™

A+ Guide to Hardware: Managing, Maintaining, and Troubleshooting, 5e

Chapter 3

All About Motherboards

Objectives

- Learn about the different types and features of motherboards
- Learn how firmware on the motherboard controls what happens when you first turn on a PC before the OS is loaded
- Learn how to install, configure, and maintain a motherboard

Motherboard Types and Features

- Motherboard
  - Most complicated computer component
  - First item to consider when building a computer
  - Contains many detailed components

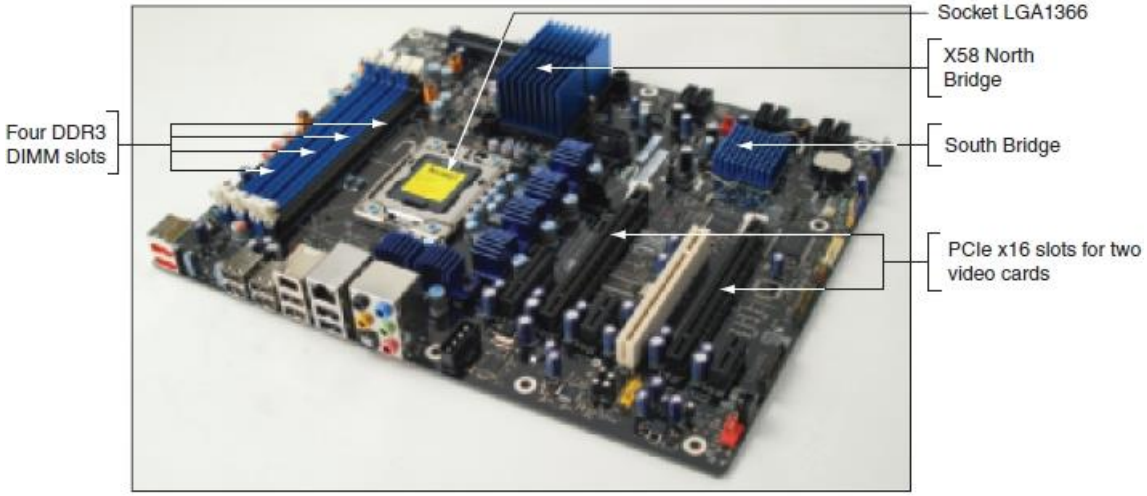

Figure 3-1 Intel DX58SO motherboard is designed with the gamer in mind
Courtesy: Course Technology/Cengage Learning

Motherboard Form Factors

- Determines motherboard size, features
  - Compatible with power supplies, cases, processors, expansion cards
- Most popular
  - ATX, MicroATX, FlexATX, BTX, NLX
- ITX form factor
  - Smaller than MicroATX
  - Sometimes used in home theatre systems

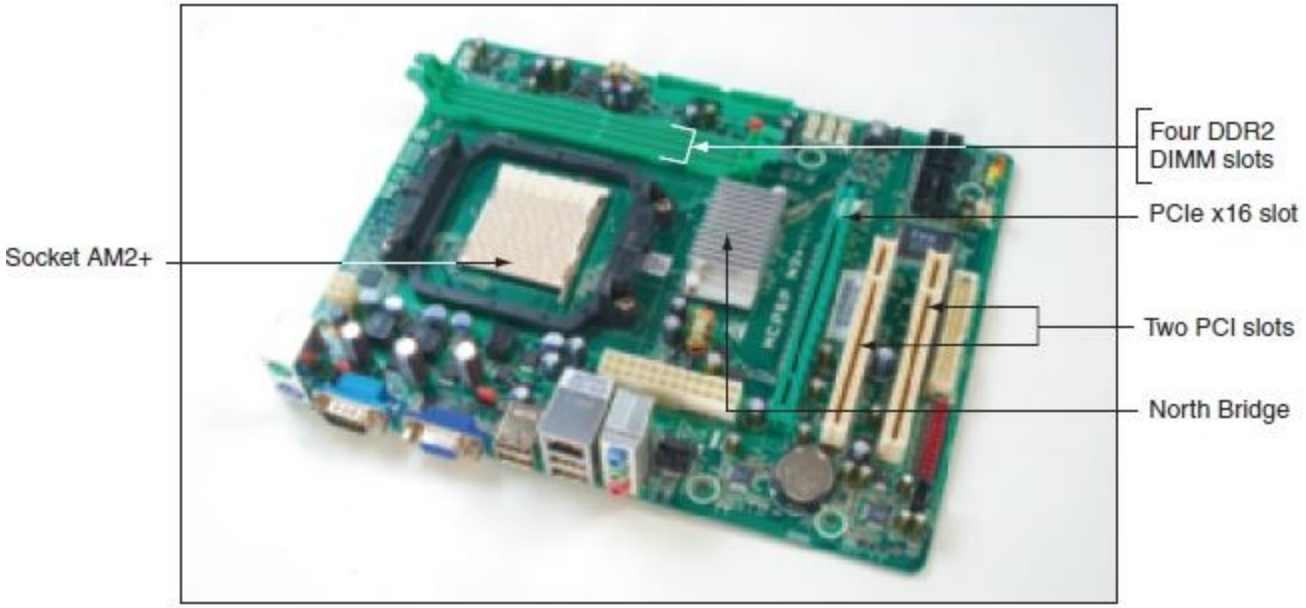

Figure 3-2 This MicroATX motherboard by Biostar has an AM2 socket that supports an AMD processor
Courtesy: Course Technology/Cengage Learning

Processor Sockets

- Determine if processors board can support socket and chipset
  - Socket holds Intel or AMD processor
- Server processors
  - Intel Itanium and Xeon processors
  - Use one socket type

Intel Socket Names	Used by Processor Family	Description
LGA1366 or Socket B	Core i7	◢ 1366 pins that touch pads on the processor ◢ Works with DDR3 memory ◢ Expected to replace LGA771 and LGA775 sockets
LGA771 or Socket J	Core 2 Extreme	◢ 771 pins that touch pads on the processor ◢ Used on high-end workstations and low-end servers ◢ Works with DDR2 memory on boards that have two processor sockets
LGA775 or Socket T	Core 2 Extreme Core 2 Quad Core 2 Duo Pentium Dual-Core Pentium Extreme Edition Pentium D Pentium Pentium 4 Many Celeron processors	◢ 775 lands or pads ◢ Works with DDR3 and DDR2 memory ◢ Most popular Intel socket
Socket 478	Pentium 4 Celeron processors	◢ 478 holes for pins ◢ Uses a dense micro PGA (mPGA) ◢ No longer sold
Socket 423	Pentium 4	◢ 423 holes for pins ◢ 39 x 39 SPGA grid ◢ No longer sold

Table 3-1 Sockets for Intel processors used for desktop computers

Processor Sockets (cont'd.)

