CompTIA® A+ 220-701 and 220-702 Cert Guide

Mark Edward Soper
Scott Mueller
David L. Prowse
# Contents at a Glance

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PC Technician Essentials</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>PC Anatomy</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>Motherboards, Processors, and Adapter Cards</td>
<td>43</td>
</tr>
<tr>
<td>4</td>
<td>BIOS</td>
<td>111</td>
</tr>
<tr>
<td>5</td>
<td>Power Supplies and System Cooling</td>
<td>153</td>
</tr>
<tr>
<td>6</td>
<td>RAM</td>
<td>195</td>
</tr>
<tr>
<td>7</td>
<td>I/O and Multimedia Ports and Devices</td>
<td>221</td>
</tr>
<tr>
<td>8</td>
<td>Video Displays and Graphics Cards</td>
<td>293</td>
</tr>
<tr>
<td>9</td>
<td>Laptops and Portable Devices</td>
<td>323</td>
</tr>
<tr>
<td>10</td>
<td>Security</td>
<td>391</td>
</tr>
<tr>
<td>11</td>
<td>Printers</td>
<td>435</td>
</tr>
<tr>
<td>12</td>
<td>Storage Devices</td>
<td>497</td>
</tr>
<tr>
<td>13</td>
<td>Using and Managing Windows</td>
<td>567</td>
</tr>
<tr>
<td>14</td>
<td>Installing and Upgrading Windows Operating Systems</td>
<td>695</td>
</tr>
<tr>
<td>15</td>
<td>Troubleshooting and Maintaining Windows</td>
<td>743</td>
</tr>
<tr>
<td>16</td>
<td>Networking</td>
<td>799</td>
</tr>
<tr>
<td>17</td>
<td>Safety and Environmental Issues</td>
<td>879</td>
</tr>
<tr>
<td>18</td>
<td>Troubleshooting and Communications Methods</td>
<td>901</td>
</tr>
<tr>
<td>A</td>
<td>Answers to the “Do I Know this Already?” Quizzes and Troubleshooting Scenarios</td>
<td>927</td>
</tr>
<tr>
<td></td>
<td>Index</td>
<td>962</td>
</tr>
</tbody>
</table>

**Elements Available on the CD**

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Memory Tables</td>
</tr>
<tr>
<td>C</td>
<td>Memory Tables Answer Key</td>
</tr>
<tr>
<td>D</td>
<td>Hardware Resources</td>
</tr>
<tr>
<td>G</td>
<td>Glossary</td>
</tr>
</tbody>
</table>
# Table of Contents

**Introduction**  xxxvi

**Chapter 1  PC Technician Essentials  3**

- PC Tools  3
- Preventing Electrostatic Discharge  4
- The CompTIA Six-Step Troubleshooting Process  5

- Numbering Systems Used in Computers  6
  - Decimal Numbering System  6
  - Binary Numbering System  6
  - *Binary Versus Decimal MB/GB*  10
  - *Data Storage and Overhead*  11
  - Hexadecimal Numbering System  14

- Measuring Data Transfer and Frequency  14
  - Bandwidth  14
  - *Parallel Information Transfers*  15
  - *Serial Transfers*  16
  - Hertz (Hz)  17

- Important Websites  18

**Chapter 2  PC Anatomy 101  21**

- “Do I Know This Already?” Quiz  22

- The Essential Parts of Any Computer  25
  - Front and Rear Views of a Desktop PC  25
  - All Around a Notebook (Laptop) Computer  27
  - Quick Reference to PC Components  28

- Points of Failure  29
  - Points of Failure on a Desktop Computer  30
  - Points of Failure on a Notebook Computer  30

- Hardware, Software, and Firmware  31
  - Hardware  31
  - Software  31
  - Firmware  32

- Why Hardware, Software, and Firmware Are Important to Understand  33

- Working Inside Your PC  33
  - Opening the Case of a Desktop PC  33
  - Taking ESD Precautions  34
  - Connecting Internal and External Data Cables  35
Chapter 3  Motherboards, Processors, and Adapter Cards  43
“Do I Know This Already?” Quiz  43
Motherboards and Their Components  47
The System Bus and I/O Bus  48
Form Factors  49
ATX and Micro ATX  49
BTX  49
NLX  51
Riser Cards and Daughterboards  51
Integrated I/O Ports  52
Memory Slots  54
Expansion Slots  54
PCI Slots  55
AGP  55
PCIe (PCI Express) Slots  56
AMR and CNR Slots  58
Mass Storage Interfaces  59
PATA/IDE  60
SATA  61
SCSI  61
Choosing the Best Motherboard for the Job  62
Installing Motherboards  63
Step-by-Step Motherboard Removal (ATX and BTX)  63
Step-by-Step Motherboard Removal (NLX)  65
Preparing the Motherboard for Installation (ATX/BTX)  66
Step-by-Step Motherboard Installation (ATX/BTX)  67
Step-by-Step Motherboard Installation (NLX)  68
Troubleshooting Motherboards  68
System Will Not Start  69
Devices Connected to the Port Cluster Don’t Work  72
Devices Connected to Header Cables Don’t Work  73
Mass Storage Devices Do Not Work Properly  74
Memory Failures  74
Chapter 4  BIOS  111

“Do I Know This Already?” Quiz  111
Understanding BIOS, CMOS, and Firmware  115
Configuring the System BIOS  117
   Accessing the BIOS Setup Program  118
   BIOS Settings Overview  120
Automatic Configuration of BIOS/CMOS Settings  123
Selecting Options  124
Main Menu  124
Standard Features/Settings  125
Floppy Drive BIOS Configuration  126
PATA and SATA BIOS Configuration  126
System Information  127
Integrated Peripherals  129
Onboard Devices  130
I/O Devices  131
PATA/IDE and SATA Configuration  132
Power Management  134
PnP/PCI Configurations  135
Hardware Monitor  136
Processor and Memory Configuration  137
Security Features  138
Exiting the BIOS and Saving/Discarding Changes  139
Power-On Self-Test and Error Reporting  140
   Beep Codes  141
   POST Error Messages  142
   POST Hex Codes  143
BIOS Updates  144
   Flash BIOS Update  145
   BIOS Chip Replacement  147

Chapter 5  Power Supplies and System Cooling  153

“Do I Know This Already?” Quiz  153
Power Supplies  157
   Power Supply Ratings  157
   Multivoltage Power Supplies  159
   Causes and Cures of Power Supply Overheating  161
Overloading 161
Fan Failure 163
Inadequate Air Flow Outside the System 163
Inadequate Air Flow Inside the System 164
Dirt and Dust 164
Replacing Power Supply Form Factors and Connectors 165
Removing and Replacing the Power Supply 168
Testing Power Supplies with a Multimeter 170
Determining Power Supply DC Voltage Levels 172
Avoiding Power Supply Hazards 174

Power Protection Types 175
Surge Suppressors 176
Battery Backup Units (UPS and SPS) 178
Power Conditioning Devices 180
Buying the Correct-Sized Battery Backup System 180

Troubleshooting Power Problems 181
System Cooling 182
Passive and Active Heat Sinks 183
North/Southbridge Cooling 184
Video Card Cooling 186
Case Fans 187
Thermal Compound 188
Liquid Cooling Systems 191

Chapter 6 RAM 195
“Do I Know This Already?” Quiz 195
RAM Basics 199
RAM Types 201
DRAM 201
SRAM 201
SDRAM 202
DDR SDRAM 202
DDR2 SDRAM 202
DDR3 SDRAM 203
Rambus 203
Operational Characteristics 204
Comparison of Memory Modules 205
Memory Module Width 206
Parity and Non-Parity Memory 207
ECC and Non-ECC Memory 208
Registered and Unbuffered Memory 209
Single-Sided and Double-Sided Memory 209
Installing DIMMs and Rambus RDRAM Modules 210
Troubleshooting Memory 212
Verifying RAM Compatibility 212
Overclocking Can Lead to System Instability 213
Avoid Mixing Metals in RAM and Sockets 213
Use Caution When Mismatching RAM Speeds 213
EDO Compatibility with Other RAM Types 214
“Parity Error - System Halted” Message 215
RAM-Sizing Errors at Bootup 215
Determining Whether Cache RAM Is the Source of a Memory Problem 216
Other Methods for RAM Testing 216
Preventative Maintenance for Memory 217

Chapter 7 I/O and Multimedia Ports and Devices 221
“Do I Know This Already?” Quiz 221
Understanding I/O Ports 225
USB 225
USB Port Types, Speeds, and Technical Details 225
Adding USB Ports 228
SCSI 229
Multiple Device Support with SCSI Host Adapters 229
Jumper Block and DIP Switch Settings for Device IDs 230
SCSI Standards 232
SCSI Cables 233
SCSI Signaling Types 234
Daisy-Chaining SCSI Devices 234
SCSI Host Adapter Card Installation 236
SCSI Daisy-Chain Maximum Length 236
SCSI Termination Methods 237
Serial (COM) 238
Serial Port Pinouts 240
Types of Serial Cables 241
Standard IRQ and I/O Port Addresses 243
How to Configure or Disable Serial Ports 243
<table>
<thead>
<tr>
<th>Serial Port Software Configuration</th>
<th>244</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding Additional Serial Ports</td>
<td>245</td>
</tr>
<tr>
<td>Parallel (LPT)</td>
<td>246</td>
</tr>
<tr>
<td><strong>Parallel Port Configuration</strong></td>
<td>248</td>
</tr>
<tr>
<td>IEEE 1394 (FireWire)</td>
<td>253</td>
</tr>
<tr>
<td>IEEE 1394 Ports and Cables</td>
<td>253</td>
</tr>
<tr>
<td>IEEE 1394–Compatible Devices and Technical Requirements</td>
<td>254</td>
</tr>
<tr>
<td><strong>Installing an IEEE 1394 Card</strong></td>
<td>254</td>
</tr>
<tr>
<td>PS/2 (Mini-DIN)</td>
<td>255</td>
</tr>
<tr>
<td>Centronics</td>
<td>255</td>
</tr>
<tr>
<td>1/8-inch Audio Mini-Jack</td>
<td>256</td>
</tr>
<tr>
<td>SPDIF Digital Audio</td>
<td>256</td>
</tr>
<tr>
<td>MIDI Port</td>
<td>257</td>
</tr>
<tr>
<td>RG-6 Coaxial</td>
<td>258</td>
</tr>
<tr>
<td><strong>Understanding Input Devices</strong></td>
<td>258</td>
</tr>
<tr>
<td>Keyboard</td>
<td>258</td>
</tr>
<tr>
<td>Mouse and Pointing Devices</td>
<td>259</td>
</tr>
<tr>
<td><strong>Mouse Resource Usage</strong></td>
<td>260</td>
</tr>
<tr>
<td>Bar Code Reader</td>
<td>260</td>
</tr>
<tr>
<td>Biometric Devices</td>
<td>260</td>
</tr>
<tr>
<td>Touch Screens</td>
<td>261</td>
</tr>
<tr>
<td><strong>Touch Screen Interfacing to the Computer</strong></td>
<td>261</td>
</tr>
<tr>
<td><strong>Understanding Multimedia Devices</strong></td>
<td>262</td>
</tr>
<tr>
<td>Webcam</td>
<td>262</td>
</tr>
<tr>
<td>Digital Camera</td>
<td>262</td>
</tr>
<tr>
<td>MIDI Music and MIDI Ports</td>
<td>262</td>
</tr>
<tr>
<td>Sound Card</td>
<td>262</td>
</tr>
<tr>
<td>Microphone</td>
<td>263</td>
</tr>
<tr>
<td>Video Capture Card</td>
<td>264</td>
</tr>
<tr>
<td><strong>Installing Input and Multimedia Devices</strong></td>
<td>264</td>
</tr>
<tr>
<td>Installing a Keyboard</td>
<td>265</td>
</tr>
<tr>
<td>Installing a Mouse or Other Pointing Device</td>
<td>265</td>
</tr>
<tr>
<td>Installing a Bar Code Reader</td>
<td>265</td>
</tr>
<tr>
<td>Installing a Webcam</td>
<td>266</td>
</tr>
<tr>
<td>Installing a Digital Camera</td>
<td>266</td>
</tr>
<tr>
<td>Installing a MIDI Port</td>
<td>267</td>
</tr>
<tr>
<td>Installing a Microphone</td>
<td>267</td>
</tr>
</tbody>
</table>
Installing a Biometric Device  268
Installing a Touch Screen  268
Installing a Sound Card  268
Installing a Video Capture Card  269
Troubleshooting Input and Multimedia Devices  270
  Troubleshooting Keyboards  270
  Troubleshooting Mice and Pointing Devices  270
  Mouse Pointer Won’t Move  272
  Jerky Mouse Pointer Movement  273
  User Can’t Double-Click Icons  274
  Troubleshooting Touch Screen  274
  Troubleshooting Sound Card  275
  Sound Card Plays Sounds But Can’t Record CD-Quality Sound  275
  Sound Card Works in Some Systems But Not in Others  275
  Sound Playback Is Distorted or Choppy  275
  No Sound at All from Sound Card  275
  Sound Card Can’t Play MIDI Files  276
  Troubleshooting SCSI Devices  277
  External SCSI Device Isn’t Available  277
  External or Internal SCSI Device Isn’t Available  278
Troubleshooting I/O Ports  278
  Troubleshooting USB Ports and Devices  278
    USB Devices Not Recognized  278
    USB Port Problems  279
  Troubleshooting IEEE 1394 Ports and Devices  280
    System Can’t Detect the IEEE 1394 Card or Port  280
    Incorrect Driver for IEEE 1394 Card or Device  281
  Troubleshooting Parallel (LPT) Ports and Devices  281
    Parallel Port Mode Problems  281
    Problems with Daisy-Chained Devices  282
    Cabling and Port Problems  282
    Testing Parallel Ports  283
    Switchbox Problems  284
  Troubleshooting Serial Ports and Devices  284
    COM 4 I/O Port Conflicts  284
    Serial Port Drops Characters When Multitasking  284
    Can’t Connect Serial Devices to Port Because of Mismatched Connectors  285
Chapter 8 Video Displays and Graphics Cards 293
“Do I Know This Already?” Quiz 293
Video (Graphics) Card Types 297
Video Card Cooling 297
Installing a Video Card 298
BIOS Configuration 298
Video Card Physical and Driver Installation 299
Display Types 301
CRT Monitor 302
LCD Monitor 303
Data Projector 303
Video Connector Types 304
VGA 305
DVI 305
HDMI 307
Component/RGB 307
S-Video 308
Composite 308
Display Settings 308
Resolution 309
Color Quality (Color Depth) 311
Refresh Rates 312
Installing a Monitor 313
Troubleshooting Displays and Video Cards 314
Troubleshooting Picture Quality Problems with OSD 314
Using Advanced Display Properties for Troubleshooting 316
Troubleshooting Video Hardware 317
Preventative Maintenance for Displays 319

Chapter 9 Laptops and Portable Devices 323
“Do I Know This Already?” Quiz 323
Using Bluetooth 358
Using Infrared (IrDA) 358
Using Cellular WAN 359
Using Ethernet 359
Using Wireless Ethernet (WLAN) 359
Working with Power Sources 363
Working with Display Subsystem Components 363
Adjusting the Amount of Shared Video Memory 364
Adjusting Brightness and Contrast on a Laptop Computer’s Display 364
Using DualView to Work with a Secondary Monitor or Projector 365
Cloning the Laptop Display to a Secondary Display or Projector 367
Safe Removal of Laptop-Specific Hardware 369
Safe Removal of PC Cards 370
Safe Removal of ExpressCards 370
Safe Removal of Batteries 370
Safe Removal and Installation of Mini-PCI Cards 372
Safe Removal and Installation of Hard Disk Drives 373
Safe Removal of Optical Drives 374
Safe Removal and Installation of Memory 375
Safe Removal of LCD Panels 376
Safe Removal and Replacement of Pointing Devices 377
Portable and Laptop Diagnostics 379
Power Troubleshooting 379
AC Power Troubleshooting 379
DC Power Troubleshooting 380
Display Troubleshooting 380
Using an External Monitor to Check the Display Subsystem 381
Solving Internal Display Problems 381
LCD Cutoff Switch 381
Checking for Backlight Problems 381
Dead Pixels 382
Other Components 382
Removing Peripherals 382
Stylus and Digitizer Problems 383
Keypad Problems 383
Antenna Wires 384
Preventative Maintenance for Laptops and Portable Devices 384
Chapter 10 Security 391

“Do I Know This Already?” Quiz 391

Security Fundamentals 395
  Secure and Insecure File Systems 395
  Authentication Technologies 395
  Username/Password/PIN 396
  Smart Cards 396
  Biometrics 396

Protection Against Viruses and Malware 397

Software Firewalls 397

Hardware Recycling and Deconstruction 398

Securing Wireless Networks 398

WEP and WPA Encryption 398

Access Point Configuration for Maximum Security 399

DHCP Versus Static IP Addresses 400

Changing the SSID 400

Disabling SSID Broadcast 401

MAC Address Filtering 402

Changing Default Administrator User Password 403

Updating Access Point Firmware 404

Firewall Features 405

Data and Physical Security 405

Data Access Local Security Policy 405

Encryption Technologies 406

Encrypting File System 406

BitLocker Encryption 407

Backups 408

Data Migration 408

Data and Data Remnant Removal 409

Password Management 409
Locking a Workstation 410
Incident Reporting 410
Social Engineering 411
Access Control Purposes and Principles 412
Operating System Access Control 412
User, Administration, and Guest Accounts 412
User Account Control (UAC) 412
Groups 413
Permissions Actions, Types, and Levels 414
Permission Inheritance and Propagation 414
Moving and Copying Folders and Files 415
Components 415
Restricted Spaces 415
Auditing and Event Logging 415
Installing, Configuring, and Troubleshooting Security Features 417
BIOS Security Features 417
Software Firewalls 418
Configuring Exceptions 419
Troubleshooting Software Firewalls 421
Wireless Network Configuration 422
Configuring a Wireless Client with Windows XP SP2/SP3 422
Configuring a Wireless Client with Windows Vista 425
Configuring a Wireless Client with Windows 7 426
Troubleshooting Wireless Clients 427
Unused Wireless Connections 428
File Systems (Converting From FAT32 To NTFS) 430
Malicious Software Protection 431
Types of Malware and Infection Methods 432
Training Users in Malware Protection 432

Chapter 11 Printers 435
“Do I Know This Already?” Quiz 435
Printing Fundamentals 439
Laser Printers 439
How Laser Printers Use Memory 440
Toner Cartridges 442
Laser Printer Paper and Media 443
Inkjet Printers 444
Printer Options 462
Printing a Test Page 466
Educating the User About Basic Functionality 467
Optimizing Printer Performance 467
Tray Switching 467
Print Spooler Settings 468
XPS Features in Windows 7 and Vista 469
Device Calibration 470
Media Types 470
Paper Orientation 471
Print Order 472
Installing and Configuring Printer Upgrades 472
Memory 473
Firmware 474
Printer Troubleshooting Tools and Techniques 475
Identify the Problem 475
Identifying Symptoms 475
Review Device Error Codes 476
Review Computer Error Messages and Logs 476
Using the Self-Test Feature 477
Using Diagnostic Tools 478
Establishing a Theory of Probable Cause 478
Reviewing Service Documentation 478
Reviewing Knowledge Base 479
Defining and Isolating the Problem 479
Testing the Theory to Determine Cause 480
Problem: A complex document (one with many fonts or graphics) does not print 480
Problem: Repetitive marks on laser-printed document 481
Establishing a Plan of Action to Resolve the Problem and Implement the Solution 481
Verifying Full System Functionality and Implementing Preventative Measures (if Applicable) 481
Documenting Findings, Actions, and Results 481
Troubleshooting Print Failures 482
Paper Out 482
Clearing Print Queue 482
Restarting Print Queue 483
Power Off, Power On Printer 483
Chapter 12 Storage Devices 497

“Do I Know This Already?” Quiz 497

Floppy Disk Drives 501
  Floppy Disk Types 502
  Floppy Disk Drive Hardware Configuration 503
  Floppy Disk Drive Physical Installation and Removal 505
  Floppy Drive BIOS Configuration 505
  Maintaining Floppy Disks, Data, and Drives 507

Hard Disk Drives 508
  PATA and SATA Data and Power Cables 509
  PATA Drive Jumpering and Cable Select 510
  ATA Specifications 511
  ATA/IDE Drive Physical Installation 512
  SATA Hard Drive Physical Installation 514
  Installing an SATA Host Adapter 516
  PATA BIOS Configuration 517
  SATA BIOS Configuration 520
  eSATA 521
  Creating an ATA or SATA RAID Array 523
  ATA/IDE Performance Optimization 526
  PIO and DMA Transfer Modes 526
  IDE Block Mode 528
  IDE Busmastering Drivers 528
Chapter 13  Using and Managing Windows  567

“Do I Know This Already?” Quiz  568

Differences in Windows Versions  572

GUI  572

System Requirements  575

Application Compatibility  576

Program Compatibility Wizard in Windows 7  576

Program Compatibility Wizard in Windows XP and Vista  577

Additional Application Compatibility Features  579

Primary Windows Components  580

Registry  580

Windows Interfaces  581

Windows Explorer  581

Common Tasks View in Windows XP  583

Windows Vista Favorite Links View  584

Windows 7 Explorer View  585

Changing Viewing Options in Windows Explorer  586

Displaying Objects in Files and Folders  587

Windows Vista Additions to Windows Explorer  588

Windows 7 Additions to Windows Explorer  589

My Computer  590

Control Panel  591

Starting Control Panel  595
Shortcuts to Control Panel Functions 596
Command Prompt 596
Network 597
My Network Places 598
Devices and Printers 598
Taskbar/Notification Area 600
Start Menu 603
Adding, Removing, and Sorting Start Menu Items and Folders with Windows Vista/XP 603
Adding and Removing Start Menu Items and Folders with Windows 7 605
Adjusting Start Menu Properties 605
Jump ListsWindows 607
Indexing 608
Essential Operating System Files 609
Windows 7 and Vista Boot Sequence 610
Windows XP Boot Sequence 610
BOOT.INI 611
NTLDR and NTDETECT.COM 612
NTBOOTDD.SYS 612
Registry Data Files 612
Backing Up Registry Data Files 613
hiberfil.sys 614
Disk Partition, File, and Folder Management 615
Disk Partitions 615
Using Disk Management 617
Mount Points and Mounting a Drive 623
Windows File Systems 624
FAT32 624
exFAT (FAT64) 625
NTFS 625
Convert.exe 626
Working with Folders Directories 628
Working with Libraries in Windows 7 629
Managing Folders in a Library 630
Changing Viewing Options 631
File Management 631
Creating Files 632
File Types 632
Naming Files 634
Long Filenames and DOS Alias Names 634
File Extensions 635
Symbolic Links 636
Setting and Displaying File and Folder Attributes in Windows Explorer 636
File Permissions 639
DEFRAG 640
NTBackup 641
Using Windows Vista’s Backup and Restore Center 643
Using Windows 7’s Backup and Restore 644
CHKDSK.EXE 647
Format/Format.exe 648
Using Format with Floppy, USB Flash, and Removable-Media Drives 649
Formatting Floppy and Hard Disks with Windows Explorer 649
Windows Explorer Command-Line Options 651
Command-Line Functions 652
Starting a Command-Prompt Session with CMD.EXE 652
Internal Commands Overview 653
Using Wildcards to Specify a Range of Files 654
HELP 655
DIR 655
EDIT 657
COPY 658
XCOPY 658
MD/CD/RD 661
System Management Tools 662
Device Manager 662
Computer Management and the MMC 665
Task Manager 666
MSCONFIG.EXE 668
REGEDIT.EXE 670
Event Viewer 672
System Restore 673
Remote Desktop 676
Configuring Your Windows System to Accept Remote Client Connections 677
Connecting Remotely 678
Ending the Remote Session 680
Optimizing Windows 680
Virtual Memory, Performance Monitor, and System Monitor 680
Hard Disk 684
Temporary Files 684
Temporary File Settings in Windows 7/Vista/XP/2000 685
Services 686
Startup 688
Applications 688
Adjusting the Balance Between Background Services and Application Response 688
Adjusting the Priority of a Process 689
Stopping Unresponsive Applications 690

Chapter 14 Installing and Upgrading Windows Operating Systems 695
“Do I Know This Already?” Quiz 695
Installing Operating Systems 699
Verifying Hardware Compatibility and Minimum Requirements 699
Comparing Windows 7 Editions 701
Migrating User Data 702
Installation Methods 704
Starting a Clean Installation of Windows 7 from the Distribution DVD 704
Starting a Clean Installation of Windows Vista from the Distribution DVD 707
Installing Windows XP from the Distribution CD 710
Network Drive Installation 711
Disk Image 712
Installing Windows from a Recovery DVD/CD 713
Using Boot Disks to Start the Installation (XP and 2000 only) 713
Installing Windows 7 or Windows Vista from a USB Thumb Drive 714
Installation Method Options 716
Attended Versus Unattended Installation 716
Network Configuration 717
Preparing the Hard Disk for Installation 718
Providing Device Drivers During Installation 722
Verifying Installation 723
Upgrading Operating Systems 726
Preparations to Make Before Upgrading to a Newer Version of Windows 727
Upgrading to Windows 7 from Windows Vista 728
Upgrading to Windows Vista from Windows XP 732
Solving Disk Problems  782
Using Diagnostic Utilities and Tools  783
Can’t Boot from Hard Disk  783
Using Task Manager  784
Troubleshooting with Device Manager  786
Using System File Checker (SFC)  790
Maintaining Windows  790
Installing Service Packs and Hotfixes  790
Using Windows Update and Microsoft Update  793
Performing Scheduled Backup and Restore  794
Image Backups  794

Chapter 16  Networking  799

“Do I Know This Already?” Quiz  800
Network Models  805
  Client/Server  805
  Servers  806
  Clients  807
  Peer-to-Peer  807
Internet Connectivity Technologies  808
  Modems and Dial-Up Internet Connectivity  808
  Modem Technologies and Types  809
  Analog Modem Installation  812
  Dial-Up Internet Service Providers  813
  Creating a Dial-Up Connection  813
  Requirements for a Dial-Up Internet Connection  814
  ISDN Internet Connectivity  814
  ISDN Hardware  815
  Setting Up an ISDN Connection  815
  Broadband Internet Services (DSL, Cable, Satellite)  816
  DSL  816
  Cable Internet  818
  Satellite  818
  LANs and Internet Connectivity  820
Network Protocols  820
  TCP/IP  820
  NetBEUI/NetBIOS  821
TCP/IP Applications and Technologies  821
ISP 821
HTTP/HTTPS 821
SSL 822
TLS 822
HTML 822
FTP 822
Telnet 823
SSH 824
DNS 824
E-mail 825
SMTP 826
POP 826
IMAP 826
Ports 826

Network Topologies 827
Network Types 828
  Wired Ethernet Types 828
  Wireless Ethernet 829
  Bluetooth 830
  Infrared 830
  Cellular 831
  VoIP 831
Cable and Connector Types 832
  UTP and STP Cabling 832
  Fiber-Optic Cabling 834
  Coaxial Cabling 836
  Plenum and PVC 837
  Connector Types 837
Installing Network Interface Cards 838
  PCI and PCI Express 838
  USB 839
  PC Card/CardBus 839
Configuring Network Interface Cards 839
  Hardware Resources 839
  Media Type 840
  Full/Half-Duplex 840
  Wireless Ethernet (WLAN) Configuration 840
Switches and Hubs 841
Beyond LANs—Repeaters, Bridges, and Routers 842
Networking Configuration 843
  Installing Network Protocols in Windows 843
TCP/IPv4 Configuration 844
TCP/IP Configuration with a DHCP Server 845
TCP/IP Alternate Configuration 846
TCP/IP User-Configured IP and DNS Addresses 847
TCP/IP User-Configured Advanced Settings 847
Understanding IP Addressing, Subnet Masks, and IP Classes 847
WINS Configuration 850
Gateway 851
DNS Configuration 851
IPv6 IP Addressing 851
NetBEUI Configuration 853
Setting Up Shared Resources 853
  Installing File and Printer Sharing 854
  Shared Folders and Drives 855
  Sharing a Folder Using Simple File Sharing 855
  Sharing a Folder with User/Group Permissions in Windows Vista or Windows 7 857
  Shared Printers 858
Administrative Shares 858
Setting Up the Network Client 858
  Installing Network Client Software 859
  Installing a Network Printer 859
Using Shared Resources 860
  The Universal Naming Convention (UNC) 861
  Fully Qualified Domain Names (FQDNs) 862
  Mapped Drives 863
Browser Installation and Configuration 864
  Setting Up Your Browser to Use Your Internet Connection 865
  Enabling/Disabling Script Settings 867
  Configuring Browser Security Settings 867
Using Network Command-Line Tools 868
  Using the Net Command 868
  Using Ping 868
  Using Tracert 869
Situational Hazards 896
Atmospheric Hazards 897
Heavy Equipment Hazards 897
Environmental and Accident Incident Handling 898

Chapter 18 Troubleshooting and Communications Methods 901

“Do I Know This Already?” Quiz 901
Troubleshooting Methods Overview 905
The Client Interview 907
Tips for Conducting the Client Interview 908
How to Evaluate the Client’s Environment 909
Testing Power 909
Looking for Sources of Interference 910
Recording Symptoms and Error Codes 910
Determining Whether a Problem Is Caused by Hardware or Software 911
What Components to Check First 914
Points of Failure on the Outside of the Computer 914
“Known-Working” Doesn’t Mean “New”—Best Sources for Replacement Parts 915
Keeping Track of Your Solutions 916
Where to Go for More Information 916
Useful Hardware and Software Tools 918
Hardware Diagnostics 918
Cleaning and Maintenance Tools 920
Recommended Equipment Cleaning Products 921
Selecting and Using a Computer-Compatible Vacuum Cleaner 922
Professional Behavior 922
How to Talk to Customers 922
How to Treat Customers’ Property 923

Appendix A Answers to the “Do I Know this Already?” Quizes and Troubleshooting Scenarios 927

Index 962

Elements Available on the CD
Appendix B Memory Tables
Appendix C Memory Tables Answer Key
Appendix D Hardware Resources
Glossary
About the Authors

Mark Edward Soper has been working with PCs since the days of the IBM PC/XT and AT as a sales person, technology advisor, consultant, experimenter, and technology writer. Since 1992, he’s taught thousands of students across the country how to repair, manage, and troubleshoot the hardware, software, operating systems, and firmware inside their PCs. He’s created many versions of his experimental computer known as “FrankenPC” for this and previous books. Mark earned his CompTIA A+ Certification in 1999 and has written two other A+ Certification books covering previous versions of the A+ Certification exams for Que Publishing.

