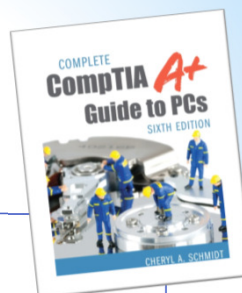


Chapter 6: Memory



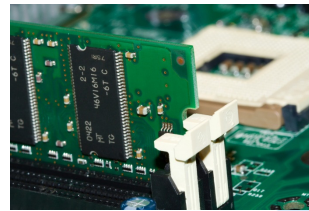
Complete CompTIA A+ Guide to PCs, 6e

CompTIA A+ Exam Objectives Covered in This Chapter

- 801-1.2: Differentiate between motherboard components, their purposes, and properties.
- 801-1.3: Compare and contrast RAM types and features.
- 801-1.5: Install and configure storage devices and use appropriate media.
- 801-3.1: Install and configure laptop hardware and components.
- 802-1.1: Compare and contrast the features and requirements of various Microsoft operating systems.
- 802-1.4: Given a scenario, use appropriate operating system features and tools.
- 802-1.5: Given a scenario, use Control Panel utilities.
- 802-3.1: Explain the basic features of mobile operating systems.
- 802-4.2: Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU, and power with appropriate tools.
- 802-4.6: Given a scenario, troubleshoot operating system problems with appropriate tools.

Chapter Objectives

- Different memory technologies
- How to plan for a memory installation or upgrade
- To install and remove memory chips
- How to optimize memory for Windows platforms
- Best practices for troubleshooting memory problems
- The benefits of teamwork



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3

Memory Overview

Computer systems need software to operate; without software, a computer is an expensive doorstop.

For a computer to operate, the software must reside in computer memory.


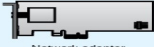

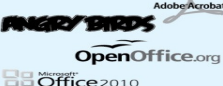
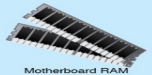


Upgrading memory is simple, but a technician must:

- understand memory terminology
- determine the optimum amount of memory for a system
- install the memory
- fine-tune it for the best performance
- and troubleshoot and solve any memory problems.

The two main types of memory are **RAM** (random-access memory) and **ROM** (read-only memory).

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4

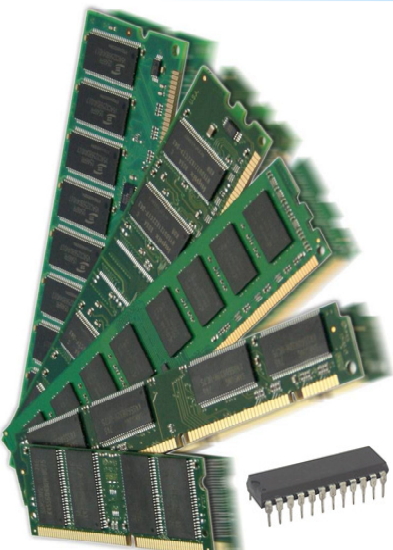
RAM vs. ROM			
RAM (random access memory)		ROM (read only memory)	
	Found on adapters		Found on adapters
Change	Can be changed		
	Volatile (data goes away when power is removed)	Change	Cannot be changed
	Holds actively running applications		
	Found on motherboards		Nonvolatile (data stays when power is removed)
	Stores part of the running operating system		

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RAM

- SRAM (Static RAM)
- DRAM (Dynamic RAM)
- RIMM (Rambus Inline Memory Module)
- DIMM (Dual Inline Memory Module)
- SIMM (Single Inline Memory Module)
- SO-DIMM (Small-Outline DIMM)
- DIP (Dual Inline Package)



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RAM – Major Types

RAM is divided into two major types:

- **DRAM** (dynamic RAM)
- **SRAM** (static RAM).

DRAM is less expensive but slower than SRAM.

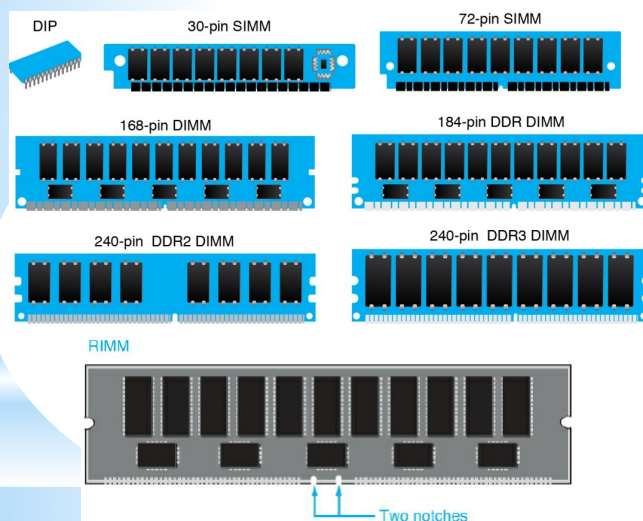
- With DRAM, the 1s and 0s inside the chip must be refreshed.
- Over time, the charge, which represents information inside a DRAM chip, leaks out.
- The information, stored in 1s and 0s, is periodically rewritten to the memory chip through the **refreshing** process.
- Refreshing is accomplished inside the DRAM while other processing occurs.
- Refreshing is one reason DRAM chips are slower than SRAM.