- Pin grid array (PGA) socket
  - Pins aligned in uniform rows around socket
- Staggered pin grid array (SPGA)
  - Pins staggered over socket
  - Squeezes more pins into a small space
  - Easily bent
- Land grid array (LGA)
  - Uses lands rather than pins
  - First LGA socket
    - LGA775 socket

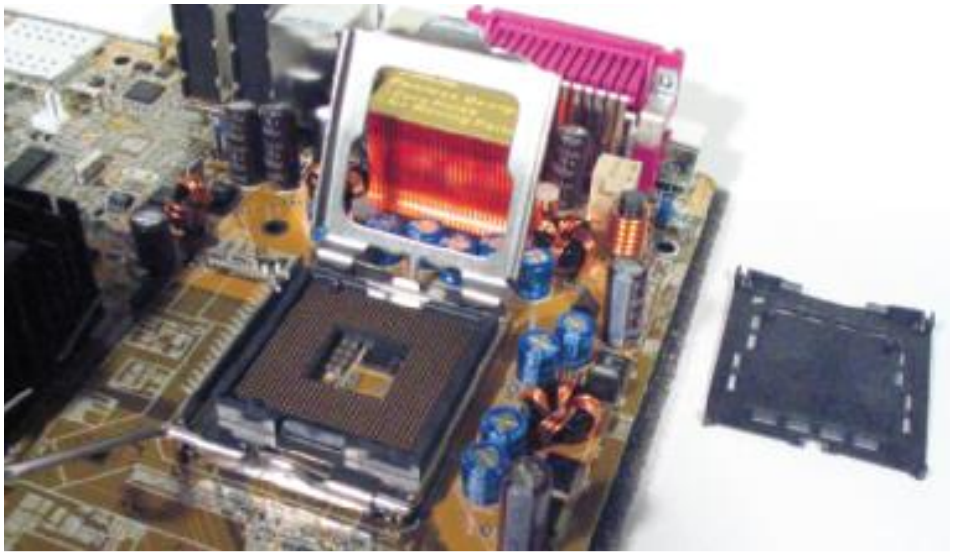

Figure 3-4 Socket LGA775 is the first Intel socket to use lands rather than pins
Courtesy: Course Technology/Cengage Learning

Processor Sockets (cont'd.)

- Latest Intel socket
  - LGA1366 socket
    - Lands in socket like pins connecting with lands on bottom of processor

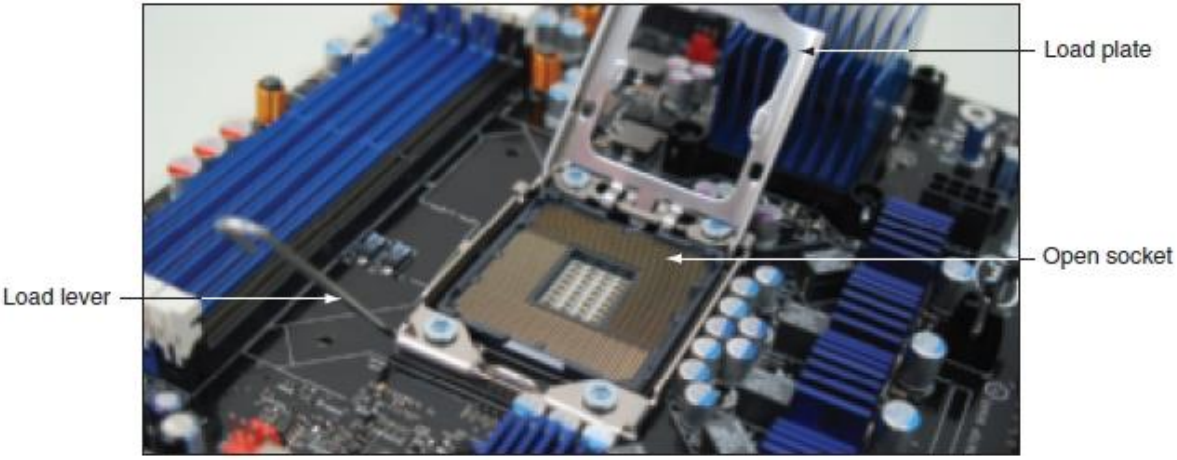

Figure 3-5 Socket LGA1366 is the latest Intel socket used by desktop, workstation, and low-end server systems
Courtesy: Course Technology/Cengage Learning

Processor Sockets (cont'd.)

- PGA, SPGA, LGA sockets
  - Square or nearly square
  - Even force is applied when inserting processor in the socket
- Zero insertion force (ZIF) sockets
  - All current processor sockets
  - Side lever lifts processor up and out of the socket
- AMD uses the PGA socket architecture (desktops)

AMD Socket	Used by Processor Family	Description
AM3 or AMD3	Phenom II	◢ 938 holes for pins (PGA) ◢ Works with DDR3 memory
AM2+ or AMD2+	Phenom II, Phenom, and Athlon	◢ 940 holes for pins (PGA) ◢ Works with DDR2 memory ◢ Faster than AMD2
AM2 or AMD2	Athlon and Sempron	◢ 940 holes for pins (PGA) ◢ Works with DDR2 memory
Socket 754	Athlon and Sempron	◢ 754 holes for pins (PGA) ◢ Works with DDR memory
Socket 940	Athlon	◢ 940 holes for pins (PGA) ◢ Works with DDR memory
Socket 939	Athlon and Sempron	◢ 939 holes for pins (PGA) ◢ Works with DDR memory ◢ No longer sold
Socket A	Athlon, Sempron, and Duron	◢ 462 holes for pins (PGA) ◢ Works with DDR memory ◢ Rarely sold today

Table 3-2 Sockets for AMD processors used for desktop computers

Processor Sockets (cont'd.)

- Intel or AMD
  - Important: match processor to motherboard
    - Refer to motherboard, processor compatibility documentation

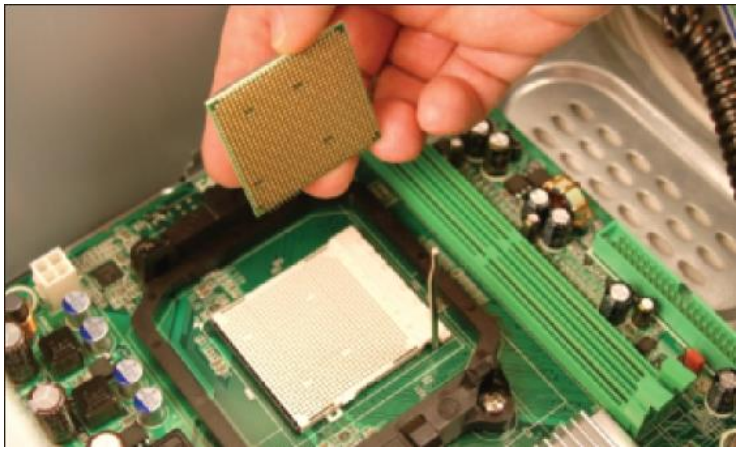

Figure 3-6 AMD Athlon 64 processor to be inserted into an AM2+ socket
Courtesy: Course Technology/Cengage Learning

The Chipset

- Set of chips on motherboard
- Collectively control:
  - Memory, motherboard buses, some peripherals
- Manufacturers
  - Intel, AMD, NVIDIA, SiS
- Popular chipsets
  - High-performance chipsets: X58
  - Mainstream desktop chipsets: P45, P43, P35, G45, G31
  - Value desktops: 910GL, 845E, 845G, 865G
  - Older value desktops: 845, 845GL

The Chipset (cont'd.)