Mark has contributed to many editions of Upgrading and Repairing PCs, working on the 11th through 18th editions, coauthored Upgrading and Repairing Networks, Fifth Edition, and written two books about digital photography, Easy Digital Cameras and The Shot Doctor: The Amateur’s Guide to Taking Great Digital Photos.

In addition, Mark has contributed to Que’s Special Edition Using series on Windows Me, Windows XP, and Windows Vista, Que’s Windows 7 In Depth, contributed to Easy Windows Vista, has written two books about Windows Vista, including Maximum PC Microsoft Windows Vista Exposed and Unleashing Microsoft Windows Vista Media Center, and two books about Windows 7, Easy Microsoft Windows 7 and Sams Teach Yourself Microsoft Windows 7 in 10 Minutes.

Mark also stays busy on the Web, posting many blog entries and articles at MaximumPC.com, as well as writing articles for Maximum PC magazine. He has taught A+ Certification and other technology-related subjects at Ivy Tech Community College in Evansville, Indiana.

David L. Prowse is a computer network specialist, author, and technical trainer. As a consultant, he installs and secures the latest in computer and networking technology. Over the past several years, he has authored and co-authored a number of networking and computer titles for Pearson Education. In addition, over the past decade, he has taught CompTIA A+, Network+, and Security+ certification courses to more than 2,000 students, both in the classroom and via the Internet.
Dedication

From Mark Edward Soper:

For Paul and Maggie, with love, always.
Acknowledgments

From Mark Edward Soper:

As always, I want to thank God for the wonderful world He created and for giving mankind the ability to discover and share knowledge and wisdom with others.

I’m once again grateful for the opportunity to work with Scott Mueller, dean of PC technology books, on another project. Scott’s *Upgrading and Repairing PCs* continues to be one of my most significant hardware references now as it was more than 20 years ago. I also want to thank David L. Prowse for helping make sure this new edition reflects the continuing improvements and changes in the CompTIA A+ Certification exams, and Chris Crayton for checking the contents for accuracy.

I’ve always been blessed with a supportive family, which continues to grow in numbers as well as technology diversity (some of them even use Macs!). Thanks, as always, to Cheryl, who has helped me find the humor in high tech; our children and their spouses and families, who have entertained us with vigorous discussions on software, hardware, firmware, and retro gaming and music; my parents and parents-in-law, my brother and sister, my brothers- and sisters-in-law—all of whom have provided me with various opportunities to keep their PCs running.

This book would not have been possible without the help of the first-class publishing team provided by Pearson Education. As you review their names on the copyright page, join me in thanking them for their achievement in seeing this book from conception to the moment you open it and begin your journey to A+ Certification.

From David L. Prowse:

Thanks to Pearson Education and Mark for letting me be a part of this project.
About the Reviewer

Chris Crayton is an author, technical editor, technical consultant, and trainer. Formerly, he worked as a computer and networking instructor at Keiser University; as network administrator for Protocol, a global electronic customer relationship management (eCRM) company; and at Eastman Kodak Headquarters as a computer and network specialist. Chris has authored several print and online books on PC Repair, CompTIA A+, CompTIA Security+, and Microsoft Windows Vista. Chris has also served as technical editor and contributor on numerous technical titles for many of the leading publishing companies. He holds MCSE, A+, and Network+ certifications.
We Want to Hear from You!

As the reader of this book, you are our most important critic and commentator. We value your opinion and want to know what we’re doing right, what we could do better, what areas you’d like to see us publish in, and any other words of wisdom you’re willing to pass our way.

As an associate publisher for Pearson IT Certification, I welcome your comments. You can email or write me directly to let me know what you did or didn’t like about this book—as well as what we can do to make our books better.

Please note that I cannot help you with technical problems related to the topic of this book. We do have a User Services group, however, where I will forward specific technical questions related to the book.

When you write, please be sure to include this book’s title and author as well as your name, email address, and phone number. I will carefully review your comments and share them with the author and editors who worked on the book.

Email: feedback@pearsonitcertification.com

Mail: David Dusthimer
Associate Publisher
Pearson IT Certification
800 East 96th Street
Indianapolis, IN 46240 USA

Reader Services

Visit our website and register this book at www.informit.com/title/9780789747907 for convenient access to any updates, downloads, or errata that might be available for this book.
Introduction

CompTIA A+ Certification is widely recognized as the first certification you should receive in an information technology (IT) career. Whether you are planning to specialize in PC hardware, Windows operating system management, or network management, the CompTIA A+ Certification exams measure the baseline skills you need to master to begin your journey toward greater responsibilities and achievements in IT.

CompTIA A+ Certification is designed to be a “vendor-neutral” exam that measures your knowledge of industry-standard technology.

Goals and Methods

The number one goal of this book is a simple one: to help you pass the 2011 version of the CompTIA A+ Certification Essentials Exam (number 220-701) and the Practical Application Exam (number 220-702) and thereby earn your CompTIA A+ Certification. Although the 2011 versions of these exams have the same numbers as the 2009 versions, the 2011 versions now include Windows 7-specific content.

Because CompTIA A+ Certification exams now stress problem-solving abilities and reasoning more than memorization of terms and facts, our goal is to help you master and understand the required objectives for each exam.

To aid you in mastering and understanding the A+ Certification objectives, this book uses the following methods:

- **Opening topics list**—This defines the topics to be covered in the chapter; it also lists the corresponding CompTIA A+ objective numbers.
- **“Do I Know This Already Quizzes?”**—At the beginning of each chapter is a quiz. The quizzes and answers/explanations (found in Appendix A, “Answers to the ‘Do I Know This Already?’ Quizzes and Troubleshooting Scenarios”), are meant to gauge your knowledge of the subjects. If the answers to the questions don’t come readily to you, be sure to read the entire chapter.
- **Foundation Topics**—This is heart of the chapter that explains the topics from a hands-on and a theory-based standpoint. This includes in-depth descriptions, tables, and figures that are geared to build your knowledge so that you can pass the exam. The chapters are broken down into several topics each.
- **Key Topics**—The key topics indicate important figures, tables, and lists of information that you should know for the exam. They are interspersed throughout the chapter and are listed in table format at the end of the chapter.
■ Memory Tables—These can be found on the DVD within Appendix B, “Memory Tables.” Use them to help memorize important information.

■ Key Terms—Key terms without definitions are listed at the end of each chapter. Write down the definition of each term and check your work against the complete key terms in the glossary.

■ Troubleshooting Scenarios—Most chapters conclude with a troubleshooting scenario. Imagine possible solutions and check your work in Appendix A.

For a number of years, the CompTIA A+ Certification objectives were divided into a hardware exam and an operating systems exam. Starting with the 2006 exam, the exams were restructured so that knowledge of hardware and operating systems were needed for both exams. This design continues with the current 2009 and 2011 objectives with the addition of:

■ Windows Vista has been incorporated into the 2009 objectives with Windows 7 incorporated into the 2011 objectives.

■ Older operating systems, such as Windows 95, 98, Me, and NT, have been removed.

■ Newer multicore processor technologies, such as Core 2 Duo and Phenom II, have been added.

■ Newer hard drive and memory technologies have been added.

■ The A+ troubleshooting process has been updated.

■ Increased amount of networking and security topics with increased difficulty.

We'll cover all these changes and more within these chapters.

For more information about how the A+ certification can help your career, or to download the latest official objectives, access CompTIA’s A+ webpage at http://www.comptia.org/certifications/listed/a.aspx.

One method used by many A+ certification authors is to simply follow the objectives step by step. The problem is that because different parts of the computer—such as hard disk, display, Windows, and others—are covered in many different objectives, this approach creates a lot of overlap between chapters and does not help readers to understand exactly how a particular part of the computer fits together with the rest.
In this book, we have used a subsystem approach. Each chapter is devoted to a particular part of the computer so you understand how the components of each part work together and how each part of the computer works with other parts. To make sure you can relate the book’s contents to the CompTIA A+ Certification objectives, each chapter contains cross-references to the appropriate objectives as needed, and we provide a master cross-reference list later in this introduction.

**Who Should Read This Book?**

The CompTIA A+ exams measure the necessary competencies for an entry-level IT professional with the equivalent knowledge of at least 500 hours of hands-on experience in the lab or field. This book is written for people who have that amount of experience working with desktop PCs and laptops. Average readers will have attempted in the past to replace a hardware component within a PC; they should also understand how to navigate through Windows and access the Internet.

Readers will range from people who are attempting to attain a position in the IT field to people who want to keep their skills sharp or perhaps retain their job due to a company policy that mandates that they take the new exams.

This book is also aimed at the reader who wants to acquire additional certifications beyond the A+ certification (Network+, Security+, and so on). The book is designed in such a way to offer easy transition to future certification studies.

**Strategies for Exam Preparation**

Strategies for exam preparation will vary depending on your existing skills, knowledge, and equipment available. Of course, the ideal exam preparation would consist of building a PC from scratch and installing and configuring the operating systems covered including Windows 7 (Ultimate edition is recommended), Windows Vista (Ultimate edition is preferred), and Windows XP Professional. To make things easier for the reader, we recommend that you use Microsoft’s Windows Virtual PC (which works with Windows 7 Professional, Ultimate, and Enterprise) or Virtual PC 2007 (which works with other Windows 7 editions, Windows Vista, and Windows XP). Either program allows you to run virtual operating systems from within your current operating system without the need for an additional computer, and they can be downloaded for free from Microsoft’s website. It is also recommended that the reader get access to a laptop, a laser printer, and as many peripheral PC devices as possible. This hands-on approach will really help to
reinforce the ideas and concepts expressed in the book. However, not everyone has access to this equipment, so the next best step you can take is to read through the chapters in this book, jotting notes down with key concepts or configurations on a separate notepad. Each chapter begins with a “Do I Know This Already?” quiz designed to give you a good idea of the chapter’s content and your current understanding of it. In some cases, you might already know most of or all the information covered in a given chapter.

After you have read through the book, have a look at the current exam objectives for the CompTIA A+ Certification Exams listed at http://www.comptia.org/certifications/listed/a.aspx. If there are any areas shown in the certification exam outline that you would still like to study, find those sections in the book and review them.

When you feel confident in your skills, attempt the practice exam included on the DVD with this book. As you work through the practice exam, note the areas where you lack confidence and review those concepts or configurations in the book. After you have reviewed the areas, work through the practice exam a second time and rate your skills. Keep in mind that the more you work through the practice exam, the more familiar the questions will become, and the practice exam will become a less accurate judge of your skills.

After you have worked through the practice exam a second time and feel confident with your skills, schedule the real CompTIA A+ Essentials exam (220-701) and Practical Application Exam (220-702), through either Sylvan Prometric (www.2test.com) or Pearson Vue (www.vue.com). To prevent the information from evaporating out of your mind, you should typically take the exam within a week of when you consider yourself ready to take the exam.

The CompTIA A+ Certification credential for those passing the certification exams is now valid for three years (effective January 1, 2011). To renew your certification without retaking the exam, you need to participate in continuing education (CE) activities and pay an annual maintenance fee of $25.00 ($75.00 for three years). To learn more about the certification renewal policy, see http://www.comptia.org/certifications/listed/renewal.aspx.
**CompTIA A+ Exam Topics**

Table I-1 lists the exam topics for the CompTIA A+ exams. This table also lists the book parts in which each exam topic is covered.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>CompTIA A+ Exam Objectives Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PC Tools; Preventing Electrostatic Discharge; The Six-Step CompTIA Troubleshooting Process; Numbering Systems Used in Computers; Measuring Data Transfer and Frequency; Important Websites</td>
<td>n/a</td>
</tr>
<tr>
<td>2</td>
<td>The Essential Parts of Any Computer; Points of Failure; Hardware, Software, and Firmware; Working Inside Your PC; Hardware Resources</td>
<td>CompTIA A+ 220-701 objectives 1.1 and 1.2 and CompTIA A+ 220-702 objectives 1.1 and 1.2</td>
</tr>
<tr>
<td>3</td>
<td>Motherboards and Their Components; Processors and CPUs; Installing Adapter Cards</td>
<td>CompTIA A+ 220-701 objectives 1.2, 1.4, and 1.5 and CompTIA A+ 220-702 objectives 1.1 and 1.2</td>
</tr>
<tr>
<td>4</td>
<td>Understanding BIOS, CMOS, and Firmware; Configuring the System BIOS; Power-On Self-Test and Error Reporting; BIOS Upgrades</td>
<td>CompTIA A+ 220-701 objective 1.2 and CompTIA A+ 220-702 objective 1.2.</td>
</tr>
<tr>
<td>5</td>
<td>Power Supplies; Power Protection Types; Troubleshooting Power Problems</td>
<td>CompTIA A+ 220-701 objectives 1.3 and 2.5 and CompTIA A+ 220-702 objectives 1.1, 1.2, and 1.4</td>
</tr>
<tr>
<td>6</td>
<td>RAM Basics; RAM Types; Operational Characteristics; Installing Memory Modules; Troubleshooting Memory; Preventative Maintenance for Memory</td>
<td>CompTIA A+ 220-701 objectives 1.2 and 1.6 and CompTIA A+ 220-702 objectives 1.1 and 1.2</td>
</tr>
<tr>
<td>7</td>
<td>Understanding I/O Ports; Understanding Input Devices; Understanding Multimedia Devices; Installing Input and Multimedia Devices; Troubleshooting Input and Multimedia Devices; Troubleshooting I/O Ports; Maintaining Input Devices</td>
<td>CompTIA A+ 220-701 objectives 1.1, 1.2, 1.8, and 1.9 and CompTIA A+ 220-702 objectives 1.1 and 1.2</td>
</tr>
</tbody>
</table>
### Table I-1 CompTIA A+ Exam Topics

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>CompTIA A+ Exam Objectives Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Video (Graphics) Cards Types; Installing a Video Card; Display Types; Video Connector Types; Display Settings; Installing a Monitor; Troubleshooting Displays and Video Cards; Preventative Maintenance for Displays</td>
<td>CompTIA A+ 220-701 objectives 1.7 and 1.9 and CompTIA A+ 220-702 objectives 1.1 and 1.2</td>
</tr>
<tr>
<td>9</td>
<td>Fundamental Features of Laptops and Portable Devices; Configuring Power Management; Applications for Portable and Laptop Hardware; Safe Removal of Laptop-Specific Hardware; Portable and Laptop Diagnostics; Preventative Maintenance for Laptops and Portable Devices</td>
<td>CompTIA A+ 220-701 objectives 1.10 and 2.4 and CompTIA A+ 220-702 objective 1.3</td>
</tr>
<tr>
<td>10</td>
<td>Security Fundamentals; Securing Wireless Networks; Data and Physical Security; Access Control Purposes and Principles; Installing, Configuring, and Troubleshooting; Security Features</td>
<td>CompTIA A+ 220-701 objectives 5.1, 5.2 and CompTIA A+ 220-702 objectives 4.1 and 4.2</td>
</tr>
<tr>
<td>11</td>
<td>Printing Fundamentals; Printer and Scanner Control; Print Processes; Interface Types; Printer and Scanner Installation; Optimizing Printer Performance; Optimizing Scanner Performance; Installing and Configuring Printer Upgrades; Printer and Scanner Troubleshooting Tools and Techniques</td>
<td>CompTIA A+ 220-701 objectives 1.11 and 2.3 and CompTIA A+ 220-702 objective 1.5</td>
</tr>
<tr>
<td>12</td>
<td>Floppy Disk Drives; Hard Disk Drives; CD and DVD Optical Drives; Removable Storage; Tape Drives; Flash Memory and Card Readers; USB Flash Memory Drives; External Hard Disks; Troubleshooting Storage</td>
<td>CompTIA A+ 220-701 objectives 1.1, 1.2, and 2.5 and CompTIA A+ 220-702 objectives 1.1 and 1.2</td>
</tr>
<tr>
<td>13</td>
<td>Differences in Windows Versions; Primary Windows Components; Windows Interfaces; Essential Operating System Files; Disk Partition, File and Folder Management; Command-Line Functions; Optimizing Windows</td>
<td>CompTIA A+ 220-701 objectives 3.2 and 3.3 and CompTIA A+ 220-702 objectives 2.2 and 2.3</td>
</tr>
<tr>
<td>14</td>
<td>Installing Operating Systems; Upgrading Operating Systems</td>
<td>CompTIA A+ 220-701 objectives 3.1 and 3.3</td>
</tr>
</tbody>
</table>
### Table I-1 CompTIA A+ Exam Topics

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>CompTIA A+ Exam Objectives Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Troubleshooting Windows; Maintaining Windows</td>
<td>CompTIA A+ 220-701 objectives 2.2, 2.5, and 3.4 and CompTIA A+ 220-702 objectives 2.1, 2.3, and 2.4</td>
</tr>
<tr>
<td>16</td>
<td>Network Models; Internet Connectivity Technologies; Network Protocols; TCP/IP Applications and Technologies; Network Topologies; Network Types; Cable and Connector Types; Installing Network Interface Cards; Switches and Hubs; Beyond LANs; Networking Configuration; Setting Up Shared Resources; Setting Up the Network Client; Using Shared Resources; Browser Installation and Configuration; Using Network Command-Line Tools; Network and Internet Troubleshooting</td>
<td>CompTIA A+ 220-701 objectives 4.1, 4.2, and 4.3 and CompTIA A+ 220-702 objectives 3.1 and 3.2</td>
</tr>
<tr>
<td>17</td>
<td>Recycling and Disposal Issues; Using an MSDS (Material Safety Data Sheet); Electrostatic Discharge; Hazards; Environmental and Accident Handling</td>
<td>CompTIA A+ 220-701 objective 6.1</td>
</tr>
<tr>
<td>18</td>
<td>Troubleshooting Methods Overview; Determining Whether a Problem Is Caused by Hardware or Software; Where to Go for More Information; Useful Hardware and Software Tools; Professional Behavior</td>
<td>CompTIA A+ 220-701 objectives 2.1, 2.2, and 6.2</td>
</tr>
</tbody>
</table>

### How This Book Is Organized

Although this book could be read cover-to-cover, it is designed to be flexible and allow you to easily move between chapters and sections of chapters to cover just the material that you need more work with. If you do intend to read all the chapters, the order in the book is an excellent sequence to use.

Chapter 1, “PC Technician Essentials,” is an introductory chapter that is designed to ease readers that are new to computers into this book. It covers foundation concepts such as PC tools, ESD, basic troubleshooting, and numbering systems. The experienced computer technician might opt to skip this chapter and start with Chapter 2, “PC Anatomy,” but it is not recommended for most readers.
The core chapters, Chapters 2 through 18, cover the following topics:

- **Chapter 2, “PC Anatomy 101”**—This chapter focuses on the components of a computer, inside and outside, and describes the common points of failure in a computer. It also describes how to work inside a desktop PC and defines the hardware resources that the reader should know.

- **Chapter 3, “Motherboards, Processors, and Adapter Cards”**—This chapter discusses some of the core components of the computer, including the motherboard, processor, and adapter cards. Everything connects to the motherboard, so it stands to reason that proper planning and design of a PC, to a certain degree, starts with this component.

- **Chapter 4, “BIOS”**—This chapter explains the motherboard’s firmware, known as the BIOS. It also describes the relationship between the CMOS and the BIOS and demonstrates how to configure and update the BIOS.

- **Chapter 5, “Power Supplies and System Cooling”**—This chapter describes the device that transforms AC power from the wall outlet into DC power that a computer can use. The chapter also walks through how to troubleshoot power problems and describes the various power protection types.

- **Chapter 6, “RAM”**—This chapter examines random access memory (RAM), delving into the RAM types and operational characteristics. It also demonstrates how to install and troubleshoot RAM and how to prevent memory issues from occurring.

- **Chapter 7, “I/O and Multimedia Ports and Devices”**—Input/output (I/O) devices allow a user to control the computer and display information. This chapter focuses on the many types of input devices, I/O ports, and multimedia devices that a technician sees in the field.

- **Chapter 8, “Video Displays and Graphics Cards”**—This chapter describes the different types of video cards including PCI, AGP, and PCIe, and the various methods of cooling video cards. It also delves into the different types of displays including LCD, CRT, and projectors.

- **Chapter 9, “Laptops and Portable Devices”**—This chapter dives into the components of a laptop and their locations and what makes a laptop different from a PC. Within these pages are techniques for the safe removal of hardware and diagnostic procedures.

- **Chapter 10, “Security”**—This chapter discusses security from personal computer and basic networking standpoints. The chapter also describes how to secure basic wireless networks and how to control access to data.

- **Chapter 11, “Printers”**—This chapter focuses on laser, inkjet, thermal, and impact printers, as well as image scanners. From printing and scanning fundamentals to installation to troubleshooting, this chapter covers everything a technician needs to know for the exam and for the field.
Chapter 12, “Storage Devices”—This chapter discusses magnetic disks such as hard drives and floppy drives, optical discs such as CD and DVD, and solid state media such as USB flash drives.

Chapter 13, “Using and Managing Windows”—This chapter demonstrates how to configure and manage Windows 7, Vista, and XP. It discusses how to use the graphical user interface (GUI) and the command-line effectively to have an efficient operating system.

Chapter 14, “Installing and Upgrading Windows Operating Systems”—This chapter discusses how to install Windows 7, Windows Vista, and Windows XP. It also demonstrates how to upgrade a system from Windows 2000/XP to Vista, how to upgrade to Windows 7, and how to upgrade from 2000 to XP.

Chapter 15, “Troubleshooting and Maintaining Windows”—This chapter demonstrates how to troubleshoot Windows effectively. It covers common problems you might encounter in Windows: how to troubleshoot boot up errors, how to fix application issues, and how to decipher error codes and messages. Finally, it shows how to maintain and update a Windows system.

Chapter 16, “Networking”—This chapter discusses network models, Internet connectivity, TCP/IP, topologies, cabling, networking devices, and much more. It also delves into how to troubleshoot a malfunctioning network connection.

Chapter 17, “Safety and Environmental Issues”—This chapter explains how to properly recycle and dispose of computer components. It also discusses material safety data sheets (MSDS) and describes how to avoid and manage hazards in the workplace.

Chapter 18, “Troubleshooting and Communications Methods and Professional Behavior”—This chapter discusses the two factors that make for a successful troubleshooter: extensive computer knowledge and an understanding of human psychology. The chapter delves into how to troubleshoot a computer or other device. It also covers the proper way to treat customers.

In addition to the 18 main chapters, this book includes tools to help you verify that you are prepared to take the exam. The DVD includes the glossary, practice test, and memory tables that you can work through to verify your knowledge of the subject matter. The DVD also contains sample videos from *CompTIA A+ Video Mentor*, which is available as part of the *CompTIA A+ Cert Kit* (ISBN-13: 9780789742438).
This page intentionally left blank
This chapter covers the following subjects:

- **Motherboards and Their Components**—This section talks about the foundation of the computer, form factors, integrated ports and interfaces, memory slots, and expansion slots, and demonstrates how to install and troubleshoot motherboards.

- **Processors and CPUs**—In this section you’ll learn about the various types of processors available, their architecture and technologies, and installing and troubleshooting processors.

- **Installing Adapter Cards**—This section demonstrates how to install video and sound cards, and how to troubleshoot common adapter card issues.

This chapter covers a portion of CompTIA A+ 220-701 objectives 1.2, 1.4, and 1.5, and CompTIA A+ 220-702 objectives 1.1 and 1.2.
In this chapter we’ll talk about some of the core components of the computer—the guts of the computer—including the motherboard, processor, and adapter cards. Everything connects to the motherboard, so it stands to reason that proper planning and design of a PC, to a certain degree, starts with this component. Just as important is the processor. The processor (or CPU) is the “brain” of the computer and takes care of the bulk of the PC’s calculations. Deciding on a CPU and motherboard should be the first tasks at hand when building a PC. Adapter cards are vital because they allow video, audio, and network capabilities. It is important to know how many and what type of adapter card slots are available on your motherboard before selecting specific adapter cards.

Within these pages you will learn how to install and troubleshoot motherboards, processors, and adapter cards and discover some of the considerations to take into account when building the core of a PC.

“Do I Know This Already?” Quiz

The “Do I Know This Already?” quiz allows you to assess whether you should read this entire chapter or simply jump to the “Exam Preparation Tasks” section for review. If you are in doubt, read the entire chapter. Table 3-1 outlines the major headings in this chapter and the corresponding “Do I Know This Already?” quiz questions. You can find the answers in Appendix A, “Answers to the ‘Do I Know This Already?’ Quizzes and Troubleshooting Scenarios.”

<table>
<thead>
<tr>
<th>Foundations Topics Section</th>
<th>Questions Covered in This Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motherboards and Their Components</td>
<td>1–5</td>
</tr>
<tr>
<td>Processors and CPUs</td>
<td>6–10</td>
</tr>
<tr>
<td>Installing Adapter Cards</td>
<td>11</td>
</tr>
</tbody>
</table>
1. The system bus and I/O bus carry four different types of signals throughout the computer. Which of the following are the signals? (Choose all that apply.)
   a. Data
   b. Power
   c. Control
   d. Adapters
   e. Address

2. Which of the following are considered expansion slots? (Choose all that apply.)
   a. PCI
   b. FireWire
   c. AGP
   d. USB

3. Which of the following can you use with SCSI (Small Computer Systems Interface)? (Choose all that apply.)
   a. Hard drives
   b. Scanners
   c. Laser printers
   d. DVD-ROMs
   e. A dot-matrix printer

4. Which of the following are in the ATX family of motherboards? (Choose all that apply.)
   a. ATX
   b. Mini-ATX
   c. FlexATX
   d. ATX and Mini-ATX only
   e. None of the options provided is correct

5. Which of the following are considered integrated I/O ports?
   a. Serial port
   b. Parallel port
   c. USB port
   d. PS/2 mouse and keyboard
   e. Audio port
   f. Ethernet port
   g. All of these options are correct
6. Which one of the listed processors was the last slot-based processor designed by Intel?
   a. Celeron  
   b. Core 2 Duo  
   c. Pentium D  
   d. Pentium III

7. Which of the following processors was the first dual-core design by AMD?
   a. Athlon 64 X2  
   b. Athlon  
   c. Duron  
   d. Sempron

8. Which of the following best describes hyperthreading?
   a. Overclocking your CPU  
   b. Processing two execution threads simultaneously  
   c. Having more than one processor  
   d. None of these options is correct

9. Before you remove the processor from the motherboard, what device should you remove first?
   a. Power supply  
   b. RAM chip  
   c. Heat sink  
   d. Thermal compound

10. You have been dispatched to a client’s computer. You have decided that the processor is overheating. Which of the following steps can you take to help with the air flow around the processor?
    a. Blow it out with compressed air  
    b. Remove the heat sink from the CPU  
    c. Place it on a surface covered with old newspapers or waste paper  
    d. Clean off the old thermal paste and reapply a small amount to the processor  
    e. All of these options are correct
11. Which of the following are causes of overheating? (Choose all that apply.)
   a. Fan failure
   b. The power supply fan is too large
   c. Incorrect heat sink
   d. Incorrect processor

12. To connect speakers to the sound card, which of the following must you use?
   a. 1/2-inch jack
   b. 1 1/4-inch jack cable
   c. 2/3-inch jack cable
   d. 1/8-inch mini-jack cable
   e. None of these options is correct
Chapter 3: Motherboards, Processors, and Adapter Cards

Foundation Topics

Motherboards and Their Components

The motherboard represents the logical foundation of the computer. In other words, everything that makes a computer a computer must be attached to the motherboard. From the CPU to storage devices, from RAM to printer ports, the motherboard provides the connections that help them work together. Figure 3-1 shows an example of a typical motherboard. The various components of the motherboard are called out in the figure. We will be referring to this figure throughout the chapter.

The motherboard is essential to computer operation in large part because of the two major buses it contains: the system bus and the I/O bus. Together, these buses carry all the information between the different parts of the computer. The location and orientation of these buses will vary depending on the type of form factor used. The form factor is the design of the motherboard, which the case and power supply must comply with. Motherboards can come with integrated I/O ports; these are usually found as a rear port cluster. The motherboard will also have memory slots, which allow a user to add sticks of RAM, thus increasing the computer’s total resources. Of course, the motherboard also has expansion slots most commonly used by audio and video cards, although the slots can be used by many other types of cards as well. You will also find mass storage ports for hard drives, CD-ROMs, and DVD-ROMs on the motherboard. After we cover all of these concepts, we’ll show how to select, install, and troubleshoot the motherboard. As you can see, the motherboard is the

Figure 3-1  A typical motherboard.
central meeting point of all technologies in the computer. There is a lot to cover concerning motherboards. Let’s begin by discussing the system and I/O busses.

The System Bus and I/O Bus

The system bus carries four different types of signals throughout the computer:

- Data
- Power
- Control
- Address

To help you understand this concept, let’s take an imaginary trip to Chicago and compare the city to a typical motherboard. If you were on the Willis Tower observation deck overlooking downtown Chicago one evening, you would first notice the endless stream of cars, trucks, and trains carrying people and goods from everywhere to everywhere else along well-defined surface routes (the expressways and tollways, commuter railroads, Amtrak, and airports). You can compare these routes to the data bus portion of the system bus, which carries information between RAM and the CPU. If you’ve ever listened to the traffic reports on a radio station such as Chicago’s WBBM (780 AM), you’ve heard how traffic slows down when expressway lanes are blocked by construction or stalled traffic. In your computer, wider data buses that enable more “lanes” of data to flow at the same time promote faster system performance.

Now, imagine that you’ve descended to street level, and you’ve met with a local utility worker for a tour of underground Chicago. On your tour, you will find an elaborate network of electric and gas lines beneath the street carrying the energy needed to power the city. You can compare these to the power lines in the system bus, which transfer power from the motherboard’s connection to the power supply to the integrated circuits (ICs or chips) and expansion boards connected to the motherboard.

Go back to street level, and notice the traffic lights used both on city streets and on the entrance ramps to busy expressways, such as the Eisenhower and the Dan Ryan. Traffic stops and starts in response to the signals. Look at the elevated trains or at the Metra commuter trains and Amtrak intercity trains; they also move as directed by signal lights. These signals, which control the movement of road and rail traffic, can be compared to the control lines in the system bus, which control the transmission and movement of information between devices connected to the motherboard.

Finally, as you look around downtown, take a close look at the men and women totting blue bags around their shoulders or driving electric vans and Jeeps around the city. As these mail carriers deliver parcels and letters, they must verify the correct street and suite addresses for the mail they deliver. They correspond to the address
bus, which is used to “pick up” information from the correct memory location among the gigabytes of RAM in computer systems and “deliver” new programs and changes back to the correct memory locations.

The I/O bus connects storage devices to the system bus and can be compared to the daily flow of commuters and travelers into the city in the morning, and out again in the evening. Between them, the system and I/O buses carry every signal throughout the motherboard and to every component connected to the motherboard.

Form Factors

Although all motherboards have some features in common, their layout and size vary a great deal. The most common motherboard designs in current use include ATX, Micro ATX, BTX, and NLX. Some of these designs feature riser cards and daughterboards. The following sections cover the details of these designs.

ATX and Micro ATX

The ATX family of motherboards has dominated desktop computer designs since the late 1990s. ATX stands for “Advanced Technology Extended,” and it replaced the AT and Baby-AT form factors developed in the mid 1980s for the IBM PC AT and its rivals. ATX motherboards have the following characteristics:

- A rear port cluster for I/O ports
- Expansion slots that run parallel to the short side of the motherboard
- Left side case opening (as viewed from the front of a tower PC)

There are four members of the ATX family, listed in Table 3-2. In practice, though, the Mini-ATX design is not widely used.

### Table 3-2  ATX Motherboard Family Comparison

<table>
<thead>
<tr>
<th>Motherboard Type</th>
<th>Maximum Width</th>
<th>Maximum Depth</th>
<th>Maximum Number of Expansion Slots</th>
<th>Typical Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATX</td>
<td>12 in</td>
<td>9.6 in</td>
<td>Seven</td>
<td>Full tower</td>
</tr>
<tr>
<td>Mini-ATX</td>
<td>11.2 in</td>
<td>8.2 in</td>
<td>Seven</td>
<td>Full tower</td>
</tr>
<tr>
<td>microATX</td>
<td>9.6 in</td>
<td>9.6 in</td>
<td>Four</td>
<td>Mini tower</td>
</tr>
<tr>
<td>FlexATX</td>
<td>9.0 in</td>
<td>7.5 in</td>
<td>Four</td>
<td>Mini tower, small form factor</td>
</tr>
</tbody>
</table>

BTX

One problem with the ATX design has been the issue of system cooling. Because ATX was designed more than a decade ago, well before the development of today’s faster components, it’s been difficult to properly cool the hottest-running
components in a typical system: the processor, memory modules, and the processor's voltage regulator circuits.

To enable better cooling for these devices, and to promote better system stability, the BTX family of motherboard designs was introduced in 2004. Compared to ATX motherboards, BTX motherboards have the following:

■ Heat-producing components such as the process, memory, chipset, and voltage regulator are relocated to provide straight-through airflow from front to back for better cooling.

■ The processor socket is mounted at a 45-degree angle to the front of the motherboard to improve cooling.

■ A thermal module with a horizontal fan fits over the processor for cooling.

■ The port cluster is moved to the rear left corner of the motherboard.

■ BTX cases include multiple rear and side air vents for better cooling.

■ Because of the standardization of processor and memory locations, it’s easy to use the same basic design for various sizes of BTX motherboards; the designer can just add slots.

■ BTX tower cases use a right-opening design as viewed from the front.

Although BTX designs are easier to cool than ATX designs, the development of cooler-running processors has enabled system designers to continue to favor ATX. There are relatively few BTX-based motherboards and systems currently on the market.

Figure 3-2 compares typical ATX and BTX motherboard layouts to each other.

Figure 3-2 The ATX motherboard family includes ATX (largest), microATX, and flexATX (smallest). The BTX motherboard family includes BTX, microBTX, nanoBTX, and picoBTX (smallest).
NOTE  The motherboard examples shown in Figure 3-2 are simplified examples of actual motherboards. Onboard ports, port headers, and additional motherboard power connectors are not shown. Also, motherboards using a particular design might have components in slightly different positions than shown here.

NLX

NLX motherboards are designed for quick replacement in corporate environments. They use a riser card that provides power and expansion slots that connect to the right edge of the motherboard (as viewed from the front). NLX motherboards have a two-row cluster of ports along the rear edge of the motherboard.

Most systems that use NLX motherboards are considered obsolete. Figure 3-3 illustrates a typical NLX motherboard and riser card.

![A typical NLX motherboard and riser card.](image)

1. Processor and passive heat sink
2. Memory modules
3. Port cluster
4. Riser card
5. Connection to motherboard
6. Expansion slots
7. Motherboard

Riser Cards and Daughterboards

Riser cards and daughterboards provide two different methods for providing access to motherboard–based resources. In current slimline or rackmounted systems based on ATX or BTX technologies, riser cards are used to make expansion slots usable that would otherwise not be available because of clearances inside the case. Riser card designs can include one or more expansion slots, and are available in PCI, PCI-X (used primarily in workstation and server designs), and PCI-Express designs. Figure 3-4 shows two typical implementations of riser card designs.

The term daughterboard is sometimes used to refer to riser cards, but daughterboard can also refer to a circuit board that plugs into another board to provide extra functionality. For example, some small form factor motherboards support daughterboards that add additional serial or Ethernet ports, and some standard-size motherboards use daughterboards for their voltage regulators.
1. Single-slot riser card
2. PCI modem inserted into riser card slot
3. Multi-slot riser card
4. Motherboard

Figure 3-4  Examples of single-slot and multi-slot riser cards.

Integrated I/O Ports

Motherboards in both the ATX and BTX families feature a variety of integrated I/O ports. These are found in as many as three locations: all motherboards feature a rear port cluster (see Figure 3-5 for a typical example), and many motherboards also have additional ports on the top of the motherboard that are routed to header cables accessible from the front and rear of the system.

Most recent motherboards include the following ports in their port cluster:

- Serial (COM)
So-called “legacy-free” motherboards might omit some or all of the legacy ports (serial, parallel, PS/2 mouse and keyboard), a trend that will continue as devices using these ports have been replaced by devices that plug into USB ports.

Some high-end systems might also include one or more FireWire (IEEE-1394a) ports, and systems with integrated video include a VGA or DVI-I video port and an S-Video or HDMI port for TV and home theater use.

Figure 3-5 illustrates a port cluster from a typical ATX system, but note that BTX systems use similar designs.

Some integrated ports use header cables to provide output. Figure 3-6 shows an example of 5.1 surround audio ports on a header cable. The header cable plugs into the motherboard and occupies an empty expansion slot.

Figure 3-6  This header cable provides support for 5.1 surround analog audio and digital audio.
INTEGRATED PORT CONSIDERATIONS

Why integrated ports? They provide clear benefits to both users and technicians who set up a system. For users, integrated ports provide lower system purchase prices, faster component performance, centralized control of components through the ROM BIOS and CMOS, and an interior that is less crowded with add-on cards. In other words, you might have a slot or two available in a brand-new system for future upgrades.

For technicians, the greatest benefits of integrated components come during initial setup. Fewer components need to be installed to make a system meet standard requirements and components can be enabled or disabled through the BIOS setup program. Very handy!

However, when systems must be repaired or upgraded, integrated components can be troublesome. If an integrated component that is essential to system operation fails, you must either replace the motherboard or disable the component in question (if possible) and replace it with an add-on card. To learn more about these ports and their uses, see Chapter 7, “I/O and Multimedia Ports and Devices.”

Memory Slots

Modern motherboards include two or more memory slots, as seen in Figures 3-1 and 3-2. At least one memory slot must contain a memory module, or the system cannot start or function.

Memory slots vary in design according to the type of memory the system supports. Older systems that use SDRAM use three-section memory slots designed for 168-pin memory modules. Systems that use DDR SDRAM use two-section memory slots designed for 240-pin modules. DDR3 SDRAM also uses two-section 240-pin memory slots, but the arrangement of the pins and the keying of the slot are different than in DDR2. DDR2 and DDR3 modules cannot be interchanged.

Each memory slot includes locking levers that secure memory in place. When memory is properly installed, the levers automatically swivel into place (see Figure 3-7).

To learn more about memory types and slots, see Chapter 6, “RAM.”

Expansion Slots

Motherboards use expansion slots to provide support for additional I/O devices and high-speed video/graphics cards. The most common expansion slots on recent systems include peripheral component interconnect (PCI), advanced graphics port (AGP), and PCI-Express (also known as PCIe). Some systems also feature audio modem riser (AMR) or communications network riser (CNR) slots for specific purposes.
Chapter 3: Motherboards, Processors, and Adapter Cards

Figure 3-7  Installing memory modules.

PCI Slots

The PCI slot can be used for many types of add-on cards, including network, video, audio, I/O and storage host adapters for SCSI, PATA, and SATA drives. There are several types of PCI slots, but the one found in desktop computers is the 32-bit slot running at 33MHz (refer to Figure 3-8 in the next section).

AGP

The AGP slot was introduced as a dedicated slot for high-speed video (3D graphics display) in 1996. Since 2005, the PCI Express x16 slot (described in the next section) has replaced it in most new systems. There have been several versions of the AGP slot, reflecting changes in the AGP standard, as shown in Figure 3-8. Note that all types of AGP slots can temporarily “borrow” system memory when creating 3D textures.

Note that the AGP 1x/2x and AGP 4x/8x slots have their keys in different positions. This prevents installing the wrong type of AGP card into the slot. AGP 1x/2x cards use 3.3V, whereas most AGP 4x cards use 1.5V. AGP 8x cards use 0.8 or 1.5V. The AGP Pro/Universal slot is longer than a normal AGP slot to support the greater electrical requirements of AGP Pro cards (which are used in technical workstations). The protective cover over a part of the slot is intended to prevent normal AGP cards from being inserted into the wrong part of the slot. The slot is referred to as a universal slot because it supports both 3.3V and 1.5V AGP cards.

CAUTION  An AGP Pro slot cover might be removed after a system has been in service for awhile, even if an AGP Pro card wasn’t inserted in a computer. If you see an AGP Pro slot without a cover and you’re preparing to install an AGP card, cover the extension with a sticker to prevent damaging a standard AGP card by inserting it improperly.
PCI slots

1. PCI slots
2. AGP 1x/2x (3.3v) slot
3. AGP 4x/8x (1.5v) slot
4. AGP Pro/Universal slot
5. AGP Pro slot cover
6. AGP 4x/8x retaining latch
7. AGP 1x/2x key
8. AGP 4x/8x key

Figure 3-8  PCI slots compared to an AGP 1x/2x slot (top), an AGP 4x/8x slot (middle), and an AGP Pro/Universal slot (bottom).

PCIe (PCI Express) Slots

PCI Express (often abbreviated as PCIe or PCIE) began to replace both PCI and AGP slots in new system designs starting in 2005. PCIe slots are available in four types:

- x1
- x4
- x8
- x16

The most common versions include the x1, x4, and x16 designs, as shown in Figure 3-9.
Table 3-3  

<table>
<thead>
<tr>
<th>Slot Type</th>
<th>Performance</th>
<th>Suggested Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI</td>
<td>133MBps</td>
<td>Video, network, SCSI, sound card</td>
</tr>
<tr>
<td>AGP 1x</td>
<td>266MBps</td>
<td>Video</td>
</tr>
<tr>
<td>AGP 2x</td>
<td>533MBps</td>
<td>Video</td>
</tr>
<tr>
<td>AGP 4x</td>
<td>1,066MBps</td>
<td>Video</td>
</tr>
<tr>
<td>AGP 8x</td>
<td>2,133MBps</td>
<td>Video</td>
</tr>
<tr>
<td>PCIe x1</td>
<td>500MBps*</td>
<td>Network, I/O</td>
</tr>
<tr>
<td>PCIe x2</td>
<td>1,000MBps*</td>
<td>Network</td>
</tr>
<tr>
<td>PCIe x8</td>
<td>4,000MBps*</td>
<td>SLI video</td>
</tr>
<tr>
<td>PCIe x16</td>
<td>8,000MBps*</td>
<td>Video (including SLI, CrossFire)</td>
</tr>
</tbody>
</table>

NOTE  At the time of publication of this book, there are three versions of PCI Express. V1.0 is rated at 250MB/s per lane, V2.0 at 500 MB/s, and V3.0 at 1GB/s with a maximum of 32 lanes. All three versions use the same slot designs but run at different speeds due to internal differences.
The data rates listed in Table 3-3 are the bidirectional (simultaneous send/receive) throughput amounts you should know for the exam (these reflect PCIe V1.0). Unidirectional data rates (send or receive) are one-half of the bidirectional data rates.

SLI is the NVIDIA method for using two or more graphics cards to render 3D game graphics.

CrossFire is the ATI/AMD method for using two or more graphics cards to render 3D game graphics.

**AMR and CNR Slots**

Some motherboards have one of two specialized expansion slots in addition to the standard PCI, PCI Express, or AGP slots. The audio modem riser (AMR) slot enables motherboard designers to place analog modem and audio connectors and the codec chip used to translate between analog and digital signals on a small riser card. AMR slots are frequently found on older systems with chipsets that integrate software modems and audio functions.

The AMR was replaced by the communications network riser (CNR) slot, a longer design that can support up to six-channel audio, S/PDIF digital audio, and home networking functions. Some vendors have used the CNR slot to implement high-quality integrated audio. Very few AMR riser cards were ever sold, but some motherboard vendors have bundled CNR riser cards with their motherboards to provide six-channel audio output and other features.

Figure 3-10 compares the AMR, PCI, and CNR slots. Figure 3-11 illustrates the AMR and CNR riser cards.

The AMR or CNR slot, when present, is usually located on the edge of the motherboard. The AMR slot was often found on Pentium III or AMD Athlon-based systems, while the CNR slot was used by some Pentium 4-based systems. Current systems integrate network and audio features directly into the motherboard and its port cluster, making both types of slots obsolete.

**NOTE** AMR and CNR riser cards were generally provided by motherboard makers because they are customized to the design of particular motherboards. Although some parts suppliers have sold AMR and CNR cards separately, it's best to get the riser card from the same vendor as the motherboard to ensure proper hardware compatibility and driver support.

To learn more about PCI, PCIe, and AGP slots when used for graphics cards, see Chapter 8, “Video Displays and Graphics Cards.” To learn more about installing adapter cards, see “Installing Adapter Cards,” later in this chapter.
Mass Storage Interfaces

Motherboards also include mass storage interfaces such as PATA/IDE, SATA, and SCSI. The following sections compare and contrast the appearance and functionality of these interfaces. Table 3-4 provides a quick overview of technical information about these interfaces.
### Table 3-4  Technical Information About Mass Storage Interfaces

<table>
<thead>
<tr>
<th>Interface</th>
<th>Performance</th>
<th>Suggested Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATA 1(^{st}) generation</td>
<td>1.5Gbps</td>
<td>Hard disk, rewritable DVD</td>
</tr>
<tr>
<td>SATA 2(^{nd}) generation</td>
<td>3.0Gbps</td>
<td>Hard disk, rewritable DVD</td>
</tr>
<tr>
<td>PATA/IDE</td>
<td>1.0–1.3Gbps</td>
<td>Rewritable DVD, rewritable CD, Zip, JAZ, REV, tape</td>
</tr>
<tr>
<td>SCSI</td>
<td>1.6–3.2Gbps*</td>
<td>Hard disk, tape backup</td>
</tr>
</tbody>
</table>

Note: *Current Ultra 160 and Ultra 320 SCSI standards; older standards are much slower.

The following sections describe each of these interfaces in greater detail.

### PATA/IDE

Until recently, most motherboards included two or more PATA/IDE (also known as ATA/IDE) host adapters for PATA devices such as hard disks, CD or DVD drives, tape backups, and removable-media drives. Each host adapter uses a 40-pin interface similar to the one shown in Figure 3-12, and can control up to two drives.

Most recent systems use a plastic skirt around the PATA connector with a notch on one side. This prevents improper insertion of a keyed PATA (ATA/IDE) cable. However, keep in mind that some older systems have unskirted connectors and some older ATA/IDE cables are not keyed. To avoid incorrect cable connections, be sure to match pin 1 on the PATA host adapter to the red-striped edge of the PATA ribbon cable.
On systems with a third PATA/IDE host adapter, the additional host adapter is typically used for a RAID 0 or RAID 1 drive array. See your system or motherboard documentation for details. Most current systems now have only one PATA/IDE host adapter, as the industry is transitioning away from PATA/IDE to SATA interfaces for both hard disk and DVD drives.

**SATA**

Most recent systems have anywhere from two to as many as eight Serial ATA (SATA) host adapters. Each host adapter controls a single SATA drive, such as a hard disk or rewritable DVD drive.

The original SATA host adapter design did not have a skirt around the connector, making it easy for the cable to become loose. Many late-model systems now use a skirted design for the host adapter (see Figure 3-13).

![SATA host adapters](image)

**Figure 3-13** Most late model systems include multiple SATA host adapters with skirted connectors.

**SCSI**

SCSI (Small Computer Systems Interface) is a more flexible drive interface than PATA (ATA/IDE) because it can accommodate many devices that are not hard disk drives. The fastest versions of SCSI are comparable in speed to today’s SATA. However, SCSI systems are usually used in servers and power workstations, as opposed to regular PCs. The following have been common uses for SCSI:

- High-performance and high-capacity hard drives
- Image scanners
- Removable-media drives such as Zip, Jaz, and Castlewood Orb
- High-performance laser printers
- High-performance optical drives, including CD-ROM, CD-R, CD-RW, DVD-ROM, and others

So-called Narrow SCSI host adapters (which use an 8-bit data channel) can accommodate up to seven devices of different varieties on a single connector on the host adapter through daisy-chaining. Wide SCSI host adapters use a 16-bit data channel and accommodate up to 15 devices on a single connector on the host adapter through daisy-chaining. Narrow SCSI devices and host adapters use a 50-pin or (rarely) a 25-pin cable and connector, while Wide SCSI devices use a 68-pin cable and connector.

Several years ago, SCSI host adapters were found on some high-end desktop and workstation motherboards. However, most recent systems use SATA in place of SCSI, and SCSI host adapters and devices are now primarily used by servers. Currently, SCSI is used primarily for high-performance hard disks and tape backups.

Systems with onboard SCSI host adapters might have one or more 50-pin or 68-pin female connectors similar to those shown in Figure 3-14.

To learn more about storage devices, see Chapter 12, “Storage Devices.”

Choosing the Best Motherboard for the Job

So, how do you go about choosing the best motherboard for the job? Follow this process:

**Step 1.** Decide what you want the motherboard (system) to do. Because most of a computer’s capabilities and features are based on the motherboard, you need to decide this first.
**Some examples:**

If you need high CPU performance, you must choose a motherboard that supports the fastest dual-core or multi-core processors available. If you want to run a 64-bit (x64) operating system, you need a motherboard that supports 64-bit processors and more than 4GB of RAM. If you want to run fast 3D gaming graphics, you need a motherboard that supports NVIDIA's SLI or ATI's CrossFire multi-GPU technologies. If you want to support multimedia uses such as video editing, you'll prefer a motherboard with onboard IEEE-1394a (FireWire 400). If you are building a system for use as a home theater, a system with HDMI graphics might be your preferred choice.

**Step 2.** Decide what form factor you need to use. If you are replacing an existing motherboard, the new motherboard must fit into the case (chassis) being vacated by the old motherboard and (ideally) be powered by the existing power supply. If you are building a new system, though, you can choose the form factor needed.

**Some examples:**

Full-size ATX or BTX motherboards provide the most room for expansion but require mid-size or full-size tower cases. If no more than three expansion slots are needed, micro ATX or micro BTX systems fit into mini-tower cases that require less space and can use smaller, less-expensive power supplies. If only one slot (or no slots) are needed, picoATX or picoBTX systems that fit into small form factor cases require very little space.

**Installing Motherboards**

What keeps a motherboard from sliding around inside the case? If you look at an unmounted motherboard from the top, you can see that motherboards have several holes around the edges and one or two holes toward the middle of the motherboard. Most ATX-family and BTX-family motherboards are held in place by screws that are fastened to brass spacers that are threaded into holes in the case or a removable motherboard tray. Before you start working with motherboards or other static-sensitive parts, see the section “Electrostatic Discharge (ESD),” in Chapter 17, “Safety and Environmental Issues,” for ESD and other precautions you should follow.