- Accelerated Hub Architecture
  - Uses hub interface
  - All I/O buses (input/output buses) connect to hub
    - Hub connects to system bus
- North Bridge
  - Fast end of hub
  - Contains graphics and memory controller
  - Connects to the system bus
- South Bridge
  - Slower end of hub
  - Contains I/O controller hub

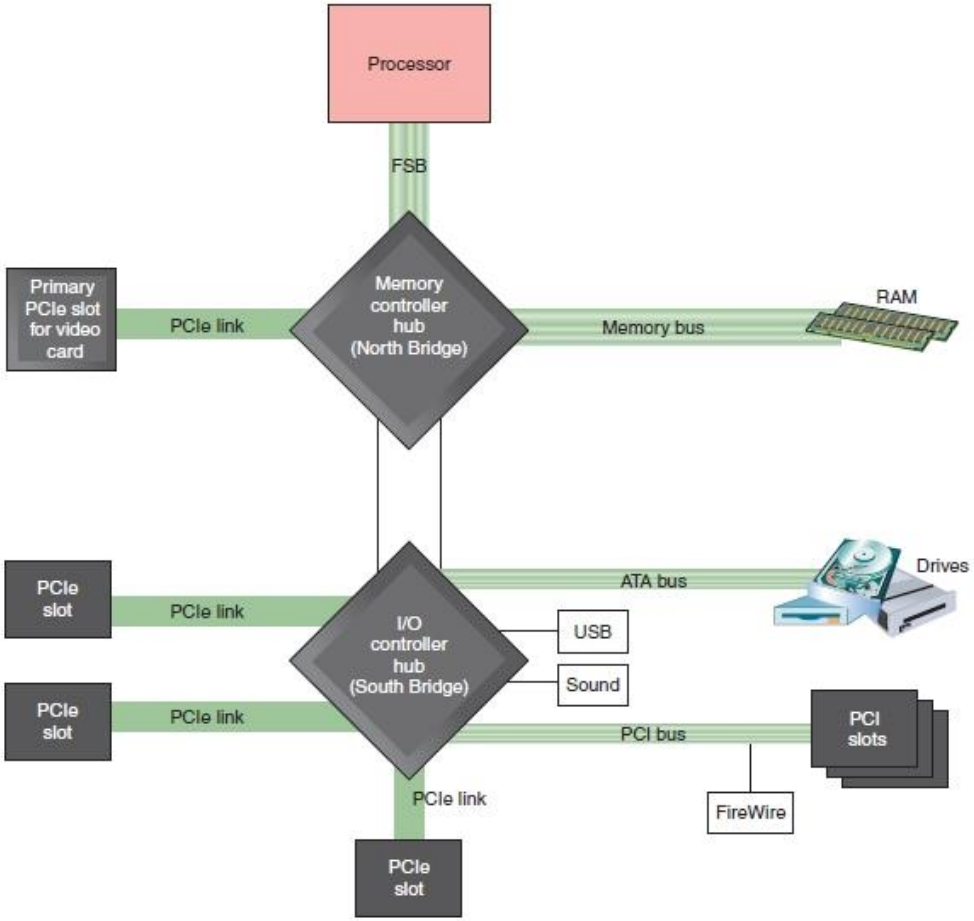

Figure 3-7 The chipset's North Bridge and South Bridge control access to the processor for all components
Courtesy: Course Technology/Cengage Learning

The Chipset (cont'd.)

- Latest Intel chipset for desktop PCs: X58 chipset
  - Keep chipset cool using fan clipped to top of North Bridge

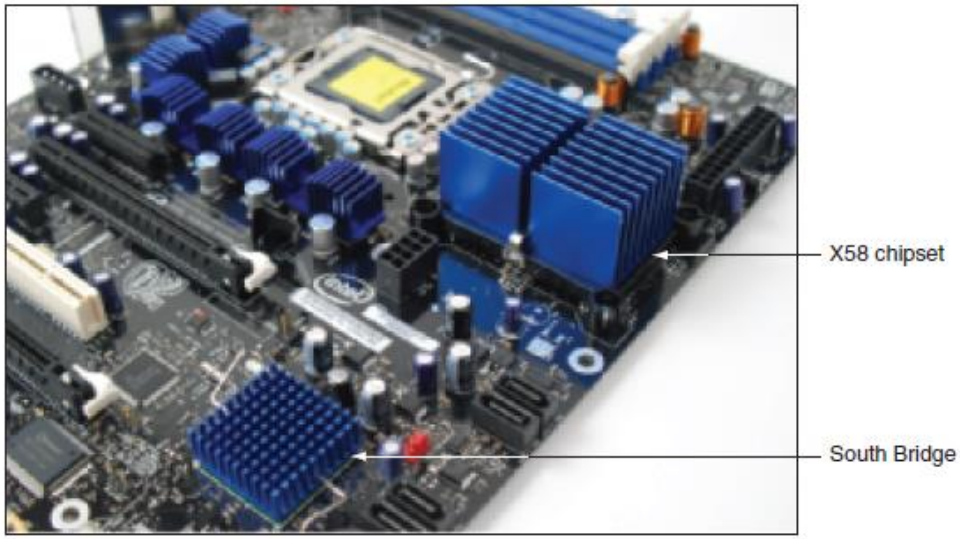

Figure 3-8 The X58 chipset uses heat sinks to stay cool
Courtesy: Course Technology/Cengage Learning

The Chipset (cont'd.)

- Newer Core i7 and X58 chipset
  - Contain memory controller within processor housing
  - Memory connects directly to processor
- X58 chipset
  - Good for gaming machines
    - Supports multiple video cards
- Installing multiple video cards in the same system
  - Scalable Link Interface (SLI) by NVIDIA
  - CrossFire by ATI Technologies

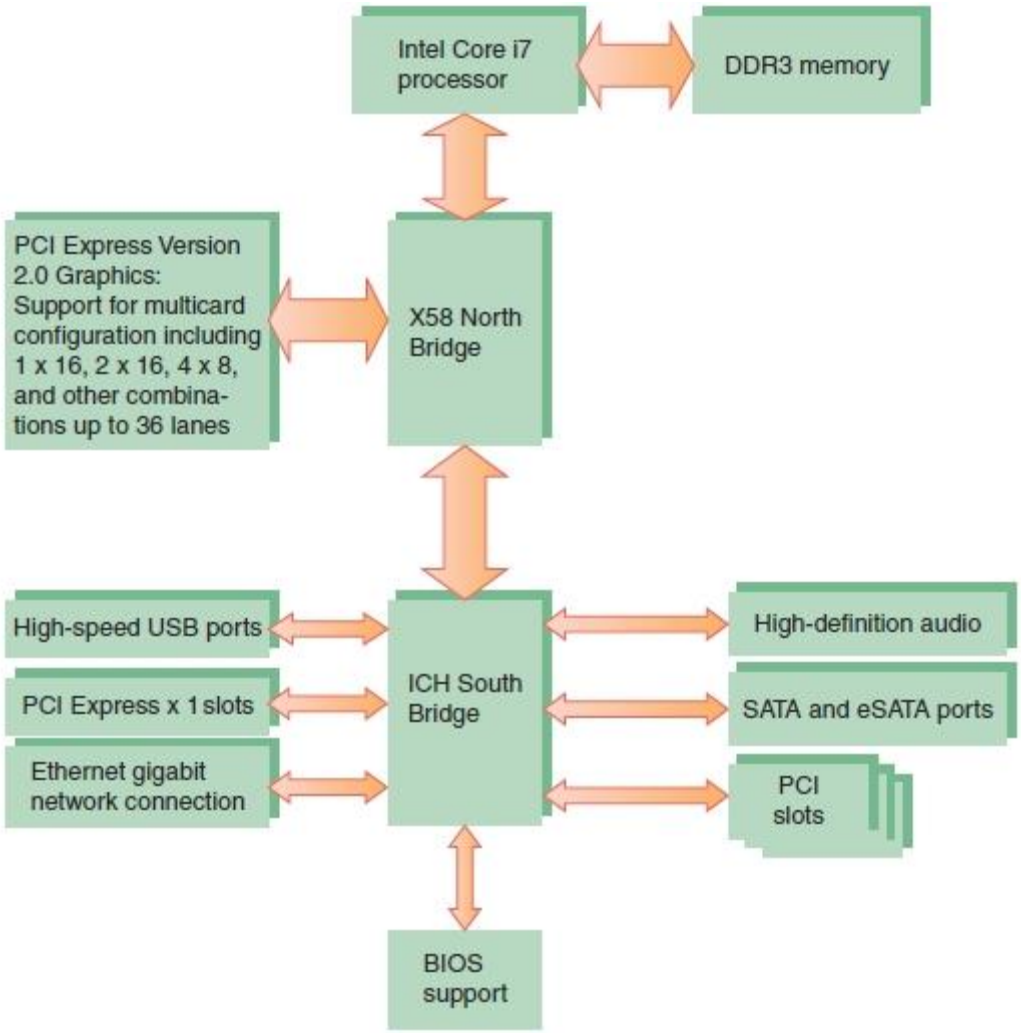

Figure 3-9 X58 chipset architecture
Courtesy: Course Technology/Cengage Learning

The Chipset (cont'd.)

- Significant chipsets by AMD:
  - AMD 7-series (AMD 790FX, 790X, 790GX, 780, and 770)
    - Designed for gamer, hobbyist, multimedia enthusiast
    - Focus on good graphics capabilities
    - Support overclocking
  - AMD 580X Crossfire chipset
    - Supports ATI CrossFire
  - AMD 780V chipset
    - Designed for business needs
  - AMD 740G and 690 chipsets
    - Designed for low-end, inexpensive systems

The Chipset (cont'd.)

- NVIDIA nForce chipset series
  - Supports high-end graphics
    - Popular with gamers
  - AMD Phenom processor, Intel Core 2 processor
  - SLI: connects multiple video cards in same system

Figure 3-10 SLI and nForce logos both by NVIDIA
Courtesy: Course Technology/Cengage Learning

The Chipset (cont'd.)

- Intel dominates chipset market
  - Knows more about its own Intel processors
    - Produces chipsets most compatible with Intel processors
  - Intel's research and development led to:
    - Creation of PCI bus, universal serial bus (USB), AGP bus for video cards, Accelerated Hub Architecture
- Chipsets
  - Generate heat
  - Some have a heat sink installed on top
  - Considered part of motherboard

Buses and Expansion Slots

- Buses
  - Analogous to highway transportation systems
- Types of cargo carried by bus:
  - Power, control signals, memory addresses, data
- Bus evolution
  - Evolved around data path and speed
  - Synchronous components work with clock cycle
  - Asynchronous components: out of step with CPU
  - Wait state: command to CPU to wait for slower device
  - Bus types: expansion, local, local I/O, local video
    - Expansion buses: asynchronous components

Bus	Bus Type	Data Path in Bits	Address Lines	Bus Frequency	Throughput
System bus	Local	64	32 or 64	Up to 1600 MHz	Up to 3.2 GB/sec
PCI Express Version 2	Local video and local I/O	Serial with up to 32 lanes	Up to 32 lanes	2.5 GHz	Up to 500 MB/sec per lane in each direction
PCI Express Version 1.1	Local video and local I/O	Serial with up to 16 lanes	Up to 16 lanes	1.25 GHz	Up to 250 MB/sec per lane in each direction
PCI Express Version 1	Local video and local I/O	Serial with up to 16 lanes	Up to 16 lanes	1.25 GHz	Up to 250 MB/sec per lane in each direction
PCI-X	Local I/O	64	32	66, 133, 266, or 533MHz	Up to 8.5 GB/sec
PCI	Local I/O	32 or 64	32 or 64	33, 66 MHz	133, 266, or 532 MB/sec
AGP 1x, 2x, 3x, 4x, 8x	Local video	32	NA	66, 75, 100 MHz	266 MB/sec to 2.1 GB/sec
FireWire 400 and 800	Local I/O or expansion	1	Serial	NA	Up to 3.2 Gbps (gigabits per second)
USB 1.1, 2.0, and 3.0	Expansion	1	Serial	3 MHz	12 or 480 Mbps (megabits per second) or 5.0 Gbps (gigabits per second)

Table 3-3 Buses listed by throughput

Buses and Expansion Slots (cont'd.)

- Peripheral Component Interconnect (PCI)
  - Improved several times
  - Categories
    - Conventional PCI, PCI-X, PCI Express

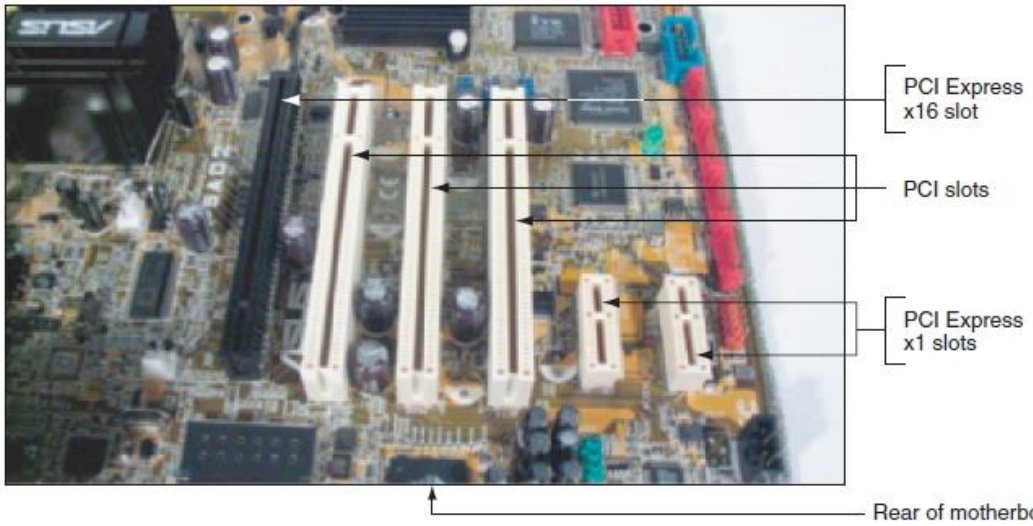

Figure 3-14 Three PCI Express slots and three PCI slots on a motherboard
Courtesy: Course Technology/Cengage Learning