**Step-by-Step Motherboard Removal (ATX and BTX)**

Removing the motherboard is an important task for the computer technician. For safety’s sake, you should remove the motherboard before you install a processor upgrade as well as if you need to perform a motherboard upgrade.
To remove ATX or BTX-family motherboards from standard cases, follow these steps:

**Step 1.** Turn off the power switch and disconnect the AC power cable from the power supply.

**Step 2.** Disconnect all external and internal cables attached to add-on cards after labeling them for easy reconnection.

**Step 3.** Disconnect all ribbon cables attached to built-in ports on the motherboard (I/O, storage, and so on) after labeling them for easy reconnection.

**Step 4.** Disconnect all cables leading to internal speakers, key locks, speed switches, and other front-panel cables. Most recent systems use clearly marked cables as shown in Figure 3-15, but if the cables are not marked, mark them before you disconnect them so you can easily reconnect them later.

**TIP** You can purchase premade labels for common types of cables, but if these are not available, you can use a label maker or blank address labels to custom-make your own labels.

**Step 5.** Remove all add-on cards and place them on an antistatic mat or in (not on top of) antistatic bags.

**Step 6.** Disconnect header cables from front- or rear-mounted ports and remove them from the system (see Figure 3-16).

**Step 7.** Disconnect the power-supply leads from the motherboard. The new motherboard must use the same power-supply connections as the current motherboard. See Chapter 5, “Power Supplies and System Cooling,” for details about power supply connections.
Chapter 3: Motherboards, Processors, and Adapter Cards

Expansion slot bracket

USB header cable connected to motherboard

Figure 3-16   A typical dual-USB header cable that uses an expansion slot bracket.

Step 8. Remove the heat sink and the processor before you remove the motherboard and place them on an anti-static mat. Removing these items before you remove the motherboard helps prevent excessive flexing of the motherboard and makes it easier to slip the motherboard out of the case. However, skip this step if the heat sink requires a lot of downward pressure to remove and if the motherboard is not well supported around the heat sink/processor area.

Step 9. Unscrew the motherboard mounting screws (refer to Figure 3-1) and store for reuse; verify that all screws have been removed.

CAUTION    Easy does it with the screwdriver! Whether you’re removing screws or putting them back in, skip the electric model and do it the old-fashioned way to avoid damaging the motherboard. If your motherboard is held in place with hex screws, use a hex driver instead of a screwdriver to be even more careful.

Step 10. Lift the motherboard and plastic stand-off spacers out of the case and place them on an antistatic mat. Remove the I/O shield (the metal plate on the rear of the system which has cutouts for the built-in ports; refer to Figure 3-17) and store it with the old motherboard.

Step-by-Step Motherboard Removal (NLX)

NLX motherboards are designed for fast, easy removal. Follow this procedure:

Step 1. As described earlier, disconnect cables from any installed add-on cards.

Step 2. Remove any add-on cards, remembering to handle the cards by their edges.
Figure 3-17  An ATX I/O shield and motherboard during installation.

Step 3. Pull the motherboard release lever to disconnect the motherboard from the NLX riser.

Step 4. Slide the motherboard out of the case.

Preparing the Motherboard for Installation (ATX/BTX)

Before you install the new motherboard into the computer, perform the following steps:

Step 1. Review the manual supplied with the new motherboard to determine correct sizes of memory supported, processor types supported, and configuration information.

Step 2. Install the desired amount of memory. See Chapter 6 for details.

Step 3. Install the processor (CPU) and heat sink as described later in this chapter.

Step 4. Configure CPU speed, multiplier, type, and voltage settings on the motherboard if the motherboard uses jumpers or DIP (Dual Inline Pin) switches. Note that many recent motherboards use BIOS configuration options instead.

To learn more about configuring the motherboard for a particular CPU, see the section “Processors and CPUs” later in this chapter.

Making these changes after the motherboard is installed in the computer is normally very difficult.
Step-by-Step Motherboard Installation (ATX/BTX)

After you have prepared the motherboard for installation, follow these steps to install the motherboard:

**Step 1.** Place the new motherboard over the old motherboard to determine which mounting holes should be used for standoffs (if needed) and which should be used for brass spacers. Matching the motherboards helps you determine that the new motherboard will fit correctly in the system.

**Step 2.** Move brass spacers as needed to accommodate the mounting holes in the motherboard.

**Step 3.** Place the I/O shield and connector at the back of the case. The I/O shield is marked to help you determine the port types on the rear of the motherboard. If the port cutouts on some I/O shields are not completely removed, remove them before you install the shield.

**Step 4.** Determine which holes in the motherboard have brass stand-off spacers beneath them and secure the motherboard using the screws removed from the old motherboard (see Figure 3-17).

**Step 5.** Reattach the wires to the speaker, reset switch, IDE host adapter, and power lights.

**Step 6.** Reattach the ribbon cables from the drives to the motherboard's IDE and floppy disk drive interfaces. Match the ribbon cable's colored side to pin 1 on the interfaces.

**Step 7.** Reattach cables from the SATA drives to the SATA ports on the motherboard. Use SATA port 1 for the first SATA drive, and so on.

**Step 8.** Reattach the power supply connectors to the motherboard.

**Step 9.** Insert the add-on cards you removed from the old motherboard; make sure your existing cards don’t duplicate any features found on the new motherboard (such as sound, ATA/IDE host adapters, and so on). If they do, and you want to continue to use the card, you must disable the corresponding feature on the motherboard.

**Step 10.** Mount header cables that use expansion card slot brackets into empty slots and connect the header cables to the appropriate ports on the motherboard.

**Step 11.** Attach any cables used by front-mounted ports such as USB, serial, or IEEE-1394 ports to the motherboard and case.
Step-by-Step Motherboard Installation (NLX)

After you have prepared the motherboard for installation, follow these steps to install the motherboard:

**Step 1.** Line up the replacement motherboard with the motherboard rails located at the bottom of the case.

**Step 2.** Slowly push the motherboard into place. After the motherboard is connected to the riser card, it stops moving.

**Step 3.** Lift and push the motherboard release lever to lock the motherboard into place.

**Step 4.** Replace the side panel. If the side panel cannot be replaced properly, the motherboard is not installed properly.

Troubleshooting Motherboards

When you’re troubleshooting a computer, there is no shortage of places to look for problems. However, because the motherboard is the “home” for the most essential system resources, it’s often the source of many problems. If you see the following problems, consider the motherboard as a likely place to look for the cause:

- **System will not start**—When you push the power button on an ATX or BTX system, the computer should start immediately. If it doesn’t, the problem could be motherboard–related.

- **Devices connected to the port cluster don’t work**—If ports in the port cluster are damaged or disabled in the system BIOS configuration (CMOS setup), any devices connected to the port cluster will not work.

- **Devices connected to header cables don’t work**—If ports connected to the header are not plugged into the motherboard, are damaged, or are disabled in the system BIOS configuration (CMOS setup), any devices connected to these ports will not work.

- **Mass storage drives are not recognized or do not work**—If mass storage ports on the motherboard are not properly connected to devices, are disabled, or are not configured properly, drives connected to these ports will not work.

- **Memory failures**—Memory failures could be caused by the modules themselves, or they could be caused by the motherboard.

- **Problems installing aftermarket processor heat sinks or replacement cards**—You cannot assume that every device fits every system.

The following sections help you deal with these common problems.
System Will Not Start

If the computer will not start, check the following:

- Incorrect front panel wiring connections to the motherboard
- Loose or missing power leads from power supply
- Loose or missing memory modules
- Loose BIOS chips
- Incorrect connection of EIDE/PATA cables to onboard host adapter
- Dead short in system
- Incorrect positioning of a standoff
- Loose screws or slot covers

The following sections describe each of these possible problems.

Incorrect Front Panel Wiring Connections to the Motherboard  The power switch is wired to the motherboard, which in turn signals the power supply to start. If the power lead is plugged into the wrong pins on the motherboard, or has been disconnected from the motherboard, the system will not start and you will not see an error message.

Check the markings on the front panel connectors, the motherboard, or the motherboard/system manual to determine the correct pinouts and installation. Figure 3-18 shows typical motherboard markings for front panel connectors (refer to Figure 3-15 for typical markings on front-panel wires).
**Loose or Missing Power Leads from Power Supply**  Modern power supplies often have both a 20- or 24-pin connection and a four- or eight-pin connection to the motherboard. If either or both connections are loose or not present, the system cannot start and you will not see an error message.

For details, see Chapter 5.

**Loose or Missing Memory Modules**  If the motherboard is unable to recognize any system memory, it will not start properly. Unlike the other problems, you will see a memory error message.

Make sure memory modules are properly locked into place, and that there is no corrosion on the memory contacts on the motherboard or on the memory modules themselves. To remove corrosion from memory module contacts, remove the memory modules from the motherboard and gently wipe the contacts off to remove any built-up film or corrosion. An Artgum eraser (but not the conventional rubber or highly abrasive ink eraser) can be used for stubborn cases. Be sure to rub in a direction away from the memory chips to avoid damage. Reinsert the modules and lock them into place.

**CAUTION**  Never mix tin memory sockets and gold memory module connectors, or vice versa. Using different metals for memory socket and module connectors has been a leading cause of corrosion.

**Loose BIOS Chips**  Socketed motherboard chips that don’t have retaining mechanisms, such as BIOS chips, can cause system failures if the chips work loose from their sockets. The motherboard BIOS chip (see Figure 3-19) is responsible for displaying boot errors, and if it is not properly mounted in its socket, the system cannot start and no error messages will be produced (note that many recent systems have surface-mounted BIOS chips).

The cycle of heating (during operation) and cooling (after the power is shut down) can lead to *chip creep*, in which socketed chips gradually loosen in the sockets. To cure chip creep, push the chips back into their sockets. Use even force to press a square BIOS chip into place. On older systems that use rectangular BIOS chips, alternately push on each end of the chip until the chip is securely mounted.

**NOTE**  Check your system or motherboard documentation to determine the location of the BIOS chip.

**Incorrect Connection of PATA/IDE Cables to Onboard Host Adapter**  Many systems are designed to wait for a response from a device connected to a PATA/IDE host adapter on the motherboard before continuing to boot. If the PATA/IDE cable is plugged in incorrectly, the system will never get the needed response, and some systems will not display an error message.
Chapter 3: Motherboards, Processors, and Adapter Cards

1. System BIOS chip
2. LPC I/O chip (for comparison)
3. PCI slots (for comparison)

Figure 3-19  If a socketed BIOS chip like this one becomes loose, the system will not boot.

Make sure pin 1 on the cable is connected to pin 1 on the EIDE/PATA device and the corresponding host adapter on the system. Check the motherboard manual for the position of pin 1 on the motherboard’s host adapter if the host adapter is not marked properly.

Dead Short (Short Circuit) in System  A dead short (short circuit) in your system will prevent a computer from showing any signs of life when you turn it on. Some of the main causes for dead shorts that involve motherboards include

- Incorrect positioning of a standoff
- Loose screws or slot covers

The following sections describe both possible causes.

Incorrect positioning of a standoff
Brass standoffs should be lined up with the mounting holes in the motherboard (refer to Figure 3-1 for typical locations). Some motherboards have two types of holes: plain holes that are not intended for use with brass standoffs (they might be used for heat sink mounting or for plastic standoffs) and reinforced holes used for brass standoffs. Figure 3.20 compares these hole types.

If a brass standoff is under a part of the motherboard not meant for mounting, such as under a plain hole or under the solder connections, the standoff could cause a dead short that prevents the system from starting.
Figure 3-20  Mounting holes compared to other holes on a typical motherboard.

Loose screws or slot covers

Leaving a loose screw inside the system and failing to fasten a slot cover or card in place are two common causes for dead shorts, because if these metal parts touch live components on the motherboard, your system will short out and stop working.

The solution is to open the case and remove or secure any loose metal parts inside the system. Dead shorts also can be caused by power supply–related problems.

For more about the power supply and dead shorts, see Chapter 5.

Devices Connected to the Port Cluster Don’t Work

The port cluster (refer to Figure 3-5) provides a “one–stop shop” for most I/O devices, but if devices plugged into these ports fail, check the disabled ports and possible damage to a port in the port cluster, as described in the following sections.

Disabled Port  If a port hasn’t been used before, and a device connected to it doesn’t work, be sure to check the system’s BIOS configuration to determine if the port is disabled. This is a particularly good idea if the port is a legacy port (serial/COM, parallel/LPT) or is the second network port. Ports can also be disabled using Windows Device Manager.

To learn how to manage integrated ports using the system BIOS setup, see Chapter 4 “BIOS.” To learn how to manage hardware using Windows Device Manager, see Chapter 15, “Troubleshooting and Maintaining Windows.”
Damage to a Port in the Port Cluster  If a port in the port cluster has missing or bent pins, it's obvious that the port is damaged, but don't expect all types of damage to be obvious. The easiest way to see if a port in the port cluster is damaged is to follow these steps:

**Step 1.** Verify that the port is enabled in the system BIOS and Windows Device Manager.

**Step 2.** Make sure the device cable is connected tightly to the appropriate port. Use the thumbscrews provided with serial/COM, parallel/LPT, and VGA or DVI video cables to assure a proper connection.

**Step 3.** If the device fails, try the device on another port or another system. If the device works, the port is defective. If the device doesn’t work, the device or the device’s cable is defective.

To solve the problem of a defective port, use one of these solutions:

- **Replace the motherboard with an identical model**— This is the best solution for long-term use. Note that if you replace the motherboard with a different model you might need to reinstall Windows, or, at a minimum, reinstall drivers and reactivate Windows and some applications.

- **Install an add-on card to replace the damaged port**— This is quicker than replacing the motherboard, but if you are replacing a legacy port such as serial/COM or parallel/LPT, it can be expensive. If the device that plugged into a legacy port can also use a USB port, use a USB port instead.

- **Use a USB/legacy port adapter**— Port adapters can be used to convert serial/COM or parallel/LPT devices to work on USB ports. However, note that some limitations might be present. Generally, this is the least desirable solution.

Devices Connected to Header Cables Don’t Work

Before assuming that a port that uses a header cable is defective or disabled, make sure the header cable is properly connected to the motherboard. If the system has just been assembled, or if the system has recently undergone internal upgrades or servicing, it’s possible the header cable is loose or disconnected.

If the header cable is properly connected to the motherboard, follow the steps in the previous section to determine the problem and solution.

**NOTE** Check system or motherboard documentation to determine how to properly connect header cables to the motherboard.
Mass Storage Devices Do Not Work Properly
Mass storage devices that connect to SATA, PATA/IDE, or SCSI host adapters on the motherboard will not work if either of the following are true, as described in the next sections:

- Mass storage ports are disabled in system BIOS or Windows
- Data or power cables are not properly connected to the motherboard or drives

Mass Storage Ports Disabled in System BIOS or Windows  Before assuming a mass storage device is defective, be sure to verify whether the port has been disabled in the system BIOS configuration (CMOS setup or in Windows Device Manager). If you cannot connect the device to another port, enable the port and retry the device. To learn how to manage integrated ports using the system BIOS setup, see Chapter 4. To learn how to manage hardware using the Windows Device Manager, see Chapter 15.

Data or Power Cables Are Not Properly Connected to the Motherboard or Drives   If internal upgrades or servicing has taken place recently, it’s possible that data or power cables have become loose or disconnected from the mass storage host adapters on the motherboard or the drives themselves. Before reconnecting the cables, shut down the computer and disconnect it from AC power.

For more about mass storage devices and cabling, see Chapter 12.

Memory Failures
Memory failures could be caused by the modules themselves, or they could be caused by the motherboard. For more information on memory problems and motherboards, see the section “Loose or Missing Memory Modules,” earlier in this chapter.

Card, Memory, or Heat Sink Blocked by Motherboard Layout
Internal clearances in late-model systems are very tight, and if you attempt to install some types of hardware in some systems, such as an oversized processor heat sink or a very large video card, it might not be possible because of the motherboard’s layout.

Before purchasing an aftermarket heat sink, check the clearances around the processor. Be especially aware of the location of capacitors and the voltage regulator; if the heat sink is too large, it could damage these components during installation. To help verify that an aftermarket heat sink will fit properly, remove the original heat sink from the processor and take it with you to compare its size to the aftermarket models you are considering.

Before purchasing an expansion card, check the slot clearance to be sure the card will fit into the desired expansion slot. In some cases, you might need to move a card
from a neighboring slot to make room for the cooling fan shroud on some high-performance graphics cards.

**Processors and CPUs**

To do well on A+ Certification exams, you must understand the major types of processors available for recent systems, their technologies, how to install them, and how to troubleshoot them.

**Overview of Processor Differences**

Although Intel and AMD processors share two common architectures, x86 (used for 32-bit processors and for 64-bit processors running in 32-bit mode) and x64 (an extension of x86 that enables larger files, larger memory sizes, and more complex programs), these processor families differ in many ways from each other, including:

- Different processor sockets
- Different types of microcode
- Differences in dual-core, triple-core, and quad-core designs (two or more processor cores help run multiple programs and programs with multiple execution threads more efficiently)
- Cache sizes (cache memory stores a copy of recently-read memory locations to help improve system performance; L1 cache is in the processor core; L2 and L3 cache are in the processor module but outside the core)
- Performance versus clock speed

**Intel Processors**

Intel processors developed from 2000 to the present include the following product families:

- Pentium III
- Pentium 4
- Pentium D
- Celeron
- Core 2 Duo
- Core 2 Quad
- Core i3
- Core i5
- Core i7
The Pentium III processor was the last Intel processor produced in both a slot-based and socket-based design. Slot-based versions use Slot 1, the same slot design used by the Pentium II and slot-based Celeron processors. Socketed versions use Socket 370, which is mechanically the same as the socket used by the first socketed Celeron processors. However, some early Socket 370 motherboards are not electrically compatible with the Pentium III.

The Pentium 4 replaced the Pentium III and ran at much higher clock speeds. Early versions used Socket 423, a socket used by no other Intel processor. Most Pentium 4 designs used Socket 478, while late-model Pentium 4 designs used Socket 775, which is also used by current Intel processors. The different sockets used by the Pentium 4 were necessary because of substantial design changes throughout the processor’s lifespan, including the introduction of 64-bit extensions (x64).

The Pentium 4’s successor was the Pentium D, which is essentially two Pentium 4 processor cores built into a single physical processor. Although it used the same Socket 775 as late-model Pentium 4 processors, it required support from different chipsets because data was transferred between processor cores via the Memory Controller Hub (North Bridge) component. The Pentium D was Intel’s first dual-core processor. The Pentium Extreme Edition is a faster version of the Pentium D designed for gaming or other high-performance tasks. The Pentium D and Pentium Extreme Edition both support x64 extensions, as does the Core 2 Duo.

The Pentium D was replaced by the Core and Core 2 families of processors. The Core and Core 2 families use processor architectures that emphasize real-world performance over clock speed. The first Core 2 processors were the Core 2 Duo (featuring two processor cores), followed by the Core 2 Quad models (with four processor cores). Although Core 2 processors run at much slower clock speeds than the fastest Pentium 4 or Pentium D processors, they perform much better in real-world operations. Core processors are single-core, while Core Duo and Core 2 Duo are dual-core. Core, Core Solo, and Core Duo processors are x86 (32-bit), while Core 2 Duo, Quad, and Extreme processors are x64 (64-bit).

The most recent processors in the Core family include the Core i7, Core i5, and Core i3, all of which support x64 (64-bit) processing. The Core i7 features quad core or six core designs with Intel HT Technology (hyperthreading, which supports two processor threads per core), Intel VT-x hardware-assisted virtualization, and Intel Turbo Boost overclocking. Core i5 is a simplified version of the Core i7, with only a few dual-core models supporting HT Technology (quad-core Core i5 does not support HT Technology); however, all Core i5 desktop processors include VT-x and Turbo Boost and some also include integrated graphics. Core i3 processors are

---

**NOTE** Intel’s Centrino technology refers to a combination of the Core 2 Duo and certain Intel chipsets made for mobile computers.
dual-core with support for HT Technology, VT-x, and integrated graphics, but lack Turbo Boost. Note that mobile processors with these same model numbers differ in some details.

Celeron is actually a brand name rather than a specific processor design. Celeron processors have been based on the Pentium II, Pentium III, Pentium 4, and Core 2 processors. However, they feature lower clock speeds, slower front side bus speeds (the clock speed of the memory bus), and smaller L2 caches, making them less powerful (and less expensive) processors than the designs they’re based on. Very few Celeron models support x64 extensions.

Because most Intel processor families have gone through many changes during their lifespans, specific models are sometimes referred to by their code names. In an attempt to make it easier to understand the performance and feature differences of models in a particular processor family, Intel has assigned processor numbers to recent versions of the Pentium 4, as well as all more recent processors.

Table 3-5 provides a brief summary of Intel desktop processors produced from 1998 to mid 2010. For additional details, see *Upgrading and Repairing PCs, 19th Edition* by Scott Mueller (Que Publishing).

**Table 3-5** Intel Desktop Processors from Pentium III through Core i7

<table>
<thead>
<tr>
<th>Processor</th>
<th>Code Names</th>
<th>Clock Speed Range</th>
<th>FSB Speed</th>
<th>Processor Socket or Slot</th>
<th>L2 Cache Sizes</th>
<th>Based On or Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pentium III</td>
<td>Katmai, Coppermine, Coppermine-T, Tualatin</td>
<td>450MHz–1.3GHz</td>
<td>100MHz, 133MHz</td>
<td>Slot 1, Socket 370</td>
<td>256KB or 512KB</td>
<td>—</td>
</tr>
<tr>
<td>Celeron</td>
<td>Coppermine-128, Tualatin 256</td>
<td>533MHz–1.4GHz</td>
<td>66MHz, 100MHz</td>
<td>Slot 1, Socket 370</td>
<td>128KB, 256KB</td>
<td>Pentium III</td>
</tr>
<tr>
<td>Pentium 4</td>
<td>Willamette, Northwood, Prescott, Cedar Mill</td>
<td>1.4GHz–3.8GHz</td>
<td>400MHz, 533MHz, 800MHz</td>
<td>Socket 423, Socket 478, Socket 775</td>
<td>256KB, 512KB, 1MB, 2MB</td>
<td>—</td>
</tr>
<tr>
<td>Pentium 4 Extreme Edition</td>
<td>Gallatin, Prescott 2M</td>
<td>3.2GHz–3.733GHz</td>
<td>800MHz</td>
<td>Socket 775</td>
<td>512KB+2 MB L3 or 2MB</td>
<td>Pentium 4 Prescott</td>
</tr>
<tr>
<td>Celeron</td>
<td>Willamette-128, Northwood-128</td>
<td>1.7GHz–2.8GHz</td>
<td>400MHz</td>
<td>Socket 478</td>
<td>128KB</td>
<td>Pentium 4 Willamette, Northwood</td>
</tr>
<tr>
<td>Celeron D</td>
<td>Prescott-256, Cedar Mill-512</td>
<td>2.13GHz–3.6GHz</td>
<td>533MHz</td>
<td>Socket 478, Socket 775</td>
<td>256KB, 512KB</td>
<td>Pentium 4 Prescott, Cedar Mill</td>
</tr>
<tr>
<td>Processor</td>
<td>Code Names</td>
<td>Clock Speed Range</td>
<td>FSB Speed</td>
<td>Processor Socket or Slot</td>
<td>L2 Cache Sizes</td>
<td>Based On or Notes</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------</td>
<td>-------------------------</td>
<td>--------------------</td>
<td>--------------------------</td>
<td>----------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>Pentium D Smithfield</td>
<td></td>
<td>2.66GHz–3.66GHz</td>
<td>533MHz, 800MHz</td>
<td>Socket 775</td>
<td>1MB×2 or 2MB ×2</td>
<td>Dual-core version of Pentium 4 Prescott</td>
</tr>
<tr>
<td>Pentium Extreme Edition</td>
<td>Smithfield</td>
<td>3.73GHz</td>
<td>800MHz</td>
<td>Socket 775</td>
<td>2MB×2</td>
<td>Pentium 4 Prescott</td>
</tr>
<tr>
<td>Core 2 Duo Conroe, Wolfdale, Allendale</td>
<td></td>
<td>1.80GHz–3.33GHz</td>
<td>800MHz, 1066MHz, 1333MHz</td>
<td>Socket 775</td>
<td>2MB, 4MB, 6MB</td>
<td>Dual-core version of Core (notebook processor)</td>
</tr>
<tr>
<td>Core 2 Extreme Conroe XE</td>
<td></td>
<td>2.93GHz</td>
<td>1066MHz</td>
<td>Socket 775</td>
<td>4MB</td>
<td>Core 2 Duo Conroe</td>
</tr>
<tr>
<td>Celeron Conroe L</td>
<td></td>
<td>1.2–2.2GHz</td>
<td>800MHz</td>
<td>Socket 775</td>
<td>512KB</td>
<td>Single-core version of Core 2 Duo Conroe</td>
</tr>
<tr>
<td>Celeron Allendale-512</td>
<td></td>
<td>1.6–2.4GHz</td>
<td>800MHz</td>
<td>Socket 775</td>
<td>512KB</td>
<td>Core 2 Duo Allendale</td>
</tr>
<tr>
<td>Core 2 Quad Kentsfield</td>
<td></td>
<td>2.4–2.6GHz</td>
<td>1066MHz</td>
<td>Socket 775</td>
<td>4MB×2</td>
<td>Two Core 2 Duo Conroe cores</td>
</tr>
<tr>
<td>Core 2 Quad Yorkfield</td>
<td></td>
<td>2.26–3.0 GHz</td>
<td>1333MHz</td>
<td>Socket 775</td>
<td>3MB×2, 6MB×2</td>
<td>Integrated quad-core design</td>
</tr>
<tr>
<td>Core 2 Extreme Kentsfield XE</td>
<td></td>
<td>2.66–3.0 GHz</td>
<td>1066MHz, 1333MHz</td>
<td>Socket 775</td>
<td>4MB×2</td>
<td>Core 2 Quad Kentsfield</td>
</tr>
<tr>
<td>Core 2 Extreme Yorkfield XE</td>
<td></td>
<td>3.0–3.2GHz</td>
<td>1333MHz, 1600MHz</td>
<td>LGA-771</td>
<td>6MB×2</td>
<td>Core 2 Quad Yorkfield</td>
</tr>
<tr>
<td>Core i3 Clarkdale</td>
<td></td>
<td>2.93–3.33GHz</td>
<td>1066MHz, 1333MHz</td>
<td>FCLGA-1156</td>
<td>4MB</td>
<td>Clarkdale used for Core i3, Core i5</td>
</tr>
</tbody>
</table>
AMD Processors

AMD processors contemporary with the Intel Pentium III and its successors include the following processor families as of mid 2010:

- Athlon
- Duron
- Athlon XP
- Sempron
- Athlon 64
- Athlon 64 FX
- Athlon 64 X2
- Phenom X3
- Phenom X4
- Phenom II X2
- Phenom II X3
- Phenom II X4
- Phenom II x6
The Athlon processor was the first (and last) AMD processor produced in a slot-based design. It uses Slot A, which physically resembled Slot 1 used by Intel Pentium II and Pentium III models, but was completely different in its pinout. Later versions of the Athlon switched to Socket A, a 462-pin socket, which was also used by the Duron, Athlon XP, and Socket A versions of the Sempron.