Bus	Bus Type	Data Path in Bits	Address Lines	Bus Frequency	Throughput
System bus	Local	64	32 or 64	Up to 1600 MHz	Up to 3.2 GB/sec
PCI Express Version 2	Local video and local I/O	Serial with up to 32 lanes	Up to 32 lanes	2.5 GHz	Up to 500 MB/sec per lane in each direction
PCI Express Version 1.1	Local video and local I/O	Serial with up to 16 lanes	Up to 16 lanes	1.25 GHz	Up to 250 MB/sec per lane in each direction
PCI Express Version 1	Local video and local I/O	Serial with up to 16 lanes	Up to 16 lanes	1.25 GHz	Up to 250 MB/sec per lane in each direction
PCI-X	Local I/O	64	32	66, 133, 266, or 533MHz	Up to 8.5 GB/sec
PCI	Local I/O	32 or 64	32 or 64	33, 66 MHz	133, 266, or 532 MB/sec
AGP 1x, 2x, 3x, 4x, 8x	Local video	32	NA	66, 75, 100 MHz	266 MB/sec to 2.1 GB/sec
FireWire 400 and 800	Local I/O or expansion	1	Serial	NA	Up to 3.2 Gbps (gigabits per second)
USB 1.1, 2.0, and 3.0	Expansion	1	Serial	3 MHz	12 or 480 Mbps (megabits per second) or 5.0 Gbps (gigabits per second)

Table 3-3 Buses listed by throughput

Buses and Expansion Slots (cont'd.)

- Riser cards
  - Used by NLX motherboards
- AGP bus replaced by PCI Express
  - Motherboard will have PCI Express x16 slot or AGP slot; not both

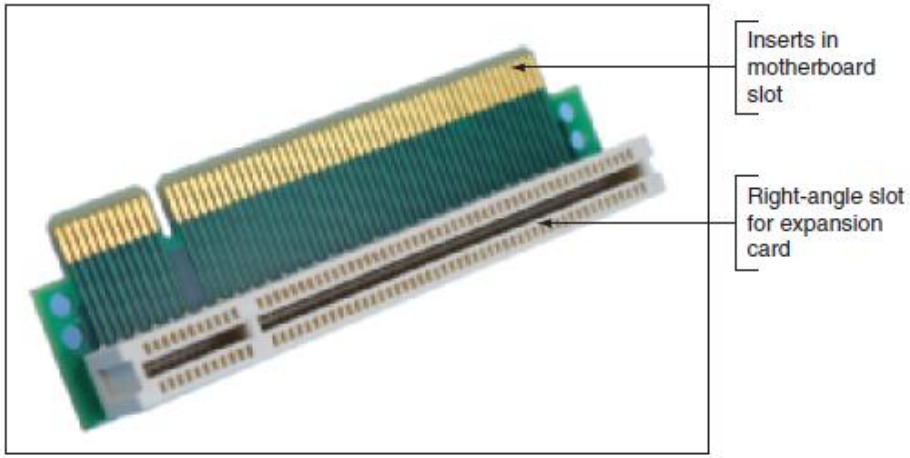

Figure 3-17 PCI riser card provides a 3.3-V slot or 3-V slot depending on which direction the card is inserted in the PCI slot
Courtesy: Course Technology/Cengage Learning

Standard	Speeds (Cycles Per Clock Beat)	Maximum Throughput	Voltage	Slots Supported
AGP 1.0	1x	266MB/sec	3.3 V	Slot keyed to 3.3 V
AGP 2.0	1x, 2x, or 4x	533MB/sec or 1.06GB/sec	3.3 V or 1.5 V	Slot keyed to 1.5 V Slot keyed to 3.3 V Universal slot (for either 1.5-V or 3.3-V cards)
AGP Pro	Applies to all speeds	NA	3.3 V or 1.5 V	AGP Pro 3.3 V keyed AGP Pro 1.5 V keyed AGP Pro Universal (for either 1.5-V or 3.3-V cards)
AGP 3.0	4x or 8x	2.12 GB/sec	1.5 V and 0.8 V	Universal AGP 3.0 (4x/8x) slot Slot keyed to 1.5 V Slot keyed to AGP Pro 1.5 V

Table 3-4 AGP standards summarized

Buses and Expansion Slots (cont'd.)

- Older motherboards reduced costs using:
  - Communication and networking riser (CNR)
  - Audio/modem riser (AMR)
  - Both accommodate small, inexpensive expansion cards (riser cards)
    - Modem riser card, audio riser card, network riser card
    - Different from NLX systems riser cards and those used to extend an expansion slot
  - Generally a short slot beside PCI or AGP slot

On-Board Ports and Connectors

- On-board ports (integrated components)
  - Ports coming directly off the motherboard
    - Keyboard, mouse port, parallel printer, USB
- I/O shield
  - Plate installed in computer case providing holes for on-board ports
- Internal connectors
  - EIDE, floppy drive, serial ATA, SCSI, FireWire (IEEE 1394)

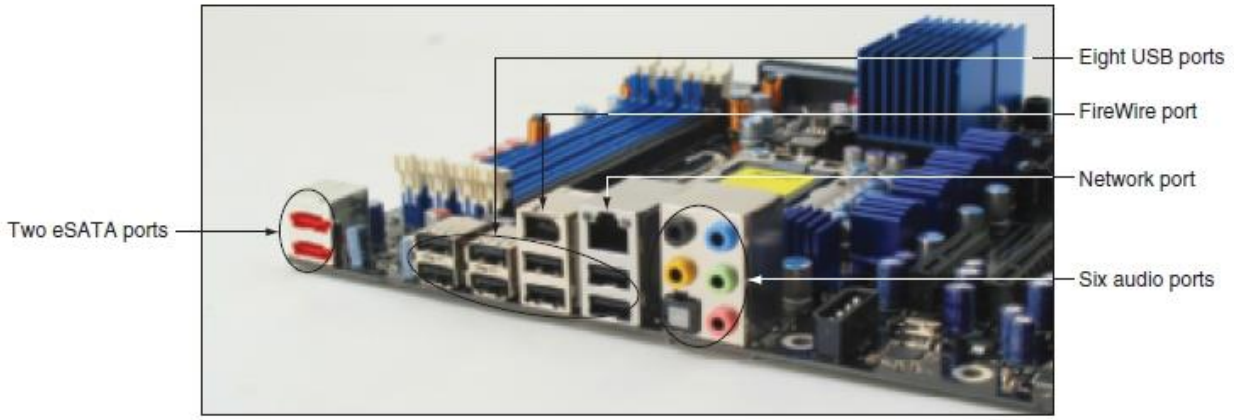

Figure 3-23 Intel DX58SO motherboard on-board ports
Courtesy: Course Technology/Cengage Learning

Figure 3-24 The I/O shield fits the motherboard ports to the computer case
Courtesy: Course Technology/Cengage Learning

Hardware Configuration

- Motherboard settings
  - Enable or disable connector or port
  - Set CPU frequency, system bus, other buses
  - Control security features
  - Control what happens when PC first boots
- Three ways to configure motherboard:
  - DIP switches
  - Jumpers
  - CMOS RAM

Hardware Configuration (cont'd.)