The Athlon XP replaced the Athlon, and featured higher clock speeds and larger L2 cache. The lower-performance counterpart of the Athlon and Athlon XP was the Duron, which featured a smaller L2 cache and slower FSB speed.

The Athlon XP design was used for the Socket A versions of the Sempron when AMD moved to 64-bit processing with the introduction of the Athlon 64, AMD’s first 64-bit desktop processor.

The Athlon 64 family initially used Socket 754, but because the memory controller is built into the processor, rather than into the North Bridge as on conventional processors, it was necessary to develop a new Socket 939 to support dual-channel memory.

The Athlon 64 FX is a faster performance-oriented version of the Athlon 64. Initial versions were based on the Opteron workstation and server processor, and thus used Socket 940. Later versions used Socket 939 and its successor, Socket AM2.

AMD’s first dual-core processor was the Athlon 64 X2, which uses a design that permits both processor cores to communicate directly with each other, rather than using the North Bridge (Memory Controller Hub) as in the Intel Pentium D. This enabled upgrades from Socket 939 Athlon 64 to the X2 version after performing a BIOS upgrade.

AMD’s economy version of the Athlon 64 is also called the Sempron, various versions of which have used Socket 754 and Socket 939.

AMD’s Phenom series is based on the AMD K10 processor architecture, and all Phenoms include multiple processor cores that are built as a single unit. Phenom II is an improved version of Phenom, featuring a smaller process, more cache, and better cache management. The Phenom II series uses a more efficient socket and increases the total possible amount of processor cores to 6. Processor speeds are also increased in this series. These processors use a more powerful chipset. The chipset is the main controller of the motherboard. When selecting an AMD processor, the motherboard’s chipset should be taken into account to ensure compatibility.

AMD’s Athlon II series is available in dual-core, triple-core, quad-core, and six-core versions (X2, X3, X4, and X6).

Because most AMD processor families have gone through many changes during their lifespans, specific models are sometimes referred to by their code names.

Table 3-6 provides a brief summary of AMD desktop processors produced over the last decade. For additional details, see *Upgrading and Repairing PCs, 19th Edition.*
<table>
<thead>
<tr>
<th>Processor</th>
<th>Code Names</th>
<th>Clock Speed Range</th>
<th>FSB Speed</th>
<th>Processor Socket or Slot</th>
<th>L2 Cache Sizes</th>
<th>Based On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athlon K7, K75, Thunderbird</td>
<td>500MHz–1.4GHz</td>
<td>200–266 MHz</td>
<td>Slot A, Socket A (aka Socket 462)</td>
<td>256–512KB</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Athlon XP Palomino, Thoroughbred, Thorton</td>
<td>1.333–2.2 GHz</td>
<td>266–400 MHz</td>
<td>Socket A</td>
<td>256–512 KB</td>
<td>—</td>
<td>Athlon Socket A</td>
</tr>
<tr>
<td>Duron Spitfire, Morgan, Applebred, Appaloosa</td>
<td>550MHz–1.8GHz</td>
<td>200–266 MHz</td>
<td>Socket A</td>
<td>64KB</td>
<td>Athlon Socket A</td>
<td></td>
</tr>
<tr>
<td>Sempron Thorton, Barton</td>
<td>1.5–2.2GHz</td>
<td>166–200 MHz</td>
<td>Socket A</td>
<td>256KB (Thorton), 512KB (Barton)</td>
<td>Athlon XP</td>
<td></td>
</tr>
<tr>
<td>Sempron Paris, Palermo</td>
<td>1.4–2.0 GHz</td>
<td>800MHz–1GHz</td>
<td>Socket 754</td>
<td>128–256 KB</td>
<td>Athlon 64 (Socket 754 versions)</td>
<td></td>
</tr>
<tr>
<td>Athlon 64 ClawHammer, Newcastle, San Diego, Venice, Orleans</td>
<td>1–2.6GHz</td>
<td>800MHz–1GHz</td>
<td>Socket 754, 939, 940, 940, Socket AM2</td>
<td>512KB–1MB</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Sempron Palermo</td>
<td>1.8–2.0GHz</td>
<td>800MHz</td>
<td>Socket 939</td>
<td>128KB–256KB</td>
<td>Athlon 64</td>
<td></td>
</tr>
<tr>
<td>Athlon 64 FX See Athlon 64 code names; also Windsor</td>
<td>2.2–2.8GHz</td>
<td>800MHz–1GHz</td>
<td>Socket 939, 940</td>
<td>1MB</td>
<td>Athlon 64</td>
<td></td>
</tr>
<tr>
<td>Sempron Manila, Sparta</td>
<td>1.6–2.3GHz</td>
<td>800MHz</td>
<td>Socket AM2</td>
<td>128–256–512KB</td>
<td>Athlon 64</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3-6  AMD Desktop Processors from Athlon through Phenom II

<table>
<thead>
<tr>
<th>Processor</th>
<th>Code Names</th>
<th>Clock Speed Range</th>
<th>FSB Speed</th>
<th>Processor Socket or Slot</th>
<th>L2 Cache Sizes</th>
<th>Based On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athlon 64 X2</td>
<td>Manchester, Toledo, Windsor, Brisbane</td>
<td>1.9–3.2GHz</td>
<td>1GHz</td>
<td>Socket 939 (Manchester, Toledo), Socket AM2 (Windsor, Brisbane)</td>
<td>256KB×2; 512KB×2; 1MB×2</td>
<td>Dual-core version of Athlon 64</td>
</tr>
<tr>
<td>Athlon 64 FX</td>
<td>Toledo, Windsor</td>
<td>2.0–3.2GHz</td>
<td>1GHz</td>
<td>Socket 939 (Toledo), Socket AM2 (Brisbane)</td>
<td>1MB×2</td>
<td>Dual-core version of Athlon 64 FX</td>
</tr>
<tr>
<td>Phenom X4</td>
<td>Agena</td>
<td>1.8–2.6GHz</td>
<td>1.6-2GHz</td>
<td>Socket AM2</td>
<td>512KB×4 + 2MB L3</td>
<td>K10 microarchitecture</td>
</tr>
<tr>
<td>Phenom X3</td>
<td>Toliman</td>
<td>2.1–2.5GHz</td>
<td>1.6-1.8GHz</td>
<td>Socket AM2</td>
<td>512KB×3 + 2MB L3</td>
<td>K10 microarchitecture</td>
</tr>
<tr>
<td>Phenom X2</td>
<td>Kuma</td>
<td>2.3–2.8GHz</td>
<td>1.8GHz</td>
<td>Socket AM2+</td>
<td>512KB×2 + 2MB L3</td>
<td>K10 microarchitecture</td>
</tr>
<tr>
<td>Athlon X2</td>
<td>Kuma</td>
<td>2.3–2.8GHz</td>
<td>1.8GHz</td>
<td>Socket AM2+</td>
<td>512KB×2 + Phenom X2</td>
<td>2MB L3</td>
</tr>
<tr>
<td>Phenom II X2</td>
<td>Callisto</td>
<td>2.8–3.3GHz</td>
<td>2GHz, 2.2GHz</td>
<td>Socket AM3</td>
<td>512KB×2 + 6MB L3</td>
<td>Deneb with two cores disabled</td>
</tr>
<tr>
<td>Phenom II X3</td>
<td>Heka</td>
<td>2.4–3.2GHz</td>
<td>2GHz</td>
<td>Socket AM3</td>
<td>512KB×3 + 6MB L3</td>
<td>Deneb with one core disabled</td>
</tr>
<tr>
<td>Phenom II X4</td>
<td>Deneb</td>
<td>2.5–3.5GHz</td>
<td>1.8GHz, 2GHz</td>
<td>Socket AM2+, AM3</td>
<td>512KB×4 + 4MB or 6MB L3</td>
<td>DDR3 memory supported on Socket AM3 only</td>
</tr>
</tbody>
</table>
Processor Sockets and Packaging

Most processors listed in the previous sections use some form of the pin grid array (PGA) package, in which pins on the bottom of the processor plug into holes in the processor socket. The exceptions include slot-mounted processors (Slot 1 and Slot A) and the current LGA and FCLGA sockets, which use a different type of processor package called the land grid array (LGA). LGA packaging uses gold pads on the bottom of the processor package to connect with raised leads in the processor socket.

Figure 3-21 compares processor packages and sockets to each other.
Figure 3-21  Intel and AMD processors and sockets.

CPU Technologies

Processor technologies in the following sections might be used by AMD only, by Intel only, or by both vendors. These technologies are used to help distinguish different processors from each other in terms of performance or features.

Hyperthreading (HT Technology)

Hyperthreading (HT Technology) is a technology developed by Intel for processing two execution threads within a single processor. Essentially, when HT Technology is enabled in the system BIOS and the processor is running a multithreaded application, the processor is emulating two physical processors. The Pentium 4 was the first desktop processor to support HT Technology, which Intel first developed for its Xeon workstation and server processor family.

Pentium 4 processors with processor numbers all support HT Technology, as do older models with 800MHz FSB and a clock speed of 3.06GHz or higher. HT
Technology is also incorporated in a number of more recent dual-core, quad-core, and six-core processors in the Core 2, Core i5, and i7 series to further improve the execution of multithreaded applications.

**Dual-Core and Multi-Core**

Two or more physical processors in a system enable it to perform much faster when multitasking or running multithreaded applications. However, systems with multiple processors are very expensive to produce and some operating systems cannot work with multiple processors. Dual core processors, which combine two processor cores into a single physical processor, provide virtually all of the benefits of two physical processors, and are lower in cost and work with any operating system that supports traditional single-core processors.

The first dual-core desktop processors were introduced by Intel (Pentium D) and AMD (Athlon 64 X2) in 2005. Athlon 64 X2’s processor cores communicate directly with each other, enabling systems running single-core Athlon 64 processors to swap processors after a simple BIOS upgrade. The Pentium D, on the other hand, required new chipsets to support it. Core 2 Duo, Core i3, and some versions of the Core i5 represent major current dual-core processor families. Like the AMD Athlon 64 X2 and newer AMD dual-core processors, these processors’ cores communicate directly with each other.

Both Intel and AMD have released processors that include more than two cores. Intel’s Core 2 Quad, Core i7, and some versions of the Core 2 Extreme contain four or more processor cores, while AMD’s Phenom and Phenom II are available in versions with two, three, four, or more processor cores.

**Processor Throttling**

Processors do not need to run at full speed when they have little, or no, work to perform. By slowing down—or throttling—the processor's clock speed when the workload is light, the processor runs cooler, the system uses less energy, and—in the case of mobile systems—the computer enjoys a longer battery life. Throttling, sometimes referred to as thermal throttling, can also take place when a processor gets too hot for the computer’s cooling system to work properly.

Intel uses the terms SpeedStep or Enhanced SpeedStep for its throttling technologies. AMD uses the term Cool’n’Quiet for its throttling technology.

**Microcode (MMX)**

All Intel and AMD processors in current use include various types of microcode instructions for boosting multimedia performance. The first processor to include this type of microcode was the Pentium MMX, which included 57 new instructions (known as MMX) for working with multimedia. MMX was the first example of what is known as single instruction, multiple data (SIMD) capability.
Later Intel processors included enhanced versions of MMX known as SSE (MMX+70 additional instructions, introduced with the Pentium III), SSE2 (MMX+SSE+144 new instructions, introduced with the Pentium 4), SSE3 (MMX+SSE+SSE2+13 new instructions, introduced with the Pentium 4 Prescott), and, most recently, SSSE3 (MMX+SSE+SSE2+SSE3+32 new instructions, introduced with the Core 2 Duo). The SSE4 instruction set, which adds 51 new instructions, was introduced with the introduction of 45nm processor technology in the Penryn versions of the Core 2 Duo and subsequent processors. SSE4.1 is a subset of SSE4, containing 47 instructions. SSE4.2 includes the seven remaining instructions and was introduced with the Core i7. The term “HD Boost” refers to SSE4 support.

AMD also provides multimedia-optimized microcode in its processors, starting with 3DNow! (introduced by the K6, which was roughly equivalent to the Pentium MMX). However, AMD’s version differs in details from Intel’s, offering 21 new instructions. The AMD Athlon introduced 3DNow! Enhanced (3DNow!+24 new instructions), while the Athlon XP introduced 3DNow! Professional (3DNow!+Enhanced+51). 3DNow! Professional is equivalent to Intel’s SSE. Starting with the Athlon 64 family, AMD now supports SSE2, and it added SSE3 support to the Athlon 64 X2 and newer versions of the Athlon 64 family. AMD also supports four SSE4 instructions as well as two SSE instructions known as SSE4a.

Overclocking

Overclocking refers to the practice of running a processor or other components, such as memory or the video card’s graphics processing unit (GPU) at speeds higher than normal. Overclocking methods used for processors include increasing the clock multiplier or running the front side bus (FSB) at faster speeds than normal. These changes are performed by altering the normal settings in the system BIOS setup for the processor’s configuration. Figure 3-22 is a typical BIOS processor configuration screen.

Most processors feature locked clock multipliers. That is, the clock multiplier frequency cannot be changed. In such cases, the only way to overclock the processor is to increase the front side bus speed, which is the speed at which the processor communicates with system memory. Increasing the FSB speed can lead to greater system instability than changing the clock multipliers.

Some processors from Intel and AMD feature unlocked clock multipliers, so that the user can choose the best method for overclocking the system. Overclocked processors and other components run hotter than normal, so techniques such as using additional cooling fans, replacing standard active heat sinks with models that feature greater cooling, and adjusting processor voltages are often used to help maintain system stability at faster speeds.

Intel’s Core i7, Core i5, and AMD’s Phenom II series support automatic overclocking according to processor load. Intel refers to this feature as Turbo Boost, while AMD’s term is Turbo Core.
Cache

Cache memory, as mentioned previously, improves system performance by enabling the processor to reuse recently retrieved memory locations without needing to fetch them from main memory. Processors from AMD and Intel feature at least two levels of cache:

- **Level 1 (L1) cache** is built into the processor core. L1 cache is relatively small (8KB–64KB). When the processor needs to access memory it checks the contents of L1 cache first.

- **Level 2 (L2) cache** is also built into the processor. On older slot-mounted processors, L2 cache was external to the processor die, and ran at slower speeds than the processor. On socketed processors, L2 cache is built into the processor die. If the processor does not find the desired memory locations in L1 cache, it checks L2 cache next.

- **Level 3 (L3) cache** is found on some very high-performance processors from Intel (such as the Core i7 series) and on several high-performance and mid-level processors from AMD. L3 is also built into the processor die. On systems with L3 cache, the processor checks L3 cache after checking L1 and L2 caches.

If cache memory does not contain the desired information, the processor retrieves the desired information from main memory, and stores copies of that information in its cache memory (L1 and L2, or L1, L2, and L3). Processors with larger L2 caches...
(or L2 and L3 caches) perform most tasks much more quickly than processors that have smaller L2 caches for two reasons. Cache memory is faster than main memory, and the processor checks cache memory for needed information before checking main memory.

**VRM**

Starting with Socket 7 versions of the Intel Pentium, processors have not received their power directly from the power supply. Instead, a device called a voltage regulator module (VRM) has been used to reduce 5V or 12V DC power from the power supply to the appropriate power requested by the processor through its voltage identification (VID) logic.

Although some motherboards feature a removable VRM, most motherboards use a built-in VRM that is located next to the processor socket, as shown in Figure 3-23.

![Figure 3-23](image) A portion of the VRM on an Athlon 64 motherboard.

**NOTE** Be sure to determine the free space around a processor before ordering or installing a third-party active heat sink. Some motherboards have VRM components located so close to the processor that some heat sinks will not fit.

**Speed (Real Versus Actual): Clock Speed Versus Performance**

A common measurement of processor performance has been clock speed. However, clock speed can be misleading. For example, the Intel Core 2 Duo and AMD Athlon 64 X2 processors perform computing tasks much more quickly than the Pentium D, even though the Pentium D runs at a much higher clock speed.
To determine the actual performance of a processor, you should use benchmark tests such as Futuremark's SYSmark, PCMark, and 3DMark.

32-bit Versus 64-bit

Processors developed before the AMD Athlon 64 were designed only for 32-bit operating systems and applications. 32-bit software cannot access more than 4GB of RAM (in fact, 32-bit Windows programs can use only 3.25GB of RAM), which makes working with large data files difficult, as only a portion of a file larger than the maximum memory size can be loaded into memory at one time.

The Athlon 64 was the first desktop processor to support 64-bit extensions to the 32-bit x86 architecture. These 64-bit extensions, commonly known as x64, enable processors to use more than 4GB of RAM and run 64-bit operating systems, but maintain full compatibility with 32-bit operating systems and applications.

Late-model Pentium 4 processors from Intel also support x64, as do subsequent processors such as the Pentium 4 Extreme Edition, Pentium D, Pentium Extreme Edition, Core 2 Duo, Core 2 Quad, Core 2 Extreme, Core i3, Core i5, and Core i7. Subsequent AMD processors including the Athlon X2, Athlon II, Phenom, and Phenom II also support x64. Most processors made today support x64 operation.

NOTE  To learn more about a particular processor’s support for x64 operation, hardware virtualization, and other features, look up the processor specifications at the manufacturer’s website.

Choosing the Best Processor for the Job

If you are buying or building a new system, you have free rein in the choice of a processor to build the system around. This section describes important considerations.

Performance

If you need a system that can handle high-resolution graphics and video, and can perform heavy-duty number crunching, get the fastest dual-core or multi-core processor you can afford. However, if your requirements are less extreme, you can save money for your clients by opting for a processor from the same family with slower clock speed or less cache memory.

Thermal Issues

Many processor models are available in two or more versions that differ in their thermal requirements; that is, the type of active heat sink necessary to cool them and the amount of power (in watts) needed to operate them. This figure is often referred to as Max TDP (maximum thermal design power). In a mid-tower or full
tower system, these considerations might be less important than in a micro-tower or small form factor system, or a system that might need to run as quietly as possible.

32-bit Versus 64-bit (x64) Compatibility

Unless you are trying to build the least-expensive system possible, you will find it difficult to find 32-bit only processors today. However, if you are repurposing existing systems, you might need to determine which systems include processors with support for 64-bit operation, and which support only 32-bit operation.

Other Processor Features

Processor features such as NX (no execute, which provides hardware-based protection against some types of viruses and malware) and hardware-based virtualization (which enables a single processor to be split into multiple virtual machines with little or no slowdown) are also important to consider in business environments. Check the specification sheets provided by processor vendors to determine the exact features supported by a particular processor.

**TIP** To help determine detailed information for current and late-model installed Intel processors (Pentium 4, Celerons based on the Pentium 4 and newer), use the Intel Processor Identification Utility available from the Intel website (www.intel.com). For older Intel processors, use the Intel Processor Frequency ID Utility, also available from the Intel website.

To help determine detailed information for installed AMD and Intel processors, download and install CPU-Z from the CPUID website (www.cpuid.com).

Installing Processors

Processors are one of the most expensive components found in any computer. Because a processor can fail, or more likely, might need to be replaced with a faster model, knowing how to install and remove processors is important. On the A+ Certification exams, you should be prepared to answer questions related to the safe removal and replacement of socketed processors.

The methods used for CPU removal vary according to two factors: the processor type and the socket/slot type.

As you saw in Tables 3-5 and 3-6, most recent processors are socketed. Before the development of the ZIF socket, the processor was held in place by tension on the chip’s legs, pins, or leads. Thus, to remove these chips, you must pull the chip out of the socket. Because the chip’s legs, pins, or leads are fragile, special tools are strongly recommended for removing chips that are not mounted in ZIF sockets.
Before removing and installing any CPU or other internal component, be sure to review and follow the ESD precautions discussed in Chapter 17.

Removing the Heat Sink

ZIF sockets are used on almost all desktop systems using Pentium III-class or newer socketed processors (except for processors using LGA sockets). They allow easy installation and removal of the processor.

What makes ZIF sockets easy to work with? They have a lever that, when released, loosens a clamp that holds the processor in place.

If the processor has a removable heat sink, fan, or thermal duct that is attached to the motherboard, you must remove these components before you can remove the processor.

Heat sinks used on Socket 370 and Socket A processors have a spring-loaded clip on one side and a fixed lug on the other side. To release this clip, press down on it using a screwdriver, as shown in Figure 3-24.

![Figure 3-24](image)

Figure 3-24 Releasing the spring clip on a Socket A processor's heat sink.
Most newer processors use heat sinks that are attached to a frame around the processor or are mounted through the motherboard. To release these heat sinks, you might need to flip up a lever on one side of the heat sink or release the locking pins. Figure 3-25 illustrates a typical installation on an Athlon 64 processor, and Figure 3-26 illustrates the components of a typical heat sink for LGA 775 processors.

1. Locking lever
2. Power lead for heat sink fan
3. Heat sink frame
4. Processor
5. Motherboard power connector for heat sink fan

**Figure 3-25** Typical heat sink assembly on Athlon 64 processor.

**Figure 3-26** Stock heat sink assembly for Intel Core 2 Duo LGA 775 processor.
BTX systems use a horizontally mounted thermal module that is equipped with a fan. The thermal module also helps cool other components such as the motherboard chipset and memory. Figure 3-27 illustrates a typical thermal module installed on a motherboard. Note that the front of the thermal module extends below the edge of the motherboard to provide cooling for both top and bottom.

To remove a thermal module from a BTX motherboard, follow these steps:

**Step 1.** Remove the screws that attach the module to the retention bracket on the underside of the motherboard.

**Step 2.** Disconnect the thermal module’s fan power lead.

**Step 3.** Lift the thermal module off the processor.

Be careful when removing head sinks or thermal modules. Be careful not to drop the heat sink or thermal module on the CPU or on the motherboard. Heat sinks and thermal modules are bulky and heavy and can easily damage the expensive parts of your computer.

**Removing the Processor**

**Figure 3-27** Thermal module placement on a typical BTX motherboard. Figure courtesy of www.Formfactors.org.
After removing the heat sink, follow these instructions to complete the processor removal process.

**Step 1.** Disconnect the active heat sink (if included) from its power source and lift the assembly away.

**Step 2.** Push the lever on the ZIF socket slightly to the outside of the socket to release it.

**Step 3.** Lift the end of the lever until it is vertical (see Figure 3-28). This releases the clamping mechanism on the processor’s pins.

![Figure 3-28](image)

*Figure 3-28*  After the heat sink fan is disconnected from power (left) to reveal the processor (center), the lever on the ZIF socket (right) can be lifted to release the processor.

**Step 4.** Grasp the processor on opposite sides, making sure not to touch the pins, and remove it from the socket. Put it into antistatic packaging.

The process of removing an LGA-based processor is a bit different:

**Step 1.** Disconnect the active heat sink (if included) from its power source and lift the assembly away.

**Step 2.** Lift the locking lever to release the load plate, which holds the processor in place.

**Step 3.** Carefully lift the processor away and place it into antistatic packaging.

Be careful when removing the processor and when unlocking any sockets. These components are very delicate. Think of yourself as a watchmaker when dealing with these parts!

**Installing a New Processor**

Before installing a new processor, verify that the processor you plan to install is supported by the motherboard. Even though a particular combination of processor and motherboard might use the same socket, issues such as BIOS, voltage, memory support, or chipset considerations can prevent some processors from working on
particular motherboards. You can destroy a processor or motherboard if you install a processor not suitable for a particular motherboard.

After verifying compatibility by checking the system or processor manual (and installing any BIOS updates required for processor compatibility), check a PGA-type processor for bent pins, and the socket of an LGA processor for bent leads. Correct these problems before continuing.

To insert a PGA-type CPU into a ZIF socket, find the corner of the chip that is marked as pin 1 (usually with a dot or triangle). The underside of some chips might be marked with a line pointing toward pin 1. Then follow these steps:

**Step 1.** Line up the pin 1 corner with the corner of the socket also indicated as pin 1 (look for an arrow or other marking on the motherboard). If you put the chip in with pin 1 aligned with the wrong corner and apply the power, you will destroy the chip.

**Step 2.** Make sure the lever on the ZIF socket is vertical; insert the CPU into the socket and verify that the pins are fitting into the correct socket holes.

**Step 3.** Lower the lever to the horizontal position and snap it into place to secure the CPU.

**Step 4.** Before attaching the heat sink or fan, determine if the heat sink has a thermal pad (also called a phase-change pad) or if you need to apply thermal compound to the processor core (refer to Figure 3-27). Remove the protective tape from the thermal pad or apply thermal compound as needed. Attach the heat sink or fan. You must use some type of thermal compound between the processor and the bottom of the heat sink.

**Step 5.** Attach the heat sink to the processor as directed by the processor vendor (for heat sinks supplied with the processor) or heat sink vendor (for aftermarket heat sinks). In some cases, you might need to attach mounting hardware to the motherboard before you can attach the heat sink.

**Step 6.** If you are installing an active heat sink (a heat sink with a fan), plug the fan into the appropriate connector on the motherboard.

To insert an LGA processor, locate the notches on each side of the processor. These correspond with key tabs in the processor socket. Then follow these steps:

**Step 1.** Make sure the load plate assembly is completely open. It has a plastic cover that can be removed at the end of Step 5.

**Step 2.** Line up the notches in the processor with the key tabs in the processor socket. This assures that the processor’s Pin 1 is properly aligned with the socket.
Step 3. Lower the processor into place, making sure the metal heat spreader plate faces up and the gold pads face down. Do not drop the processor, as the lands in the processor socket could be damaged.

Step 4. Push down the load plate and close the load plate assembly cam lever.

Step 5. Lock the lever in place on the side of the socket. Remove the plastic cover and save it for future use.

Step 6. Before attaching the heat sink or fan, determine if the heat sink has a thermal pad (also called a phase-change pad) or if you need to apply thermal compound to the processor core (refer to Figure 3-27). Remove the protective tape from the thermal pad or apply thermal compound as needed. Attach the heat sink or fan. You must use some type of thermal compound between the processor and the bottom of the heat sink.

Step 7. Attach the heat sink to the processor as directed by the processor vendor (for heat sinks supplied with the processor) or heat sink vendor (for aftermarket heat sinks). In some cases, you might need to attach mounting hardware to the motherboard before you can attach the heat sink.

Step 8. If you are installing an active heat sink (a heat sink with a fan), plug the fan into the appropriate connector on the motherboard.

Check the processor installation by booting the computer and by checking the speed of the processor in the BIOS and in Windows.

Slot-Type CPU (early Pentium III, early AMD Athlon, and Others)

You won’t see many slot-type CPUs anymore, but if you need to install one on a motherboard, make sure the motherboard has a retention mechanism attached. If the motherboard doesn’t have one, you will need to remove the motherboard from the case to attach a retention mechanism if it is not already attached.