- Dual inline package (DIP) switch
  - ON (binary 1) and OFF (binary 0) positions
  - Reset DIP switch when adding or removing device
  - Use pointed instrument (not graphite pencil)
- Jumpers
  - Retain setup or installation information
  - Opened and closed using jumper covers
  - Typical setting
    - Enabling/disabling keyboard power-up

Figure 3-27 DIP switches used to store setup data on older motherboards
Courtesy: Course Technology/Cengage Learning

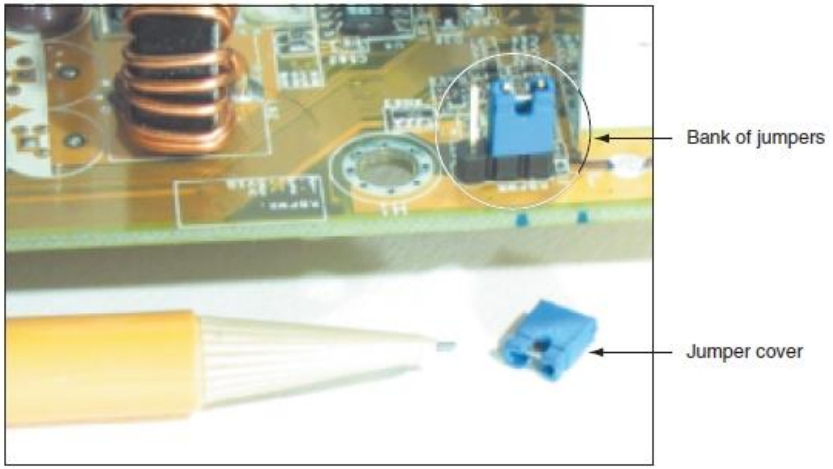

Figure 3-28 Setup information about the motherboard can be stored by setting a jumper on (closed) or off (open). A jumper is closed if the cover is in place, connecting the two pins that make up the jumper; a jumper is open if the cover is not in place
Courtesy: Course Technology/Cengage Learning

Hardware Configuration (cont'd.)

- CMOS RAM
  - Also called clock/nonvolatile RAM (RTC/NVRAM)
  - Retains data even when computer turned off
  - BIOS settings are in motherboard manual
  - CMOS battery enables CMOS RAM to hold configuration data

How to Select a Motherboard

- Types of motherboards:
  - Board providing most expansion room
  - Board suiting computer's current configuration
  - Board meeting present needs with moderate room for expansion
- On-board components
  - Located on the board
  - More commonly offered as a separate device
  - Avoid board with too many embedded components
    - Do not easily accept add-on devices

How Startup BIOS Controls the Boot Process

- Startup BIOS on motherboard in control until operating system loaded and takes over
- PC technician must understand how startup BIOS controls the boot
  - Knowledge helps in troubleshooting a failed boot before operating system loaded

Booting a Computer

- Booting
  - Computer brings itself up to a working state
    - Without user just pressing on button
- Hard boot (cold boot)
  - Turn on power with on/off switch
- Soft boot (warm boot)
  - Use operating system to reboot

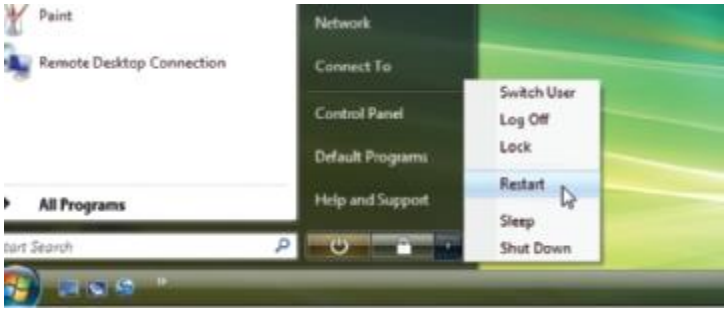

Figure 3-31 Windows Vista menu to perform a restart
Courtesy: Course Technology/Cengage Learning

Figure 3-32 Windows XP Turn off computer dialog box
Courtesy: Course Technology/Cengage Learning

Choosing Between a Hard Boot and a Soft Boot

- Hard boot takes more time than a soft boot
  - Initializes processor and clears memory
  - Soft boot saves time in most circumstances
- If operating system boot not possible
  - Use power or reset buttons on front or rear of case
- Power switches
  - Power button, reset button on case front
  - Power switch on case back side

The Startup BIOS Controls the Beginning of the Boot

- Contained on motherboard firmware chip
- Successful boot
  - Hardware, BIOS, operating system all perform without errors (beeps, text or voice messages)
- Boot functions
  - Startup BIOS runs POST and assigns system resources
  - Startup BIOS program searches for and loads an OS
  - OS configures system and completes its own loading
  - Application software is loaded and executed

System Resource	Definition
IRQ numbers	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.
I/O addresses	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.
Memory addresses	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.
DMA channels	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.

Table 3-7 System resources used by software and hardware

Step 1: Post and Assignment of System Resources

- Turn on PC power
  - Processor begins the boot by initializing itself
  - Turns to startup BIOS for instructions
    - Startup BIOS first performs POST
    - 17 key steps involved

Step 2: Startup Bios Finds and Loads the OS

- Startup BIOS looks to CMOS RAM to find boot device

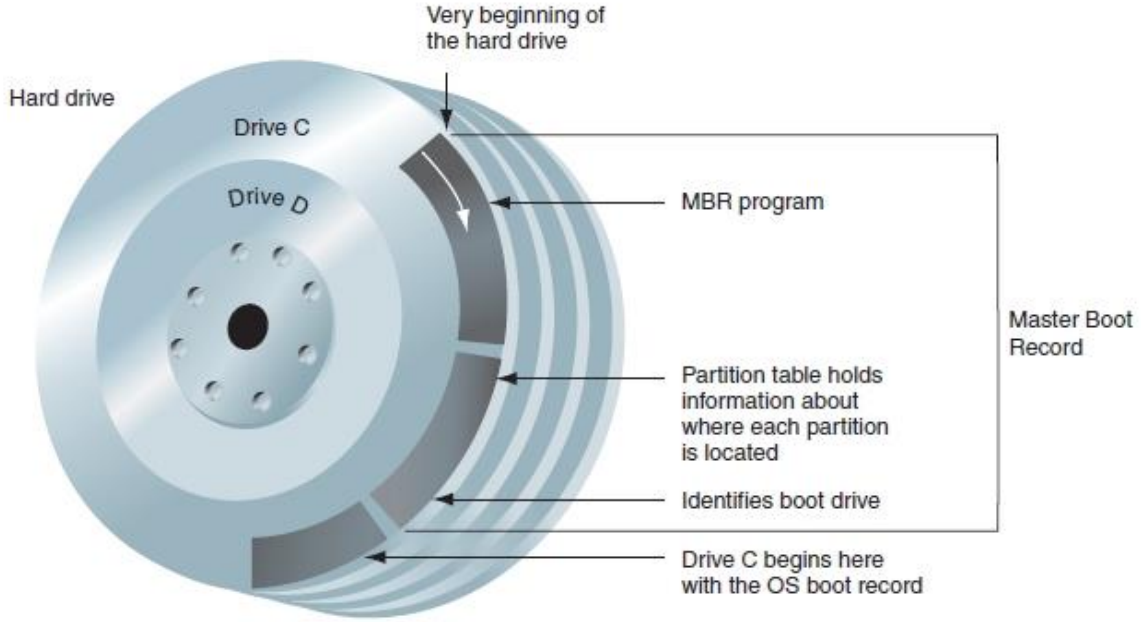

Figure 3-35 For a successful boot, a hard drive must contain a healthy Master Boot Record (MBR) and a healthy OS boot record
Courtesy: Course Technology/Cengage Learning

Step 2: 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)

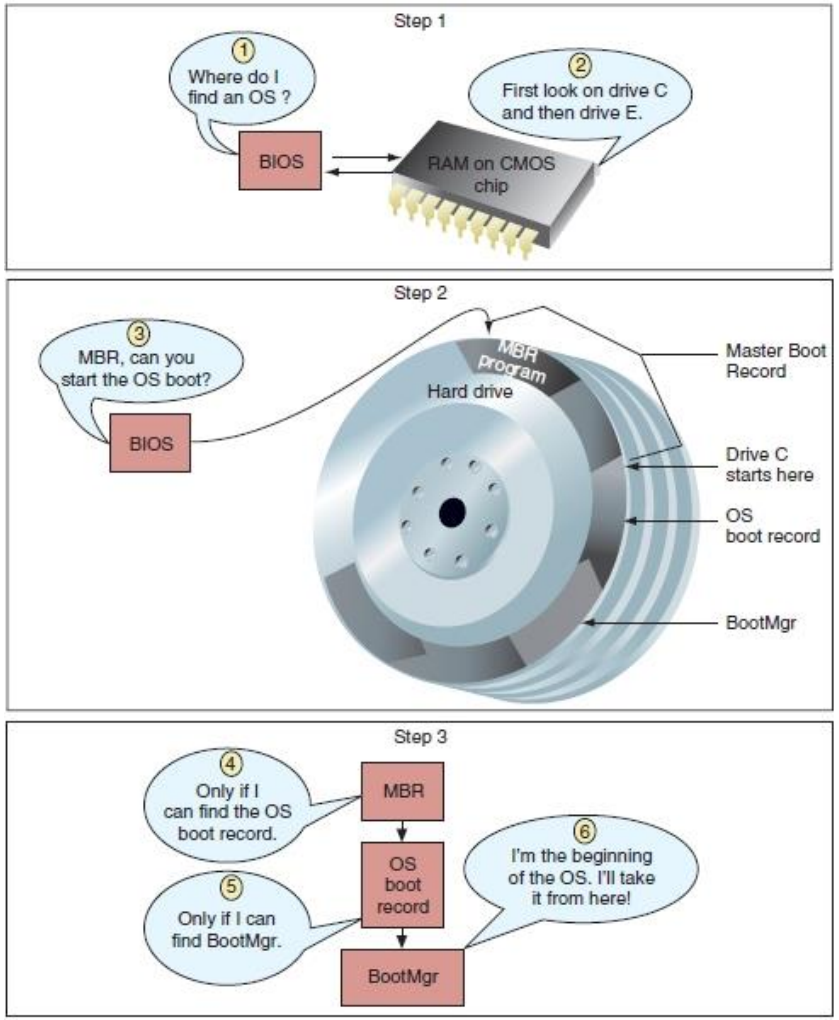

Figure 3-36 Numbered steps show how BIOS searches for and begins to load an operating system (in this example, Windows Vista is the OS)
Courtesy: Course Technology/Cengage Learning

Maintaining, Installing, and Configuring a Motherboard

- Motherboard is considered a field replaceable unit
  - Need to know:
    - How to replace one when motherboard goes bad
    - After new board installed, how to configure using BIOS setup

Maintaining a Motherboard

- Two chores:
  - Update motherboard drivers
    - Use Windows internal divers, bundled CD drivers, or download drivers from manufacturer site
  - Flash BIOS
    - Process of upgrading or refreshing the ROM BIOS chip
    - BIOS updates downloaded from motherboard manufacturer’s Web site or third party site
    - Performed if motherboard unstable, incorporating new feature, or component

Maintaining a Motherboard (cont'd.)

- Methods of installing BIOS updates
  - Express BIOS update
  - Update from a bootable floppy disk
  - Update from a bootable USB drive or bootable CD
  - Recovery from a failed update
- Identify motherboard and current BIOS version
- Download file, unzip, follow manufacturer directions
- Read motherboard documentation
- "If it's not broke, don't fix it"

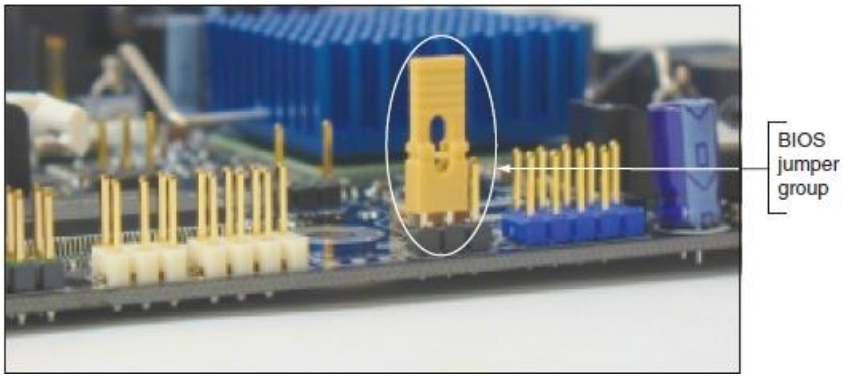

Figure 3-40 This group of three jumpers controls the BIOS configuration
Courtesy: Course Technology/Cengage Learning

Jumper Position	Mode	Description
1 3	Normal (default)	The current BIOS configuration is used for booting.
1 3	Configure	After POST, the BIOS displays a menu in CMOS setup that can be used to clear the user and supervisor power-on passwords.
1 3	Recovery	Recovery is used to recover from a failed BIOS update. Details can be found on the motherboard CD.

Figure 3-41 BIOS configuration jumper settings
Courtesy: Course Technology/Cengage Learning

Maintaining a Motherboard (cont'd.)

- BIOS jumpers
  - Recover from failed BIOS update, forgotten power-on password
    - See motherboard documentation
- Motherboard CMOS battery: field replaceable unit
  - Choose correct replacement battery
  - Power down system, unplug it, press power button to drain the power, remove case cover
  - Use ground bracelet, remove old battery using a flat-head screwdriver, pop new battery into place

Installing or Replacing a Motherboard

- General process for replacing motherboard
  - 1. Verify right motherboard selected
  - 2. Get familiar documentation, features, settings
  - 3. Remove components to reach old motherboard
  - 4. Set any jumpers or switches on the motherboard
  - 5. Install motherboard
  - 6. Install processor and processor cooler
  - 7. Install RAM
  - 8. Attach cabling (case switches, power supply, drives)
  - 9. Install video card on motherboard

Installing or Replacing a Motherboard (cont'd.)