To remove a slot-type CPU, follow these steps:

Step 1. Push down on the retainers at each end of the CPU to release the CPU from the retention mechanism.

Step 2. Disconnect the power lead to the CPU fan (if present).

Step 3. Remove the CPU and fan/heat sink from the retention mechanism. The CPU slides straight up from the slot.

To attach a slot-type CPU, follow these steps:

Step 1. Attach the CPU retention mechanism to the motherboard. Leave the foam backing on the bottom of the motherboard while pushing the
supports into place. Lift up the motherboard and secure the retention mechanism with the screws supplied.

Some motherboards are shipped with the retention mechanism already installed, so this step might not apply to you. If the retention mechanism is folded against the motherboard, unfold it so the supports stand straight up.

**Step 2.** Attach the fan and heat sink to the CPU if it is not already attached; some CPUs have a factory-attached heat sink/fan, whereas others require you to add it in the field.

**Step 3.** Match the pinouts on the bottom of the CPU to the motherboard’s slot; note that the slot has two sides of unequal length, making it easy to match the slot with the CPU.

**Step 4.** Insert the CPU into the retention mechanism; push down until the retaining clips lock the CPU into place. Figure 3-29 shows the CPU in place.

**Step 5.** Connect the power lead from the fan (if present) to the motherboard or drive power connector as directed.

*Figure 3-29* A Slot 1–based Celeron CPU after installation. The heat sink and fan are attached to the rear of the CPU.
Troubleshooting Processors

Keeping the processor running reliably is vital to correct system operation. This section focuses on some common problems and solutions.

System Runs Slower Than Rated Speed

A system running slower than its rated speed might do so because of processor throttling due to overheating, less than optimal settings in the Windows Power Options in Control Panel, or because of incorrect BIOS timing.

Overheating of the Processor or System

A system that overheats will stop operating, and with some older processors serious damage can result. Most processors today are fitted with active heat sinks that contain a fan. If the fan stops working, the process will overheat.

Fan Failure

Heat sink fans don’t have to stop turning to fail; if they turn more slowly than they are specified to run, they can cause processor overheating.

Fan failures can be caused by dirt in the fan, worn-out bearings, or a bad connection to the motherboard or drive-cable power. In most cases, it’s better to replace the heat sink fan than to try to clean it. If you must clean it, follow these steps:

**Step 1.** Remove the heat sink from the CPU.

**Step 2.** Place it on a surface covered with old newspapers or waste paper.

**Step 3.** Blow it out with compressed air.

Before reattaching the heat sink, clean the old thermal material from the processor and the heat sink and reapply a small amount of thermal material to the top center of the processor cap. For specific thermal material installation recommendations for a particular processor, check the processor manufacturer’s website.

If you opt for a replacement fan, improve reliability and life by specifying a ball-bearing fan rather than the typical (and cheap) sleeve-bearing units. Overheating can also be caused by a dirty power supply or case fan, or by missing slot covers. Clean or replace the fans, and replace the slot covers. Don’t overlook cleaning out the inside of the case, because a dirty case interior will eventually clog other components due to the system’s airflow.

Incorrect Heat Sink for Processor Type/Speed

If the processor overheats and the heat sink is properly attached and the fan is running, make sure the heat sink is designed for the processor type and speed in use. Heat sinks made for lower speed processors might not provide adequate cooling for faster processors, which often run at higher temperatures.
Use the heat sink provided by the processor vendor, or, if you are using a separately purchased heat sink, make sure the heat sink is designed for the processor type and speed in use.

The hardware monitor feature in the system BIOS can warn of overheating or fan failure. This is most effective if the motherboard or system vendor’s monitoring software is also installed so you can be warned of problems while Windows is running.

*Windows Power Options in Control Panel*

Computers which are configured to use power settings other than High Performance will run more slowly at times to help save power and reduce heat. Systems using settings other than High Performance might also go into sleep mode more quickly, which can reduce system responsiveness. For maximum performance, use the High Performance power management setting (known as power scheme in some versions of Windows). Note that some older laptop computers use a special keystroke to activate or manage proprietary power management software.

**Underclocked System** Some systems revert to a “fail-safe” setting in which the CPU frequency and/or clock multiplier default to low-speed settings if the system fails to boot properly or is shut off before starting. Check the system speed reported on the System properties sheet in Windows XP/Vista/7 or the CPU frequency/multiplier values in the BIOS. If these values are incorrect, set the CPU frequency and multiplier values according to the processor manufacturer’s guidelines. See Chapter 4 for details.

If the system is configured to automatically detect the correct values for CPU frequency and clock multiplier but will not report the correct speed, the system might need a BIOS upgrade to properly support the processor, or you might be using a re-marked processor (one that has had its original model number and technical information altered to make it appear as if it’s a faster processor).

**Processor Failure**

If the processor is not locked into place, you will not be able to attach the heat sink. Never run the system if the processor is not properly installed, including heat sink installation.

**Installing Adapter Cards**

Although most desktop systems are equipped with a wide variety of I/O ports and integrated adapters, it is still often necessary to install adapter cards to enable the system to perform specialized tasks or to achieve higher performance. The following sections show you how to perform typical installations.
General Installation

Before installing an adapter card, you should determine the following:

■ **Does the adapter card perform the same task as an integrated adapter?**—For example, if you are installing a display adapter (also called a graphics card or video card), does the system already have an integrated adapter? If you are installing a sound card, does the system already have a sound card? Depending upon the type of card you are installing, it might be necessary to disable the comparable onboard feature first to avoid hardware resource conflicts.

■ **What type(s) of expansion slots are available for expansion cards?**—A typical system today might have two or three different types of expansion slots, such as PCI Express x16, PCI Express x1 and PCI, or PCI and AGP, as shown in Figure 3-30. PCI Express x1 and PCI slots can be used for a variety of adapter cards, while PCI Express and AGP slots are designed for display adapters. The adapter card you select must fit into an available slot.

![Figure 3-30](image)

**Figure 3-30** AGP, PCI, PCI Express x1 and x16 slots on typical motherboards. Arrow indicates rear of motherboard.

■ **When PCI and PCI Express x1 slots are available, which slot should be used?**—PCI Express x1 slots provide higher performance than PCI slots, and should be used whenever possible. Use PCI cards if PCIe cards are not available.

To learn how to change BIOS configuration settings to disable onboard ports, see Chapter 4.

The general process of installing an adapter card works like this:

**Step 1.** Shut down the system.
Step 2. Disconnect it from AC power, either by unplugging the system or by turning off the power supply with its own on/off switch.

Step 3. Remove the system cover. Depending upon the motherboard design and case design, the exact method varies:

- If the case has a one-piece design, remove the entire case.
- If the case is a tower design with removable side panels, remove the left side panel (as seen from the front) to install cards into an ATX system. Remove the right side panel to install cards into a BTX system.

Step 4. Locate the expansion slot you want to use. If the slot has a header cable installed in the slot cover, you will need to move the header cable to a different slot. Figure 3-31 illustrates a typical system that has some available slots.

![Figure 3-31](image)

**Figure 3-31** A typical system has some available slots and some that are not available for various reasons.

Step 5. Remove the slot cover corresponding to the slot you want to use for the adapter card. Most slot covers are held in place by set screws that fasten the slot cover to the rear of the case, as shown in Figure 3-31. However, some systems use different methods.

**TIP** If you are unable to remove the slot cover after removing the set screw, loosen the set screw on the adjacent slot cover. Sometimes the screw head overlaps the adjacent slot cover.
Step 6. Remove the card from its antistatic packaging. Hold the card by the bracket, not by the circuit board, chips, or card connector. Figure 3-32 illustrates a typical card and where to hold it safely.

![Figure 3-32](image)

1. Card bracket – hold card here
2. Card circuits and chips – do not touch
3. Card connector – do not touch

Step 7. Insert the card into the expansion slot, lining up the connector on the bottom.

Step 8. Push the card connector firmly into the slot.

Step 9. Secure the card bracket; on most systems, you will secure the card bracket by replacing the set screw. See Figure 3-33.

Step 10. Connect any cables required for the card.

Step 11. Reconnect AC power and restart the system.
Step 12. When the system restarts, provide drivers as prompted.

The following sections discuss some special installation considerations that apply to some types of adapter cards.

Display Adapters

Before installing a display adapter in a working system, you should open Device Manager and uninstall the current display adapter. To learn more about using Device Manager, see Chapter 13 “Using and Managing Windows”.

Display adapters are available for PCI Express x16, AGP, and PCI expansion slots. Display adapters in PCI form factor are intended for use in systems that don’t have PCI Express or AGP slots, or to provide support for additional displays on systems that already have PCI Express or AGP cards installed.

When you install a card into an AGP slot, make sure the card locking mechanism on the front of the slot is open before you install the card. Locking mechanisms sometimes use a lever that is moved to one side, flips up and down, or has a locking tab that is pulled to one side.
After installing the display adapter, install the drivers provided by the graphics card vendor. If possible, use updated drivers downloaded from the vendor’s website rather than the ones provided on CD.

When connecting the monitor(s) to the display adapter, keep in mind that CRT and some LCD monitors use the 15-pin VGA connector, while many LCD monitors use the larger DVI connector or the compact HDMI adapter that supports home theater systems (HDTVs and audio amplifiers). You can use an adapter to enable a DVI-I connector on a display adapter to connect to a monitor that uses the VGA connector and a DVI to HDMI adapter to connect a DVI port to a display or HDTV with an HDMI connector. To learn more about display adapters and graphics cards, see Chapter 8.

**Sound Cards**

After installing a sound card, you must connect 1/8-inch mini-jack cables from speakers and the microphone to the sound card. Most sound cards use the same PC99 color-coding standards for audio hardware that are used by onboard audio solutions, as described in Table 3-7.

<table>
<thead>
<tr>
<th>Usage</th>
<th>Color</th>
<th>Jack Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microphone input (mono)</td>
<td>Pink</td>
<td>Mini-jack</td>
</tr>
<tr>
<td>Line in (stereo)</td>
<td>Light blue</td>
<td>Mini-jack</td>
</tr>
<tr>
<td>Speaker or headphone (front/stereo)</td>
<td>Lime green</td>
<td>Mini-jack</td>
</tr>
<tr>
<td>Speaker out/subwoofer</td>
<td>Orange</td>
<td>Mini-jack</td>
</tr>
<tr>
<td>Game port/MIDI out</td>
<td>Gold</td>
<td>15-pin DIN</td>
</tr>
</tbody>
</table>

After installing the sound card, you are prompted to install drivers when you restart the system. The driver set might also include a customized mixer program that is used to select speaker types, speaker arrangement (stereo, 5.1, and so on), and provides speaker testing and diagnostics. Be sure to test the speakers to assure they are plugged into the correct jack(s) and are working properly.

**Video Capture Cards**

Video capture cards are used to capture video from analog or digital video sources. Video capture card types include

- IEEE 1394 (FireWire) cards—These capture video from DV camcorders and can also be used for other types of 1394 devices, such as hard disks and scanners. An onboard IEEE 1394 port can also be used for video capture.
Analog video capture cards—These capture video from analog sources, such as cable or broadcast TV, composite video, or S-video. Many of these cards also include TV tuners. Examples include the Hauppauge WinTV PVR series and the ATI Theater Pro series.

Digital video capture card—These capture digital video from HDMI sources, such as HDTV.

The ATI All-in-Wonder series—These cards incorporate accelerated 3D video display output to monitors, video capture, and TV tuner support.

After installing any type of video capture card, you need to install the drivers provided with the card, connect the card to video sources, and, in the case of cards with onboard TV tuners, set up the TV tuner feature.

Troubleshooting Adapter Cards

Adapter card problems can be detected in the following ways:

- A device connected to the adapter card doesn’t work.
- The adapter card listing in Device Manager indicates a problem.

To solve these problems, see the following sections.

Device Connected to Adapter Card Doesn’t Work

If a device connected to an adapter card doesn’t work, it could indicate a variety of issues. After verifying that the device works on another system, check the following:

Step 1. Check Device Manager and make sure the adapter card is listed as working. Windows XP uses the yellow ! symbol to indicate devices that are not working, and the red X mark to indicate devices that have been disabled. Windows Vista and Windows 7 also use a yellow ! mark for non-working devices, but use a down-arrow icon for disabled devices. In some cases, an adapter card will work after you install a driver upgrade. To learn more about driver and firmware upgrades, see “Performing Driver and Firmware Upgrades,” in this chapter. To learn more about using Device Manager, see Chapter 13.

Step 2. Check the system BIOS setup to ensure that any onboard devices that might interfere with the adapter card’s operation have been disabled.

Step 3. Make sure the adapter card is properly secured in the expansion slot. Refer to Figure 3-33.

Step 4. If the adapter card requires additional power, make sure an appropriate power cable is connected from the power supply to the card. Some IEEE-1394 and display adapter cards require additional power to operate properly.
Performing Driver and Firmware Upgrades

A device is only as good as the software that makes it work. Device drivers are found in two forms:

- Driver files
- Firmware

The drivers for most devices installed in Windows can be updated through the Update Driver wizard found in the properties sheet for the device in Device Manager. The wizard can locate updated drivers on the Internet or can be directed to install drivers from a location you provide, such as drivers on a floppy disk, CD, or a particular folder on a hard disk.

To learn more about using Device Manager, see Chapter 13.

Firmware, which is software stored on a flash memory chip, can also be upgraded, although most adapter cards don’t use upgradeable firmware. If a firmware upgrade is available from the adapter card vendor, follow the vendor’s instructions for installing the upgrade.

Some upgrades are installed by creating a special boot disk from the downloaded file provided by the vendor, while others are installed from within Windows. Regardless of how firmware is upgraded, it’s very important to keep in mind that the upgrade process can take two or three minutes and must not be interrupted. If the firmware process is interrupted, the card will no longer function, and it must be repaired or replaced.
Exam Preparation Tasks

Review All the Key Topics

Review the most important topics in the chapter, noted with the key topics icon in the outer margin of the page. Table 3-8 lists a reference of these key topics and the page numbers on which each is found.

<table>
<thead>
<tr>
<th>Key Topic Element</th>
<th>Description</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 3-1</td>
<td>A typical ATX motherboard with support for NVIDIA’s scalable link interface (SLI) technology.</td>
<td>47</td>
</tr>
<tr>
<td>Figure 3-5</td>
<td>A port cluster on a late ATX system model.</td>
<td>52</td>
</tr>
<tr>
<td>Figure 3-8</td>
<td>PCI slots compared to AGP slots.</td>
<td>56</td>
</tr>
<tr>
<td>Figure 3-9</td>
<td>PCI Express slots compared to a PCI slot.</td>
<td>57</td>
</tr>
<tr>
<td>Figures 3-10 and 3-11</td>
<td>AMR slots and risers.</td>
<td>59</td>
</tr>
<tr>
<td>Table 3-4</td>
<td>Technical Information About Mass Storage Interfaces.</td>
<td>60</td>
</tr>
<tr>
<td>Figure 3-12</td>
<td>PATA and SATA host adapters on a typical motherboard.</td>
<td>60</td>
</tr>
<tr>
<td>Figure 3-32</td>
<td>How to safely hold an adapter card.</td>
<td>102</td>
</tr>
<tr>
<td>Figure 3-33</td>
<td>Proper and improper adapter card installations.</td>
<td>103</td>
</tr>
<tr>
<td>Table 3-7</td>
<td>PC99 Color Coding for Audio Jacks.</td>
<td>104</td>
</tr>
</tbody>
</table>

Complete the Tables and Lists from Memory

Print a copy of Appendix B, “Memory Tables,” (found on the CD), or at least the section for this chapter, and complete the tables and lists from memory. Appendix C, “Memory Tables Answer Key,” also on the CD, includes completed tables and lists to check your work.

Definitions of Key Terms

Define the following key terms from this chapter, and check your answers in the glossary.
Motherboard, CPU, system bus, I/O bus, integrated circuits, PCI, AGP, PCI Express, PATA, SATA, SCSI

**Troubleshooting Scenario**

You have recently purchased a 500GB storage device. You plug it in to your system and nothing happens. What could be the cause of the problem, and how would you correct this?

Refer to Appendix A for the answer.
This page intentionally left blank
Index

Numbers

1/8-inch audio min-jacks, 256
1.44MB floppy drive, 501
3-claw parts retrieval tool, 3
3.5 inch floppy drives, 502
- BIOS, configuring, 505-506
- installing, 505
- maintaining, 508
8P8C (8 position, 8 contact), 833
10BASE5, 836
10BASE-T, 829
12V power supplies, 157
64-bit processes versus 32-bit, 89
80 PLUS certification standard, 162
100BASE-TX, 829
802.11 WLAN support for printers, 458
802.11b, 830
802.11g, 830
802.11n, 830
1000BASE-T, 829

A

AC adapters for portable/laptop computers, 351-353, 379
access control
- event logging, 415-416
- for operating systems, 412
  - components, 415
  - groups, 413-414
  - permissions, 414-415
  - restricted spaces, 415
  - UAC, 412-413
  - user accounts, 412
accessing BIOS setup program, 118-119
accessory bays, 333
accident incident handling, 898
account levels, 412
ACPI (advanced configuration and power interface), 353, 355
Acronis True Image WD Edition, 794
active heat sinks, 183
active-matrix LCD screens, 344
adapter cards
- installing, 100-103
- troubleshooting, 105-106
Add Printer Wizard, 459-461
add-on card modems, 809
adding
- LPT ports, 252
- serial ports, 245
- USB ports, 228-229
adjusting
- brightness on laptop computers, 364
- contrast on laptop computers, 364
- shared video memory, 364
administrator accounts, 412
administrator password, configuring for wireless networks, 403
Advanced BIOS Settings/Features menu (BIOS setup), 128-129
Advanced Boot Options, 749-751
advanced display properties, troubleshooting picture quality, 316-317
adware, 432
Aero, 572
AES, 841
AGP slots, 55
AMD processors, 79-80, 83
  - cache memory, 87-88
  - sockets, 83
AMR (audio modem riser) slots, 58
ANSI/IEEE C62.41 Category A standards, 177
answer file, 711
antenna wires, troubleshooting, 384
antistatic electronic wipes, 921
antistatic spray, 888
antistatic wrist straps, 4
anycast addresses, 853
applications, 32
  - compatibility, 576-579
    - Windows 7, 576
    - Windows XP/Vista, 577-578
  - GPFs, troubleshooting, 781-782
  - optimizing performance, 688-690
  - troubleshooting, 774-776
APs
  - administrator password, 403
  - configuring, 400
  - firmware, 404-405
  - MAC address filtering, 402-403
  - NAT, 405
  - SSID, 400-401
Archive attribute (files), 636
ASR (Automated System Recovery), 760-761
ATA RAID arrays, configuring, 523-526
ATA specifications, 511-512
ATA/IDE hard drives
installing, 512-514
performance, optimizing, 526
disk-cache settings, 530
DMA transfers, 528-529
IDE block mode, 528
IDE busmastering drivers, 528
transfer rates, 526-527
Athlon 64 FX processor, 80
Athlon 64 X2 processor, 80
Athlon processor, 80
Athlon XP processors, 80
atmospheric hazards, 897
attaching
cables to internal/external drives, 35
VGA cables, 37-38
attended installation, 716-717
ATTRIB command, 637-638
attributes (file/folder), 636-639
ATX form factor, 49
ATX motherboards
installing, 66-67
removing, 63-65
auditing, 415-416
authentication, 395-396
Auto Restart errors, troubleshooting, 769-770
Automated System Recovery (ASR), 760-761
automatic BIOS configuration, 123-124
automatic CMOS configuration, 123-124
autoranging, 171
autoswitching power supplies, 160
avoiding power supply hazards, 174-176
BIOS, 111, 115-117
chip, replacing, 147-149
configuring, 120-124
for floppy drives, 505-506
for PATA hard drives, 517-519
for SATA hard drives, 520
POST, 140
beep codes, 141-142
error messages, 142
hex codes, 143
security features, 417
setup program
accessing, 118-119
Advanced BIOS
Settings/Features menu, 128-129
exiting, 139
Hardware Monitor menu, 136-138
I/O Devices menu, 131
Integrated Peripherals menu, 129, 134
main menu, 124
Onboard Devices menu, 130
PnP/PCI Configuration dialog, 135
PnP/PCI Configurations menu, 135
Power Management menu, 134
Processor and Memory Configuration menu, 137-138
security features, 138
Standard Features/Settings menu, 125, 128
updating, 144-146
video card settings, 298-299
BitLocker, 407-408
bits, 10
Blu-ray drives, 532
Bluetooth, 340-341, 358, 457, 830
BNC (Bayonet Neill-Concelman) connectors, 837
Boot Configuration Data (BCD), 610
boot disks, starting
Windows XP/2000 installation from, 713-714
boot errors
for Windows 7/Vista, 777-779
for Windows XP/2000, 779-780

boot sequence
Windows 7/Vista, 610
Windows XP, 610-612
Boot.ini, 610-611
Bootmgr (Windows Boot Manager), 610
Bootsect.dos, 611
BRI, 815
brightness, adjusting on laptop computers, 364
broadband Internet services, 816
cable Internet, 818
dsl, 816
satellite Internet, 818-819
BSOD errors, troubleshooting, 767, 769
BTX form factor, 50-51
BTX motherboards
cooling systems, 183
installing, 66-67
removing, 63-65
buffer underrun failures, 559-560
bus topology, 827
bus-powered hubs, 229
bytes, 10-11

C

C-shaped paper path, 484
cable Internet, 818
cables
attaching to external/ internal drives, 35
coaxial, 836
fiber-optic, 834-836
IEEE 1394, 253
LPT ports, 247-250
plenum, 837
PVC, 837
RG-11, 837
SCSI, 233-234
serial, 241
STP, 832-834
UTP, 832-834
cache memory, 87-88
calculating bytes, 11
calibrating printers, 462
cans, disposing, 884
CardBus network adapters, 839
case fans, 187-188
categories of UTP/STP cabling, 833
CD command, 661
CD drives, speed ratings, 532
CD-R drives, 531
CD-ROM drives, 554-561
CD-RW drives, 531
CDs, recording
in Windows Vista, 535-536
in Windows XP, 534
Celeron processors, 77
cellular Internet connectivity, 831
cellular WAN, 342, 359
Centronics ports, 255
certifications, 32
changeline support, 549
charging corona wire, 442
CHDIR command, 662
checking hard drives for errors, 647-648
chemical solvents, disposing, 884
chip creep, 70
chips, firmware, 32
chipsets, cooling, 184
chkdsk.exe, 647-648
clean installs, performing
for Windows 7, 704-706
for Windows Vista, 707-710
for Windows XP, 710-711
cleaning
floppy disk drives, 508
printers, 489-491
cleaning tools, 920-922
cleaning solutions, 492
vacuum cleaners, 922
clearing print queue, 482-483
client interview process, 762-763, 907-910
client/server network model, 805
clients, 807
servers, 806
clients, 807
clock speed, 88
cloning laptop displays, 367-369
CMOS, 116-117, 123-124
CMOS Checksum errors, 149
CNR (communications network riser) slots, 58
coxial cable, 836
color depth, 311-312
color laser printers, 442, 453
COM ports. See serial ports combo cards, 840
Combo PC Cards, 336
command prompt, 596
command-line functions, 652
CD, 661
CHDIR, 662
COPY, 658
DIR, 655-656
EDIT, 657-658
HELP, 655
ipconfig, 870
MD, 661
net, 868
nslookup, 870
ping, 868
RD, 661
starting command-prompt sessions, 652
table of internal commands, 653-654
tracert, 869
wildcards, 654-655
XCOPY, 658-661
command-prompt sessions, starting, 652
Common Tasks view, 583-584
communications connections for portable/laptop computers
Bluetooth, 340-341, 358
cellular WAN, 342, 359
Ethernet, 342, 359
IrDA, 341, 359
WLAN, 343, 359-363
comparing
DHCP and static IP addresses, 400
file systems, 535
memory modules, 205
portable and desktop
computers, 327-329
Windows 7 editions,
701-702
compatible devices for 
IEEE 1394, 254
compatible mode, 248
Complete PC Backup, 759
component/RGB connectors, 307
components, access control, 415
composite connectors, 308
compressed air, 920-922
compressed capacity, 538
computer hardware, disposing, 884-885
configuring
APs, 400
administrator password, 403
firmware, 404-405
MAC address filtering, 402-403
NAT, 405
SSID, 400-401
BIOS, 120-124, 298-299
CMOS, 123-124
displays
color depth, 311-312
refresh rate, 312-313
resolution, 310
floppy disk drives, 503-506
hard disk drives
PATA, 517-519
SATA, 520
ISDN connections, 815
LPT ports, 248-251
PS2 mode, 249
standard mode, 248-249
NetBEUI, 853
network cards
duplex mode, 840
hardware resources, 839
media type, 840
printer options, 462-465
SATA hard drives, RAID arrays, 523-526
serial ports, 243-246
TCP/IP, 844-847
Web browsers, 865-866
script settings, 867
security, 867
wireless clients, 422
with Windows 7, 426-427
with Windows Vista, 425-426
with Windows XP
SP2/SP3, 422-425
Wireless Ethernet, 840
connecting VGA cables, 37-38
connectors, 837
BNC, 837
for power supplies, 165-167
contrast, adjusting on laptop computers, 364
Control Panel, 591-596
Convert.exe, 626-627
converting
decimal to binary, 7-10, 850
FAT32 to NTFS, 430
file systems, 626-627
cooling pipes, 298
cooling systems
fans, 163
heat sinks, 183
negative pressure, 164
north/southbridge cooling, 184
case fans, 187-188
liquid cooling, 191
thermal compound, 188
video card cooling, 186
on portable/laptop computers, preventative maintenance, 384
for video cards, 297-299
COPY command, 658
Core 2 processor family, 76-77
Core processor family, 76-77
CPUs. See processors
crosstalk, 250
CRT displays, 302-303
discharging, 894
as high voltage hazard, 892-893
picture quality, troubleshooting, 315-317
CS (Cable Select), 511
CSMA/CD, 828
customers, talking to, 923-924
customizing Start menu
properties, 605, 608
in Windows 7, 605
in Windows XP/Vista, 603-605
cylinders, 518
CYMY devices, 444
daisy-chaining, 229, 234-237
data, 32
data migration, 408, 702-703
data projectors, 303-304
data removal, 409
data security policies, 405-406
data storage, 13-14
data transfer bandwidth
measuring, 14-15
parallel transfers, 15-16
serial transfers, 16-18
daughterboards, 51
DB-9 connectors, 241
DC power supply, troubleshooting on
portable/laptop computers, 380
DC voltage levels for power supplies, 172-174
DDR SDRAM, 202
DDR2 SDRAM, 202-203
DDR3 SDRAM, 203-204
dead pixels, 382
dead shorts, 71
dead systems, 181-182
decimal, converting to binary, 7-10, 850
decrypting files, 407
default.LOG, 612
defrag, 640
defragmenting hard disks, 640
deleting folders, 629
desktop computers
case, opening, 33
features, comparing with portable computers, 327-329
displays 967

front view, 25
interior view, 25-27
points of failure, 30
rear view, 25
device calibration, 470
device drivers
installing for printers, 459
Add Printer Wizard, 459-461
vendor-supplied drivers, 461
providing for Windows installation, 722-723
Device Manager, 662-664, 786-790
devices
gateways, 851
hubs, 842
repeaters, 842
routers, 842
startup errors, troubleshooting, 780
switches, 842-843
Devices and Printers folder, 598-600
DHCP, 400
diagnostic utilities
Device Manager, 786-790
SFC, 790
Task Manager, 785
dial-up Internet
connectivity
DUN connections, 813
ISPs, 813
modems, 809-810
installing, 812-813
requirements, 814
digital cameras, 262, 266
digitizers, 347, 383
DIMMs, 205, 209-212
DIR command, 655-656
directories. See also folders
creating, 629
deleting, 629
in libraries, 629-631
navigating between, 628
dirty read/write heads, 547
disabling
hibernation, 615
indexing, 609
serial ports, 243-244
SSID broadcast, 402
discharging CRT monitors, 894
disk cloning, 712-713
disk image installation, 712-713
Disk Management, 617-621
disk partitions, 615-617
explained, 615
extended partitions, 616
primary partitions, 615
disk scrubbing, 398
disk-cache settings, adjusting for PATA devices, 530
display adapters, installing, 103
displays
advanced display properties, 316-317
color depth, 311-312
component/RGV connectors, 307
composite connectors, 308
CRT, 302-303, 894
data projectors, 303-304
disposing, 884-885
DVI connectors, 305
HDMI connectors, 307
as high voltage hazard, 892-893
installing, 313-314
LCD, 303, 343
active-matrix, 344
passive-matrix, 344
resolution, 344
screen quality, 345
for portable/laptop computers
brightness, adjusting, 364
cloning, 367-369
contrast, adjusting, 364
DualView, 365-366
preventative maintenance, 386
shared video memory, adjusting, 364
troubleshooting, 380-382
OSD, 315
preventative maintenance, 319
refresh rates, 312-313
resolution, 309-312
S-Video connectors, 308
VGA connectors, 305
video hardware, troubleshooting, 317-319
disposing
batteries, 883
chemical solvents, 884
computer hardware, 884-885
distribution DVD
installing Windows 7 from, 704-706
installing Windows Vista from, 707-710
installing Windows XP from, 710-711
DLP projectors, 303-304
DMA transfers, enabling for PATA devices, 528-529
DNS (domain name system), 824, 851
docking stations, 331
documenting solutions, 916
dongle, 810
DOS alias names, 634-635
dot-matrix printers, 448
dot pitch, 302
DRAM, 201
drive lock technology, 415
drivers
driver signing, 774
for printers, 450
providing for Windows installation, 722-723
upgrades, 106
troubleshooting, 777
drives
drive jumpering, 510-511
mounting, 623
drop-on-demand printers, 454
DSL, 816
dual-core processors, 85
DualView, enabling on laptops, 365-366
duplex mode, configuring on network interface cards, 840
DuPont FE-36, 897
DVD drives
speed ratings, 532
troubleshooting, 554-561
DVD+R, 531
DVD+RW, 531
DVD-R, 531
DVD-RAM, 531
DVD-RW, 531
DVDs
installing Windows 7 from, 704-706
installing Windows Vista from, 707-710
installing Windows XP from, 710-711
recording in Windows Vista, 535-536
recording in Windows XP, 534
DVI connectors, 305
DxDiag, 773
dye-sublimation, 446, 454