- General process for replacing motherboard (cont'd.)
  - 10. Plug in PC, attach monitor, keyboard
  - 11. Boot system, enter BIOS setup
  - 12. Verify settings set to default
  - 13. Observe POST, verify no errors
  - 14. Check for conflicts with system resources
  - 15. Install the motherboard drives
  - 16. Install other expansion cards, drives
  - 17. Verify system operating properly, make final OS and BIOS adjustments (power management settings)

Installing or Replacing a Motherboard (cont'd.)

- General steps for installing motherboard in the case
  - 1. Install I/O shield
  - 2. Verify standoff locations
  - 3. Place motherboard inside the case
  - 4. Connect power cords from power supply
  - 5. Connect wire leads from front panel of case
  - 6. Connect wires to ports on case front panel
  - 7. Install video card, plug in keyboard, monitor
  - 8. Turn on system and observe POST
  - 9. After Windows desktop loads, execute any setup programs, drivers on the OS CD

Configuring the Motherboard Using BIOS Setup

- Access BIOS setup program
  - Setup screen appears with menus and Help features
  - Change system features

BIOS	Key to Press During POST to Access Setup
AMI BIOS	Del
Award BIOS	Del
Older Phoenix BIOS	Ctrl+Alt+Esc or Ctrl+Alt+s
Newer Phoenix BIOS	F2 or F1
Dell computers using Phoenix BIOS	Ctrl+Alt+Enter
Compaq computers such as the ProLinea, Deskpro, Deskpro XL, Deskpro XE, or Presario	Press the F10 key while the cursor is in the upper-right corner of the screen, which happens just after the two beeps during booting.*

*For Compaq computers, the BIOS setup program is stored on the hard drive in a small, non-DOS partition of about 3 MB. If this partition becomes corrupted, you must run setup from a bootable CD or floppy disk that comes with the system. If you cannot run setup by pressing F10 at startup, suspect a damaged partition or a virus taking up space in memory.

Table 3-9 How to access BIOS setup

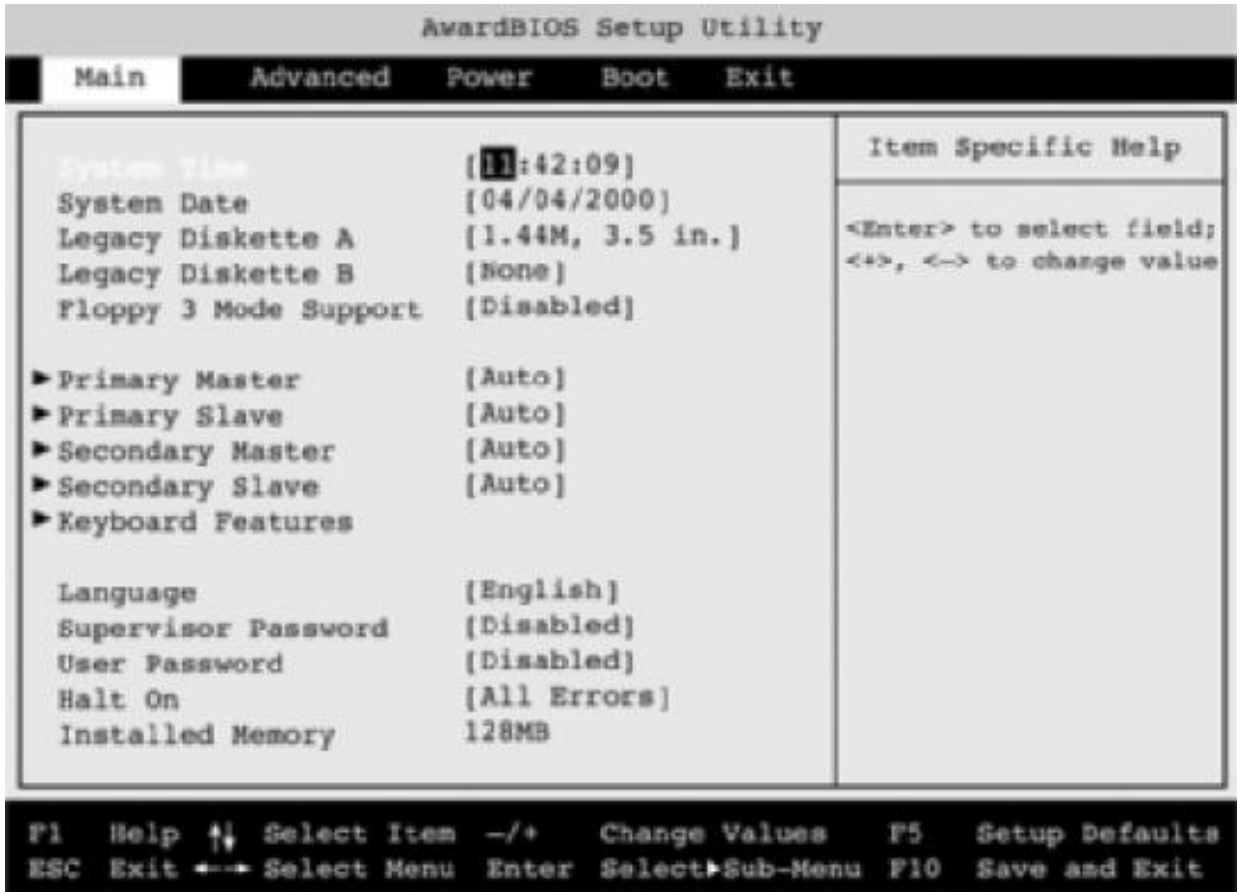

Figure 3-59 BIOS Setup Main menu
Courtesy: Course Technology/Cengage Learning

Configuring the Motherboard Using BIOS Setup (cont'd.)

- Change boot menu in BIOS setup
  - Set boot sequence
- Startup password allows access to computer
  - Enabled and set in BIOS setup
  - Password stored in CMOS RAM
  - Changed by accessing setup screen
- Exit screen options
  - Save or discard changes and exit program
  - Restore default settings
  - Save changes and remain in program

Configuring the Motherboard Using BIOS Setup (cont'd.)

- Brand-name computer manufacturers
  - Use their own custom-designed setup screens
- CMOS RAM setting is lost if battery goes bad or disconnected
  - Restore default settings
  - Restore customized settings from written record of all changes
    - Important to keep records up to date, stored with the hardware documentation in a safe place, well labeled

Summary

- Motherboard form factor drives motherboard selection
- Configurable components: bus, expansion slots, other connectors
- Cargo carried by a computer bus: electrical power, control signals, memory address, data
- Bus types: local, local video, local I/O, expansion
- PCI buses: improved several times

Summary (cont'd.)

- Tools for configuring a motherboard
  - DIP switches, jumpers, CMOS setup program
- CMOS setup program
  - Stored on floppy disk or ROM BIOS chip
- Document configuration settings for recovery needs
- Flashing is a technique to upgrade ROM BIOS