E

ECC (error-correcting code), 207-208
ECP (Enhanced Capabilities Port) mode (LPT), 249
EDAC (Error Detection and Correction), 208
EDIT command, 657-658
EEPROM, 144
EFS (Encrypting File System), 406-407
EIDE/PATA host adapters, 60-61
electrical systems, testing, 887
electrophotographic (EP) process, 451
electrostatic discharge. See ESD
e-mail, 825-826
Emergency Repair Disk (ERD), 761
enabling. See also configuring
DualView on laptops, 365-366
Windows Firewall, 418-419
e-amento, 406-408
environmental incident handling, 898
environmental issues
batteries, 883
chemical solvents, 884
computer hardware, 884-885
printer cartridges, 883
toner, 883
EP process, 451
EPP (Enhanced Parallel Port) mode (LPT), 249
EPP/ECP mode (LPT), 249
ERD (Emergency Repair Disk), 761
error messages
POST, 142
printers, 487-488
recording, 766-767, 910
startup errors, 780
Windows 7/Vista boot errors, 777-779
Windows XP/2000 boot errors, 779-780
ers, checking hard drives for, 647-648
eSATA, 521, 552-554
ESD (electrostatic discharge)
explained, 885-886
preventing, 4-5, 34-35, 886-887
protecting against, 888-890, 893
Ethernet, 342, 359, 457, 828, 837. See also
Wireless Ethernet
event logging, 415-416, 764
Event Viewer, 672
exceptions, Windows Firewall, 419-420
exFAT, 625
exiting BIOS setup program, 139
expansion slots, 54
AGP slots, 55
AMR slots, 58
CNR slots, 58
for video cards, 297
on portable/laptop computers, 334
Mini-PCI, 338-340
Mini-PCIe, 338-340
PCMCIA, 334-337
PCI slots, 55
PCle slots, 56-58
ExpressCards, removing from laptops, 370
extended partitions, 616
extension magnets, 492
extensions (file), 635
external commands, 32
external drives
attaching, 35
hot-swapping, 545
troubleshooting, 561-563
external modems, 809
external TAs, 815
eyebrow tweezers, 3

F

failed BIOS updates, recovering from, 147
fans, failure of, 163
Faraday cage antistatic bags, 889
FAST (Files and Settings Transfer) Wizard, 703
FAT file systems, 395
FAT32, 624-625
converting to NTFS, 430
FAT64, 625
fatal errors, 141
Favorite Links view, 584
fiber-optic cabling, 834, 836
File and Printer Sharing, 854
file formats, 13
file sharing
comparing, 535
simple file sharing, 855
user/group permissions configuring in Windows Vista, 857
configuring in Windows XP, 855-857
file systems
converting, 626-627
converting to NTFS, 430
exFAT, 625
explained, 624
FAT32, 624-625
NTFS, 625-626
security, 395
files. See also specific files
attributes, 636-639
creating, 632
displaying in Windows Explorer, 587-588
encrypting, 407-408
extensions, 635
formats, 13
long filenames, 634-635
naming, 634
permissions, 639-640
sharing
simple file sharing, 855
user/group permissions, 855-857
symbolic links, 636
text versus binary, 632-634
Files and Settings Transfer (FAST) Wizard, 703
FileZilla, 823
firewalls, 397
configuring exceptions, 419-420
troubleshooting, 421-422
Windows Firewall, 418-419
FireWire. See IEEE 1394
firmware, 32
BIOS. See BIOS
for printers, 450, 474-475
upgrading, 106
five-wire resistive technology, 261
Flash BIOS updates, 145-146
flash memory, 539-540
card readers, 541-542
hot-swapping, 543-545
USB flash memory drives, 543
Flash recovery jumper, 147
flicker-free refresh rates, 312
floppy drives, 501-502
BIOS, configuring, 505-506
cables, 35
configuring, 503-504
installing, 505
maintaining, 508
troubleshooting, 547-550
Fn keys, 347
folders. See also directories
attributes, 636-639
creating, 629
deleting, 629
Devices and Printers, 598-600
displaying in Windows Explorer, 587-588
in libraries, 629-630
managing in libraries, 630-631
navigating between, 628
Format.exe, 648-650
formatting hard drives, 648-650
four-wire resistive technology, 261
FQDNs, 862-863
Front Side Bus Frequency Switching, 350
front view of desktop PC, 25
FTP, 822
full-duplex, 840
FXO ports, 831
G

Gadgets, 573
gateways, 851
Gb (Gigabit), 10
GB (Gigabyte), 10
geosynchronous satellites, 819
GPFs (general protection faults), 781-782
GPU (graphics processing unit) chips, cooling, 186, 297-299
grayware, 432
groups, 413
guest accounts, 412
GUIs, 572
Windows 7, 572-573
Windows Vista, 573-574
Windows XP, 574
H

Hal.dll, 610
half-duplex, 840
Halon, 897
hard disks, 508-509
ATA specifications, 511-512
checking for errors, 647-648
defragmenting, 640
Disk Management, 617-621
external, 545
formatting, 648-650
MBR, repairing, 783-784
mounting, 623
optimizing performance, 684
partitions, 615-617
explained, 615
extended partitions, 616
primary partitions, 615
PATA drive jumpering, 510-511
installing, 536
preparing for Windows installation, 718-722
removing from laptops, 373-374
troubleshooting, 782-783
hardware compatibility, verifying for operating systems, 699-701
hardware diagnostics, 918-919
Hardware Monitor menu (BIOS setup), 136-138
hardware resources, 39, 839
HDMI connectors, 307
header cables, troubleshooting, 73
heat sinks, 183
heavy equipment hazards, 897
HELP command, 655
hemostat clamp, 3
Hertz, 14, 17-18
hex codes (POST), 143
hex drivers, 3
hexadecimal numbering system, 6, 14
hiberfil.sys, 614-615
hibernate.sys, 356
disabling, 615
Hidden attribute (files), 637
high-speed bidirectional modes (LPT), 249
high voltage hazards, 891
CRT monitors, 892-893
power supply, 891-892
printers, 891
systems in suspend mode, 893
HKEY_CLASSES_ROOT, 580
HKEY_CURRENT_CONFIG, 580
HKEY_CURRENT_USER, 580
HKEY_LOCAL_MACHINE, 580
HKEY_USERS, 580
hot-swapping external hard disks, 545
hot-swapping flash memory cards, 543
hot-swapping USB flash memory drives, 544-545
hotfixes, 792
HSP (host signal processing), 809
HTML, 822
HTTP, 821
HTTPS, 821
hubs, 842
hybrid mouse devices, 273
hyperthreading, 84

I/O bus, 49
I/O devices, troubleshooting, 773
I/O Peripherals menu (BIOS setup), 131
I/O ports
Centronics, 255
IEEE 1394, 253
cables, 253
card installation, 254-255
compatible devices, 254
troubleshooting, 280-281
LPT, 246-247
adding, 252
cables, 247-250
configuration settings, 250-251
configuring, 248-249
troubleshooting, 281-284
MIDI, 257
port addresses, 243
PS/2, 255
RG-6 coaxial, 258
SCSI, 229
cables, 233-234
daisy-chaining, 234-237
device ID, 231-232
host adapter card installation, 236
multiple device support, 229-230
signaling types, 234
standards, 232-233
termination methods, 237-238
serial, 238-239
adding, 245
cables, 241
configuring, 243-246
IRQ, 243
pinouts, 240-241
troubleshooting, 284-286
SPDIF, 256
USB, 225
adding, 228-229
connectors, 226-228
troubleshooting, 278-280
ICH (I/O Controller Hub) chip, 184
IDE block mode, 528
IDE busmastering drivers, 528
identifying
event logs, 764
hardware versus software problems, 911-914
points of failure, 914-915
services, 764
IEEE 802.3, 828
IEEE 802.11, 829-830
IEEE-1284-B port, 246
IEEE 1394 (FireWire), 253
cables, 253
card installation, 254-255
compatible devices, 254
technical requirements, 254
troubleshooting, 280-281
IEEE 1394a, 253
IEEE 1394b, 253
image backups, 757-758, 794
IMAP (Internet message access protocol), 826
impact print process, 455
impact printers, 447-448
inadequate air flow as cause of overheating, 163-164
incident reporting, 410
incorrect drivers, troubleshooting, 777
indexing, 608-609
infrared (IrDA) support for printers, 458
infrared networking, 830
inheritance, 414
ink cartridges, 444-446
inkjet printers, 444
cleaning, 490
ink cartridges, 444-446
inkjet print process, 453-454
paper and media, selecting, 446
input devices
bar code readers, 260, 266
biometric devices, 260
keyboards, 258-259
installing, 265
maintaining, 288
troubleshooting, 270
mouse, 259
installing, 265
maintaining, 286-287
resource usage, 260
troubleshooting, 270-274
for portable/laptop computers, 346
digitizers, 347
Fn keys, 347
pointing stick, 349
stylus, 347
touch pads, 347-349
TrackPoint, 349
touch screens, 261-262, 274-275
installing
adapter cards, 100-103
analog modems, 812-813
ATA/IDE drives, 512-514
bar code readers, 266
biometric devices, 268
digital camera, 266
display adapters, 103
displays, 313-314
File and Printer Sharing, 854
flash card readers, 542
floppy disk drives, 505
hard disk drives, 514-517
IEEE 1394 cards, 254-255
keyboard, 265
memory modules
  DIMMs, 210-212
  Rambus RDRAM modules, 210-212
microphones, 267-268
MIDI ports, 267
motherboards, 66-68
mouse, 265
network cards
  PCI, 838
  PCI Express, 838
network client software, 859
network protocols in Windows, 843-844
optical drives, 533
PATA hard drives, 536
PCI cards, 38-39
power supplies, 169
printer maintenance kits, 489
printers
  device drivers, 459-461
  firmware, 474-475
  memory, 473-474
processors, 90, 93-97
SCSI host adapter cards, 236
service packs, 790-792
sound cards, 104, 268-269
touch screens, 268
updates, 793
video capture cards, 269-270
video cards, 298-301
Web browsers, 864
webcam, 266
Windows operating systems, 704
  attended installation, 716-717
  device drivers, 722-723
  from boot disks, 713-714
  from disk image, 712-713
  from distribution DVD, 711
hard disk, preparing, 718-722
  providing, 722-723
  from recovery DVD/CD, 713
unattended installation, 716-717
from USB thumb drives, 714-716
verifying installation, 723-726
Windows 7 installation from distribution DVD, 704-706
Windows Vista installation from distribution DVD, 707-710
Windows XP installation from distribution DVD, 710-711
integrated I/O ports, 52-53
  expansion slots, 54
  AGP slots, 55
  AMR slots, 58
  CNR slots, 58
  PCI slots, 55
  PCIe slots, 56-58
  memory slots, 54
integrated modems, 809
Integrated Peripherals menu (BIOS setup), 129-130, 134
Intel processors, 75, 79
  cache memory, 87-88
  sockets, 83
VRM, 88
interior view of desktop PC, 25-27
internal commands, 32
internal drives
cables, 35
  replacing on notebook computers, 31
internal TAs, 815
Internet connectivity
  broadband, 816
  cable Internet, 818
  DSL, 816
  satellite, 818-819
cellular, 831
DUN connections, 813-814
ISDN, 814-815
ISPs, 813
LANs, 820
modems, 809-813
Web browsers
  configuring, 865-867
  installing, 864
interviewing clients, 762-763, 907-910
Iomega REV drives, 537
Iomega Zip drives, 537
IP addressing, 847-853
IP classes, 847-850
ipconfig command, 870
IPv6 IPaddressing, 851-853
IrDA (Infrared Data Association), 341, 359, 458, 830
IRQs, 39
ISDN, 814-815
isopropyl alcohol, 921
ISPs, 813, 821
J
jeweler's screwdriver set, 3
jitter, 16
jump lists, 607
K
Kb (Kilobit), 10
KB (Kilobyte), 10
keyboard pullers, 920
keyboards, 258-259
  installing, 265
  maintenance, 288
  troubleshooting, 270
keypads, troubleshooting, 383
L
L1 cache, 87
L2 cache, 87
L3 cache, 87
LANs, 820
laptop computers, 27
  AC power supply, troubleshooting, 379
  batteries, removing, 370-372
  communications connections
    Bluetooth, 340-341, 358
    cellular WAN, 342, 359
    Ethernet, 342, 359
    IrDA, 341, 359
    WLAN, 343, 359-363
cooling systems, 384
DC power supply, troubleshooting, 380
displays
brightness, adjusting, 364
cloning, 367-369
contrast, adjusting, 364
DualView, 365-366
preventative maintenance, 386
shared video memory, adjusting, 364
troubleshooting, 380-382
expansion slots, 334
Mini-PCI, 338-340
Mini-PCIe, 338-340
PCMCIA, 334-337
ExpressCards, removing, 370
features, comparing with desktop computers, 327-329
hard disk drives, removing, 373-374
hardware, removing, 369
input devices, 346
digitizers, 347
Fn keys, 347
pointing stick, 349
stylus, 347
touch pads, 347-349
TrackPoint, 349
internal drives, replacing, 31
LCD screen technologies, 343
active matrix, 344
passive matrix, 344
removing, 376-377
replacing, 31
resolution, 344
screen quality, 345
memory, 329
removing, 375-376
Mini-PCI cards, removing, 372-373
optical drives, removing, 374
PC cards, removing, 370
peripherals, 331
docking stations, 331
drive bays, 333
port replicators, 332
removing, 382
troubleshooting, 383-384
points of failure, 30
pointing devices, removing, 377-378
ports, 28
power management, 350
ACPI, 353-355
hibernate mode, 356
S3 sleep state, 356
stand by mode, 357
power sources, 363
AC adapters, 351-353
batteries, 350-351
processor throttling, 350
recommended operating environments, 386
storage devices, 330-331
storage methods, 386
transporting, 386
Laptop Repair 101 website, 369
laser print process, 451-453
laser printers, 439
cleaning, 489-490
color, 453
memory, 440-441
paper, 443
toner cartridges, 442
Last Known Good Configuration, 747-749
LCD displays, 303, 343
active-matrix, 344
on notebook computers, 343
active matrix, 344
passive matrix, 344
removing, 376-377
replacing, 31
resolution, 344
screen quality, 345
passive-matrix, 344
picture quality, troubleshooting, 315-317
resolution, 344
screen quality, 345
LCD projectors, 303-304
LED printers, 440
Li-ion batteries, 351
libraries, 629-631
limited accounts, 412
liquid cooling systems, 191
liquid hazards, 896
Live File System, 535
loadstate.exe, 703
locking workstations, 410
long filenames, 634-635
loopback address, 849
loopback plugs, 919
LPT ports, 246-247
adding, 252
cables, 247-250
configuration settings, 250-251
configuring, 248
PS/2 mode, 249
standard mode, 248-249
troubleshooting, 281-284
LS-240 SuperDisk drives, 503
LSB (Least Significant Bit), 7

M
MAC address filtering, 402-403
magnifier, 3
mAh (milliampere hours), 351
maintaining
floppy disk drives, 508
input devices
keyboards, 288
mice, 286-287
printers, 489
maintenance tools, 920-922
malicious software protection, 431-432
malware, 397, 431-432
mapped drives, 863-864
mass storage devices, troubleshooting, 74
mass storage interfaces, 59
EIDE/PATA, 60-61
SATA host adapters, 61
SCSI host adapters, 61-62
Material Safety Data Sheet (MSDS), 885
Mb (Megabit), 10
MB (Megabyte), 10
MBR, repairing, 783-784
MCM (Memory Controller Hub) chip, 184
MD command, 661
measuring bandwidth, 14-18
mechanical hazards, 895
media
  selecting for inkjet printers, 446
  selecting for laser printers, 443
media bays, 333
media slices, 332
memory
  CMOS, 116-117, 123-124
  installing in printers, 473-474
  laser printers, 440-441
  memory slots, 54
  portable/laptop computers, 329
  preventative maintenance, 217
RAM, 199
  compatibility, 201
  DDR SDRAM, 202
  DDR2 SDRAM, 202-203
  DDR3 SDRAM, 203-204
  DRAM, 201
  ECC, 208
  memory modules, 205-207
  parity checking, 207
  Rambus, 203-204
  registered, 209
  SDRAM, 202
  SRAM, 202
  troubleshooting, 213-216
  unbuffered, 209
  variables, 199-201
  removing from laptops, 375-376
  virtual memory, 680-682
mesh topology, 828
Micro ATX form factor, 49
microfilters, 817
microphones, 263, 267-268
Microsoft Management Console (MMC), 665-666
Microsoft System Configuration Utility (MSCONFIG.EXE), 668
Microsoft Technet, 18
MIDI, 262
MIDI ports, 257, 267
migrating user data, 702-703
Mini-DIN ports, 255
Mini-PCI, 338-340, 372-373, 809
Mini-PCIe, 338-340
minimum requirements, verifying for Windows operating systems, 699-701
Mitnick, Kevin, 411
MMC (Microsoft Management Console), 665-666
MMX, 85
modem cables, 242
modems, 809-810
  analog, 812-813
  cellular, 831
  DSL, 816
  PC Card, 812
monitors. See displays
monochrome laser printers, 442
motherboards, 47
  ATX form factor, 49
  BTX form factor, 50-51
  chipsets, cooling, 184
  daughterboards, 51
  expansion slots, 54
    AGP slots, 55
    AMR slots, 58
    CNR slots, 58
    for video cards, 297
    PCI slots, 55
    PCIe slots, 56-58
  header cables, troubleshooting, 73
  installing, 66-68
  integrated I/O ports, 52-53
  I/O bus, 49
  mass storage devices, troubleshooting, 74
mass storage devices, troubleshooting, 74
mass storage interfaces, 59
  EIDE/PATA, 60-61
  SATA host adapters, 61
  SCSI host adapters, 61-62
memory slots, 54
  NLX form factor, 51
non-starting, troubleshooting, 69-72
port cluster, troubleshooting, 72-73
removing, 63-66
riser cards, 51
selecting, 63
slot clearances, troubleshooting, 74
system bus, 48-49
troubleshooting, 68
mount points, 623
mounting drives, 623
mouse, 259
  installing, 265
  maintenance, 286-287
  resource usage, 260
  troubleshooting, 270-274
MSB, 7
MSCONFIG.EXE, 668
MSDS (Material Safety Data Sheet), 885
MSKB (Microsoft Knowledge Base), 18
multi-core processors, 85
multi-mode fiber-optic cable, 834
multicast addresses, 853
multimedia devices
  biometric devices, 268
digital cameras, 262, 266
microphones, 263, 267-268
MIDI, 262, 267
MMX processors, 85
sound cards, 263, 268-269, 275-277
touch screens, 268
video capture cards, 264, 269-270
webcam, 262, 266
multimeters, 491
multitesters, 170-172
multivoltage power supplies, 159-160
My Computer, 590-591
My Network Places, 598

naming files, 634
Narrow SCSI host adapters, 62, 229
NAT, 405
native capacity, 538
navigating between folders, 628
needle-snose pliers, 3
negative pressure, 164
net command, 868
NetBEUI, configuring, 853
network adapters
CardBus, 839
PC Card, 839
USB, 839
network cards
duplex mode, 840
hardware resources, 839
media type, 840
PCI, 838
PCI Express, 838
network client software, configuring, 853
network configuration
717-718
network drive installation, performing on Windows operating systems, 711
network models
client/server, 805
clients, 807
servers, 806
peer-to-peer, 807
SOHO networks, creating, 874-875
troubleshooting, 871-873
network printers
installing, 859-860
troubleshooting, 874
network protocols. See specific protocols
Network Setup wizard (Windows XP), 853
network topologies, 827
Network window, 597
New Technology File System (NTFS), 625-626
nibble, 10
NiCd batteries, 351
NiMH batteries, 351
NLX motherboards, 51
installing, 68
removing, 66
non-ECC memory, 208
non-starting motherboards, troubleshooting, 69-72
non-volatile memory, 116
northbridge cooling, 184
case fans, 187-188
liquid cooling, 191
thermal compound, 188
video card cooling, 186
notebook computers. See laptop computers
Notification area, 600-602/nslookup command, 870
NTBackup, 641-642, 760-761
Ntbootdd.sys, 611-612
Ntdetect.com, 610-612
NTFS (New Technology File System), 395, 625-626
NTLDR, 610-612
Ntoskrnl.exe, 610
NTUSER.DAT.LOG, 613
null-modem cable, 242
numbering systems, 6
binary, 6-7
capacity, measuring, 11
converting, 7-10
data storage, 11-14
decimal, 6
hexadecimal, 14
NX (no execute), 90
octets, 849
odd parity, 207
opening desktop PC case, 33
operating system recovery. See recovering, Windows operating systems. See also specific operating systems
access control, 412
components, 415
for operating systems, 413-414
permissions, 414-415
restricted spaces, 415
UAC, 412-413
user accounts, 412
attended installation, 716-717
commands, 32
hardware compatibility, verifying, 699-701
unattended installation, 716-717
optical drives, 530-532
installing, 533
removing from laptops, 374
speed ratings, 532
optimizing performance
ATA/IDE hard drives, 526
disk-cache settings, 530
DMA transfers, 528-529
IDE block mode, 528
IDE busmastering drivers, 528
transfer rates, 526-527
printer performance
device calibration, 470
media types, 470
paper orientation, 471
print order, 472
print spooler settings, 468
XPS, 469
Windows
applications, 688-690
hard disks, 684
Performance Monitor, 680-682
services, 686-687
startup, 688
System Monitor, 680-682
temporary files, 684-685
virtual memory, 680-682
OSD picture quality, troubleshooting, 315-317
overclocking, 86, 138, 213
overheating
overheated power supplies, 161-164
overheated processors, 98-99
preventing on portable/laptop computers, 384
overloaded power supplies, 159-162
overvoltages, 176
page printers, 451
PANs (personal area networks), 830
paper
paper counts, resetting on printers, 489
paper jams, troubleshooting, 483-484
paper-out errors, troubleshooting, 482
selecting
  for impact printers, 448
  for inkjet printers, 446-447
  for laser printers, 443
parallel ports, 246
parallel transfers, 15-16
parity checking, 207
parity errors, 215
partitions, 615-617
  explained, 615
  extended partitions, 616
  primary partitions, 615
passive heat sinks, 183
passive-matrix LCD screens, 344
passwords
  creating for wireless networks, 399
  managing, 409
PATA hard drives, 61, 509
  ATA RAID arrays, 523-526
  BIOS, configuring, 517-519
  configuring, 126, 132
  drive jumping, 510-511
  installing, 512-514, 536
  performance, optimizing, 526
  disk-cache settings, 530
  DMA transfers, 528-529
  IDE block mode, 528
  IDE busmastering drivers, 528
  transfer rates, 526-527
  troubleshooting, 550-552
PC Card network adapters, 839
PC Cards, 334-337, 370
PC tools, 3
PCCard modems, 809, 812
PCI cards, installing, 38-39, 838
PCI Express network cards, installing, 838
PCI Express x16 slots, 297
PCI slots, 55
PCle (PCI-Express) slots, 56-58
peer-to-peer network model, 807, 828, 859
penlight, 3
Pentium 4 processor, 76
Pentium D processor, 76
Pentium III processor, 76
Pentium MMX processor, 85
  performance
    of ATA/IDE hard drives, 526-530
    of printers, optimizing
      device calibration, 470
      media types, 470
      paper orientation, 471
      print order, 472
      print spooler settings, 468
      XPS, 469
    of Windows. See optimizing performance, Windows processors, 88
Performance Monitor, 680-682
peripherals
  antenna wires, 384
  keypads, 383
  portable/laptop computers, 331
    docking stations, 331
    drive bays, 333
    port replicators, 332
  removing from
    portable/laptop computers, 382
  stylus, 383
permissions, 414-415
  file permissions, 639-640
  inheritance, 414
phantom directories, 549
Phenom processor family, 80
phishing, 411
physical security policies, 405-406
PIN authentication, 396
Pin to Start Menu command, 605
pincushion distortion, 315
ping command, 868
pinouts for serial ports, 240-241
PIO peak transfer rates, 527
pixels, 309-312
plenum cable, 837
PnP/PCI Configuration dialog (BIOS setup), 135
PnP/PCI Configurations menu, 135
points of failure, 29-30, 914-915
POP (post office protocol), 826
port clusters, 53, 72-73
port replicators, 332
portable computers
  AC power supply, 379
  communications connections
    Bluetooth, 340-341, 358
    cellular WAN, 342, 359
    Ethernet, 342, 359
    IrDA, 341, 359
    WLAN, 343, 359-363
  cooling devices, 384
  DC power supply, 380
  displays
    brightness, adjusting, 364
    contrast, adjusting, 364
    DualView, 365-366
    preventative maintenance, 386
    shared video memory, adjusting, 364
    troubleshooting, 380-382
  expansion slots, 334
  Mini-PCI, 338-340
  Mini-PCIe, 338-340
  PCMCIA, 334-337
  features, comparing with desktop computers, 327-329
  input devices, 346
    digitizers, 347
    Fn keys, 347
    pointing stick, 349
    stylus, 347
    touch pads, 347-349
    TrackPoint, 349
  LCD screen technologies, 343
    active-matrix, 344
    passive-matrix, 344
    resolution, 344
    screen quality, 345
    memory, 329
  peripherals, 331
    docking stations, 331
    drive bays, 333
    port replicators, 332
    removing, 382
troubleshooting, 383-384
power management, 350
  ACPI, 353-355
  hibernate mode, 356
  S3 sleep state, 356
  stand by mode, 357
power sources, 363
  AC adapters, 351-353
  batteries, 350-351
processor throttling, 350
recommended operating environments, 386
storage devices, 330-331
storage methods, 386
transporting, 386
ports. See I/O ports
POST (power-on self test), 116, 140
  beep codes, 141-142
  error messages, 142
  hex codes, 143
power conditioning units, 181
power diagnostics, 887
power management
  for portable/laptop computers
    ACPI, 353-355
    hibernate mode, 356
    S3 sleep state, 356
    stand by mode, 357
  on portable/laptop computers, 350
Power Management menu
  (BIOS setup), 134
power supplies, 157
  as high voltage hazard, 891-892
  connectors, 165-167
  DC voltage levels, 172-174
  efficiency, 162
  for portable/laptop computers
    AC adapters, 351-353
    AC power, troubleshooting, 379
    batteries, 350-351
    DC power, troubleshooting, 380
    WLAN, 363
  hazards, avoiding, 174-176
  minimum safety standard compliance, 159
  multivoltage, 159-160
  overheated, 161-164
  overloaded, 159
  power conditioning units, 181
  ratings, 157
  removing, 168-169
  replacing, 165-169
  SPS systems, 178-180
  surge protectors, 176-177
  testing, 170-172
  troubleshooting, 181-182
  UPS, 178-180
PPPoE connections, 818
preparing hard disk for installation, 718-722
pretexting, 411
preventative maintenance
  for cooling systems on portable/laptop computers, 384
  for displays, 319, 386
  for memory, 217
  for portable/laptop computers, 386
  for printers, 489-491
preventing ESD, 4-5, 34-35, 886-887
PRI, 815
primary corona wire, 442
primary partitions, 615
print failures
  error messages, 487-488
  paper jams, 483-484
  paper-out errors, 482
  print quality problems, 484-486
  troubleshooting, 482-483
print processes, 450-451
  impact print process, 455
  inkjet print process, 453-454
  laser print process, 451-453
  thermal print process, 454-456
print quality problems, 484-486
print queue
  clearing, 482-483
  restarting, 483
printer cartridges, recycling, 883
printers. See also print processes
  802.11 WLAN support, 458
  as high voltage hazard, 891
  Bluetooth support, 457
  calibrating, 462
  cleaning, 489-491
  device drivers, 450, 459-461
  educating users about, 467
  Ethernet support, 457
  File and Printer Sharing, 854
  firmware, 450, 474-475
  impact, 447-448
  paper, selecting, 444
  ribbons, 448
  infrared (IrDA) support, 458
  inkjet, 444
    ink cartridges, 444-446
    paper and media, selecting, 446
  installing, 458-459
  laser, 439
    memory, 440-441
    paper, 443
    toner cartridges, 442
  LED, 440
  maintenance kits, 489
  memory, installing, 473-474
  network printers, installing, 859-860
  options, configuring, 462-463, 465
  paper counts, resetting, 489
  performance, optimizing
device calibration, 470
  media types, 470
  paper orientation, 471
  print order, 472
  print spooler settings, 468
  XPS, 469
  printing test pages, 466
  shared, 858
  thermal, 446
    paper, 447
    ribbons, 446
  toner cartridges, 442
  tray switching, 467
  troubleshooting
    findings, documenting, 482
    identifying the problem, 475-478
“out of memory” errors, 440-441
plan of action, establishing, 481
recommended tools, 491-492
stalled print spoolers, 776
system functionality, verifying, 481
theory of probable cause, 478-481
PrinterTechs.com, Inc., 489
printing test pages, 466
priority of processes, adjusting, 689
Processor and Memory
Configuration menu (BIOS setup), 137-138
processor throttling, 350
processors
32-bit versus 64-bit, 89
AMD, 79-80, 83
cache memory, 87-88
clock speed, 88
cooling systems, 183
dual-core, 85
hyperthreading, 84
installing, 90, 93-97
Intel, 75, 79
MMX, 85
multi-core, 85
NX, 90
overclocking, 86, 138
packaging, 83
performance, 88
selecting, 89-90
sockets, 83
throttling, 85
troubleshooting, 98-99
VRM, 88
Program Compatibility
Wizard, 576-579
protecting against ESD, 889-890, 893
PS/2 mode, 249
PS/2 ports, 255
PVC cabling, 837
Q-R
QoS (quality of service), 831
RAID arrays, configuring, 523-526
RAM, 199
compatibility, 201
DDR SDRAM, 202
DDR2 SDRAM, 202-203
DDR3 SDRAM, 203-204
DRAM, 201
ECC, 208
memory modules
installing, 210-212
comparing, 205
width, 206-207
parity checking, 207
Rambus, 203-204
registered memory, 209
SDRAM, 202
SRAM, 202
troubleshooting, 213-216
unbuffered memory, 209
variables, 199-201
Rambus, 203-204
Rambus RDRAM modules, installing, 210-212
RD command, 661
RDRAM modules, 205
Read-only attribute (files), 636
rear view of desktop PC, 25
recommended operating environments for portable/laptop computers, 386
recording
DVDs and CDs in Windows Vista, 535-536
DVDs and CDs in Windows XP, 534
error codes, 910
symptoms and error codes, 766-767
recovering
from failed BIOS updates, 147
Windows
Complete PC Backup, 759
Last Known Good Configuration, 747-749
System Restore, 757
Windows 7 image backup, 757-758
WinRE, 751-752
with ERD, 761
Recovery Console, 753-757
recovery DVD/CD, installing Windows from, 713
recycling
hardware, 398
printer cartridges, 883
toner, 883
refresh rate, 312-313
REGEDIT.EXE, 670-672
registered memory, 209
Registry, 580
data files
backing up, 613-614
explained, 612-613
editing, 670-672
Remote Desktop, 676-680
removable storage devices, 537-538
removable-media drives, troubleshooting, 561-563
removing
laptop hardware, 369
ExpressCards, 370-372
hard disk drives, 373-374
LCD panel, 376-377
memory, 375-376
Mini-PCI cards, 372-373
optical drives, 374
PC cards, 370
pointing devices, 377-378
motherboards, 63-66
peripherals from portable/laptop computers, 382
power supplies, 168-169
repairing MBR, 783-784
repeaters, 842
replacing
BIOS chips, 147-149
internal drives on notebook computers, 31
LCD displays on notebook computers, 31
power supplies, 165-169
video cards, 299
replacing parts, 915
resetting printer paper counts, 489
resolution, 309-312, 344
resolving IP addresses, 850
resources for troubleshooting, 916-917
restarting print queue, 483
restoring from backup, 673
Complete PC Backup, 759
Windows 7 image backup, 757-758
restricted spaces, access control, 415
REV drives, 537-538
RG-6 coaxial cable, 258, 836
RG-11 cable, 837
RG-59 coaxial cable, 836
ribbons for impact printers, 448
RIMMS, 203
ring topology, 828
ripping, 533
riser cards, 51
RJ45 connectors, 833
rootkits, 432
routers, 831, 842

S
S-Video connectors, 308
S3 sleep state, 356
S4 sleep state, 356
Safe mode (Windows), 747-749
safety issues
electrical systems, testing, 887
ESD
  preventing, 886-887
  protecting against, 888-890
hazards
  atmospheric, 897
  CRT monitors, discharging, 894
  heavy equipment, 897
  high voltage, 891-893
  liquid, 896
  mechanical, 895
  situational, 896-897
  tripping, 895-896
  MSDS, 885
safety standard compliance for power supplies, 159
SAM.LOG, 612
SATA drives, 509
  BIOS, 520
    configuring, 126, 132
  eSATA, 521
  host adapters, 516-517
    installing, 514-517
  RAID arrays, configuring, 523-526
    troubleshooting, 552-554
SATA host adapters, 61
satellite Internet, 818-819
scanning infrared technology, 261
Scanstate.exe, 703
Scheduled Tasks wizard, 794
Scott Mueller’s Upgrading and Repairing PCs, 116
screen quality for LCD screens, 345
screws, 3, 492
SCSI, 229
  cables, 233-234
  daisy-chaining, 234-237
  device ID, 231-232
  host adapter card installation, 236
  host adapters, 61-62
  multiple device support, 229-230
  signaling types, 234
  standards, 232-233
  termination methods, 237-238
  troubleshooting, 277-278
SDRAM, 202
Seagate DiscWizard for Windows and Maxtor MaxBlast 5, 794
sectors, 508, 517
security
  access control
    event logging, 415-416
    for components, 415
    for operating systems, 412-415
    for restricted spaces, 415
  UAC (User Account Control), 412-413
authentication, 395
  biometrics, 396
  smart cards, 396
  username/password, 396
backups, 408
  BIOS, 138, 417
  data access local security policy, 405-406
  data migration, 408
  data removal, 409
  encryption, 406-408
  file systems, 395
  hardware recycling, 398
  incident reporting, 410
malicious software protection, 431-432
malware, 397
password management, 409
  social engineering, 411
  software firewalls, 397, 418-419
    configuring exceptions, 419-420
  troubleshooting, 421-422
  Web browser configuration, 867
wireless clients, 422
  configuring with Windows 7, 426-427
  configuring with Windows Vista, 425-426
  configuring with Windows XP SP2/SP3, 422-425
wireless networks
  access points, configuring, 400-405
  clients, troubleshooting, 427
  unused connections, 428-430
WEP, 398-399
WPA, 398-399
workstations, locking, 410
SECURITY.LOG, 612
selecting
  battery backup units, 180
  motherboards, 63
  processors, 89-90
  vacuum cleaners, 922
self-powered hubs, 229
self-test feature (printers), 477-478
serial ports, 238-239
adding, 245
configuring, 243-246
disabling, 243-244
IRQ, 243
pinouts, 240-241
port addresses, 243
troubleshooting, 284-286
serial transfers, 16-18
Series A connectors, 226
Series B connectors, 226
serious errors, 141
servers, 806
service packs, installing, 790-792
services
identifying problems, 764
optimizing performance, 686-687
SFC (System File Checker), 790
shared resources, 860-861
File and Printer Sharing, 854
file sharing, 855
FQDNs, 862-863
mapped drives, 863-864
shared printers, 858
troubleshooting, 874
UNC, 861-862
user/group permissions
configuring in Windows Vista, 857
configuring in Windows XP, 855-857
shared video memory, adjusting, 364
shipping portable/laptop computers, 386
Shortcut Wizard, 604
shortcuts to Control Panel functions, 596
signal skew, 16
SIM (Windows System Image Manager), 711
SIMMs, 205, 209
simple file sharing, 855
single-mode fiber-optic cable, 834
SIP, 831
SIPP, 205
situational hazards, 896-897
six-step troubleshooting process, 5
Sleeper, 357
slot clearances, troubleshooting on motherboard, 74
Small Computer Systems Interface. See SCSI
small outline Rambus modules, 205
smart cards, 396
SMTP, 826
social engineering, 411
sockets, 83
SODIMMs, 205, 329
software. See applications
software firewalls, 397, 418-419
configuring exceptions, 419-420
troubleshooting, 421-422
software RAID arrays, 523
SOFTWARE.LOG, 612
SOHO networks, 874-875
solid state drives (SSDs), 546
solutions, documenting, 916
sound cards, 263
installing, 104, 268-269
troubleshooting, 275-277
southbridge cooling, 184
case fans, 187-188
liquid cooling, 191
thermal compound, 188
video card cooling, 186
SPDIF ports, 256
spikes, 176
SPS systems, 178-180
spyware, 432
SRAM, 202
SSDs (solid state drives), 546
SSE, 86
SSH, 824
SSID, 400-401, 841
SSL, 822
Stabilant-22a, 922
stand by mode, 357
Standard Features/Settings menu (BIOS setup), 125, 128
Start menu, 573-574, 603
customizing
in Windows 7, 605
in Windows XP/Vista, 605-608
properties, 605, 608
starting
command prompt sessions, 652
Control Panel, 595
Welcome Center, 574
startup
optimizing performance, 688
POST, 140
beep codes, 141-142
error messages, 142
hex codes, 143
startup errors, troubleshooting, 780
static electricity. See ESD
static IP addresses, 400
STOP errors, troubleshooting, 767-769
stopping unresponsive applications, 690
storage media, 530-533
storage methods for portable/laptop computers, 386
STP cabling, 832-834
stripe pitch, 302
strong passwords, creating for wireless networks, 399
stylus, 347, 383
subnet masks, 847-850
subsystems, 911
SuperLooper loopback plugs, 919
SuperMulti DVD drives, 532
surface wave technology, 261
surge protectors, 176-177
surge suppressors, 177
surges, 176
suspend mode, 893
switches, 842-843
symbolic links, 636
symptoms of problem, recording, 766-767
Sysprep utility, 712
System attribute (files), 636
System BIOS, 111
system bus, 48-49
system errors, 142
System Image Manager (SIM), 711
system lockups, troubleshooting, 770-772
system management tools
Device Manager, 662-664
Event Viewer, 672
Microsoft Management Console (MMC), 665-666
MSCONFIG.EXE, 668
REGEDIT.EXE, 670-672
Remote Desktop, 676-680
System Restore, 673-676
Task Manager, 666-667
System Monitor, 680-682
system requirements (Windows), 575-576
system restoration disc, 713
System Restore, 673-676, 757
system.LOG, 613

T

table mats, 888
tags (HTML), 822
talking to customers, 923-924
tape drives, 538-539, 561-563
TAs (terminal adapters), 815
Task Manager, 666-667, 785
Taskbar, 600-602
TCP/IP, 820
configuring, 844-847
DNS, 824
e-mail, 825-826
FTP, 822
HTML, 822
HTTP/HTTPS, 821
IP addresses, 847-850
IPv6, 851-853
ISPs, 821
ports, 826
SSH, 824
SSL, 822
Telnet, 823-824
TLS, 822
Telnet, 823-824
temporary files, optimizing performance, 684-685
termination methods, SCSI, 237-238
test pages, printing, 466
testing
electrical systems, 887
hardware, 918-919
power supplies, 170-172
text files, 632-634
thermal compound, 188
thermal print process, 454-456
thermal printers, 446
paper, 447
ribbons, 446
Thicknet, 837
Thin Ethernet, 836
throttling, 85
thumb drives, installing
Windows 7/Vista from, 714-716
TKIP (Temporal Key Integrity Protocol), 841
TLS (Transport Layer Security), 822
toner cartridges, 442, 883
topologies, 827
torx drivers, 3
touch pads, 347-349
touch screens, 261-262
installing, 268
troubleshooting, 274-275
touch-on-tube technology, 261
tracert command, 869
TrackPoint, 349
tracks, 517
transporting portable/laptop computers, 386
tray switching, 467
tripping hazards, 895-896
Trojan horses, 411, 432
troubleshooting. See also optimizing performance, Windows
adapter cards, 105-106
applications, 774-776
Auto Restart errors, 769-770
BIOS security issues, 417
boot errors
Windows 7/Vista, 777-779
Windows XP/2000, 779
client interview, 907-910
disk problems, 782-783
displays
advanced display properties, 316-317
OSD, 315
driver signing, 774
drivers, 777
GPFs, 781-782
I/O devices, 773
identifying hardware versus software problems, 911-914
IEEE 1394 ports, 280-281
keyboards, 270
LPT ports, 281-284
methodologies, 5, 905-906
analyzing the problem, 763
client interviews, 762-763
identifying the problem, 764
symptoms and error codes, recording, 766-767
mice, 270-274
motherboards, 68
header cables, 73
mass storage devices, 74
non-starting, 69-72
port cluster, 72-73
slot clearances, 74
network printers, 874
networks, 871-873
parts, replacing, 915
peripherals on portable/laptop computers
antenna wires, 384
keypads, 383
stylus, 383
points of failure, 914-915
portable/laptop computers
AC power supply, 379
DC power supply, 380
displays, 380-382
power problems, 181-182
print failures
error messages, 487-488
paper jams, 483-484
paper-out errors, 482
print quality problems, 484-486
print queue, 482-483
printers
  finding, documenting, 482
  identifying the problem, 475-478
  “out of memory” errors, 440-441
plan of action, establishing, 481
recommended tools, 491-492
system functionality, verifying, 481
theory of probable cause, 478-481
processors, 98-99
RAM, 213-216
resources, 916-917
SCSI devices, 277-278
serial ports, 284-286
shared resources, 874
software firewalls, 421-422
solutions, keeping track of, 916
sound cards, 275-277
stalled print spoolers, 776
startup errors, 780
STOP errors, 767-769
storage devices
  CD-ROM/DVD drives, 554-561
  external hard drives, 561-563
  floppy drives, 547-550
  PATA drives, 550-552
  SATA drives, 552-554
  tape drives, 561-563
system lockups, 770-772
touch screens, 274-275
troubleshooting cycles, 911
troubleshooting tools
  Device Manager, 786-790
  DxDiag, 773
  hardware diagnostics, 918-919
  SFC, 790
USB ports, 278-280
video hardware, 317-319
Windows upgrades,
  736-738
Windows. See recovering,
  Windows
  wireless clients, 427
turning off
  hibernation, 615
  indexing, 609
TVSS ratings, 177

U
UAC (User Account Control), 412-413
UART (universal asynchronous receiver transmitter), 809
UL standards for surge suppressors, 177
Unattend.xml, 711
unattended installation,
  716-717
unbuffered memory, 209
UNC, 861-862
UNC path names, 807
underclocked systems, troubleshooting, 99
unicast addresses, 852
Universal Serial Bus ports.
  See USB ports
unresponsive applications, stopping, 690
unused wireless network connections, security, 428-430
updates, installing, 793
updating
  AP firmware, 404-405
  BIOS, 144-145
  failed updates, recovering from, 147
  Flash BIOS updates, 145-146
upgrading Windows operating systems, 726-727,
  733
preparation, 727-728
to Windows 7
  from Windows Vista,
    727-730
  from Windows XP,
    734-735
to Windows Vista from
  Windows XP, 732
to Windows XP from
  Windows 2000, 735-736
troubleshooting Windows upgrades, 736-738
UPS systems, 178-179
  selecting, 180
USB 2.0 loopback plugs, 919
USB flash memory drives, 543-545
USB network adapters, 839
USB ports, 225
  adding, 228-229
  connectors, 226-228
  troubleshooting, 278-280
USB thumb drives, installing Windows 7/Vista from, 714-716
user accounts, 412
user data, migrating, 702-703
User State Migration Tool (USMT), 703
user/group permissions, configuring
  in Windows Vista, 857
  in Windows XP, 855-857
username/password authentication, 396
USMT (User State Migration Tool), 703
UserState.dat.LOG, 613
utilities, 32
UTP cabling, 832-834

V
vacuum cleaners, selecting, 922
verifying
  hardware compatibility for operating systems, 699-701
  Windows installation, 723-726
VGA cables, attaching, 37-38
VGA connectors, 305
video capture cards, 104, 264
installing, 269-270
video cards
bus types, 297
cooling, 186, 297-299
installing, 299-301
BIOS configuration, 298-299
video hardware, troubleshooting, 317-319
viewing event logs, 416
virtual memory, 680-682
viruses, 397
Vista. See Windows Vista
VoIP, 831
VRM (voltage regulator module), 88

W
wattage ratings for power supplies, 157
Web browsers
configuring, 865-866
installing, 864
script settings, configuring, 867
security, configuring, 867
web resources, 18
webcams, 262
installing, 266
Welcome Center, 573
WEP, 398-399, 841
“white box” systems, opening, 33
Wi-Fi, 829
Wide SCSI host adapters, 62, 229
width of memory modules, 206-207
Windows
application compatibility, 576
Backup and Restore, 644-646
boot errors, 777-779
boot sequence, 610
Computer, 590-591
configuring wireless clients with, 426-427
Devices and Printers folder, 598-600
editions, 701-702
Explorer view, 585
GUI, 572-573
image backup, 757-758
installing
from distribution DVD, 704-706
from USB thumb drive, 714-716
Network window, 597
Start menu, customizing, 605
system requirements, 575
upgrading
from Windows Vista, 727-730
from Windows XP, 734-735
Windows Explorer, 589
Windows 2000
boot errors, 779-780
ERD, 761
installation, starting from boot disk, 713-714
NTBackup, 641-642
Recovery Console, 753, 755-757
system requirements, 575
upgrading
to Windows Vista, 733
to Windows XP, 735-736
Windows Aero, 572
Windows calculator, 850
Windows Easy Transfer, 703
Windows Explorer, 581-589
command-line options, 651-652
Windows Firewall
configuring exceptions, 419-420
enabling, 418-419
Windows Gadgets, 573
Windows operating system. See also specific versions of Windows (for example, Windows Vista)
Advanced Boot Options, 749-751
application compatibility, 576-579
chkdsk.exe, 647-648
command prompt, 596
command-line functions, 652
CD, 661
CHDIR, 662
COPY, 658
DIR, 655-656
EDIT, 657-658
HELP, 655
MD, 661
RD, 661
starting command-prompt sessions, 652
table of internal commands, 653-654
wildcards, 654-655
XCOPY, 658-661
Control Panel, 591-596
DEFRAG, 640
device drivers, providing for installation, 722-723
Device Manager, 662-664, 786-790
differences in Windows versions, 572-579
Disk Management, 617-621
disk partitions, 615-617
explained, 615
extended partitions, 616
primary partitions, 615
Event Viewer, 672
file systems
converting, 626-627
exFAT, 625
explained, 624
FAT32, 624-625
NTFS, 625-626
files. See also specific files
attributes, 636-639
creating, 632
extensions, 635
long filenames, 634-635
naming, 634
permissions, 639-640
symbolic links, 636
text versus binary, 632-634
folders
attributes, 636-639
creating, 629
deleting, 629
in libraries, 629-630
Wireless Ethernet 983

managing in libraries, 630-631
navigating between, 628
Format.exe, 648-650
hard disk, preparing for installation, 718-722
indexing, 608-609
installation, 704
attended versus unattended installation, 716-717
from boot disks, 713-714
from disk image, 712-713
from network drive, 711
from recovery DVD/CD, 713
from USB thumb drives, 714-716
Windows 7 installation from distribution DVD, 704-706
Windows Vista installation from distribution DVD, 707-710
Windows XP installation from distribution DVD, 710-711
Microsoft Management Console (MMC), 665-666
minimum requirements, 699-701
mounting drives, 623
MSCONFIG.EXE, 668
My Computer, 590-591
network configuration, 717-718
Network window, 597
Notification area, 600-602
optimizing
applications, 688-690
hard disks, 684
Performance Monitor, 680-682
services, 686-687
startup, 688
System Monitor, 680-682
temporary files, 684-685
virtual memory, 680-682
recovering, 747-749
REGEDIT.EXE, 670-672
Registry, 580
data files, 612-614
editing, 670, 672
Remote Desktop, 676-680
Start menu, 573-574, 603
customizing, 603-605
properties, 605, 608
system requirements, 573-576
System Restore, 673-676
Task Manager, 666-667, 785
Taskbar, 600-602
upgrading, 726-727, 733
preparation, 727-728
troubleshooting Windows upgrades, 736-738
Windows 7 from Windows Vista, 727-730
Windows 7 from Windows XP, 734-735
Windows Vista from Windows XP, 732
Windows XP from Windows 2000, 735-736
verifying installation, 723-726
Welcome Center, 573
Windows Aero, 572
Windows Explorer, 581-589
customizing, 603-605
properties, 605, 608
system requirements, 575
upgrading, 733
to Windows 7, 727-730
to Windows XP, 732
user/group permissions, configuring, 857
Windows Explorer, 588
Windows XP, 583-584
application compatibility, 577-578
ASR, 760-761
boot errors, 779-780
boot sequence, 610-612
CDs, recording, 534-536
configuring wireless clients with, 422-425
DVDs, recording, 534
GUI, 574
installation
from boot disk, 713-714
from distribution DVD, 710-711
log files, 724
My Network Places, 598
Network Setup wizard, 853
NTBackup, 641-642
Recovery Console, 753-757
simple file sharing, 855
Start menu, customizing, 603-605
system requirements, 575
upgrading
from Windows 2000, 735-736
to Windows 7, 734-735
to Windows Vista, 732-733
user/group permissions, configuring, 855-857
WinRE, 751-752
WINS (Windows Internet Naming Service), 850
wire cutters, 920
Wireless Ethernet, 829-830
configuring, 840
wireless networks
APs, configuring, 400-405
clients, configuring, 422
with Windows 7, 426-427
with Windows Vista, 425-426
with Windows XP SP2/SP3, 422-425
clients, troubleshooting, 427
unused connections, 428-430
WEP, 398-399
WPA, 398-399
wizards
Add Printer Wizard, 459-461
Program Compatibility Wizard, 576-579
Scheduled Tasks wizard, 794
Shortcut Wizard, 604
WLANs, 343, 359-363
workstations, locking, 410
World Wide Web Consortium, 822
WPA, 398-399, 841
wrist straps, 4, 888-890

X-Y-Z
XCOPY command, 658-659, 661
XPS (XML Paper Specification), 469
zero compression, 851
Zip drives, 537
Zoomed Video (ZV) support, 336