Most memory on a motherboard is DRAM, but a small amount of SRAM can be found inside the processor (L1) inside the processor housing (L2), and sometimes on the motherboard (L3). SRAM is also known as **cache memory**.

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Memory Physical Packaging



DIP – used by oldest motherboards

SIMM – 30 and 72 pins came next

DIMM – used today: 168, 184, or 240 pins

RIMM – used in older Pentium 4 computers

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Planning the Memory Installation

Along with knowledge about memory types, there are some key points to follow when planning a memory installation:

- Refer to the system or motherboard documentation to see what type of **memory technology** is supported.
- Determine what **features** are supported.
- Determine how much memory (**capacity**) is needed.
- Determine how many (**amount**) of each memory module is needed.
- Research prices and purchase memory module(s).

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Memory Technologies

FPM (Fast Page Mode)

EDO (Extended Data Out)

BEDO (Burst EDO)

SDRAM (Synchronous DRAM)

DDR (Double Data Rate)

DDR2

DDR3

DDR3L

RDRAM (Rambus DRAM)

Technology	Explanation
FPM (fast page mode)	FPM, EDO, and burst EDO speed up DRAM on sequential accesses to the memory chip. For example, if you have a 50ns DRAM and a 50ns FPM memory module, both types take 50 ns to access the chip the first time. On the second try, the FPM SIMM is accessed in 40ns. Used with SIMMs.
EDO (extended data out)	See explanation for FPM. A 50ns EDO memory module would take 50ns to access the chip, but on the second access, only 25ns are needed. Used with 72-pin SIMMs and 168-pin DIMMs.
BEDO (burst EDO)	See explanation for FPM. A 50ns BEDO memory module would take 50ns to access the chip, but on the second access, only 15ns are needed. Used with SIMMs and 168-pin DIMMs.
SDRAM (synchronous DRAM)	Performs very fast burst memory access similar to BEDO. New memory addresses are placed on the address bus before the prior memory address retrieval and execution is complete. SDRAM synchronizes its operation with the CPU clock signal to speed up memory access. Used with DIMMs.
DDR (double data rate)	Sometimes called DDR SDRAM or DDR RAM and developed from SDRAM technology. DDR memory can send twice as much data as PC133 SDRAM because with DDR, data is transmitted on both sides of the clock signal (rising and falling edges instead of just rising edge).
DDR2	Sometimes called DDR2 RAM. DDR2 uses 240-pin DIMMs and is not compatible with DDR.
DDR3	The latest in DDR technology that is an upgrade from DDR2 (8 bit prefetch buffer compared to 4 bits with DDR2). The technology better supports multi-core processor-based systems and more efficient power utilization.
DDR3L	A DDR3 module that runs at a lower voltage (1.35V) than the 1.5V or higher DDR/DDR2/DDR3 modules. Less voltages means less heat and less power consumed.
RDRAM (Rambus DRAM)	Developed by Rambus, Inc., and packaged in 184-pin RIMMs (which is a trademark of Rambus, Inc.). Must be installed in pairs with dual- and quad-channel motherboards. When RIMMs are used, all memory slots must be filled, even if a slot is not needed because the memory banks are tied together. Put a C-RIMM (continuity RIMM), which is a blank module, in any empty (unfilled) slot.

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Mobile Device Memory

The memory chips used with laptops are different from the ones used in desktop or tower computers.

Portables that use DIMMs use special types such as a **SO-DIMM** (small-outline DIMM).

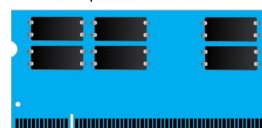
Older laptops used a 144- or 172-pin **microDIMM**.

Portables that used RIMMs used **SO-RIMMs** (small-outline RIMMs).

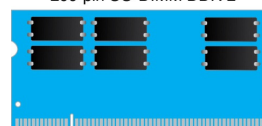
SO-DIMMs are the most popular, and come in:

- 72-pin version for 32-bit transfers
- 144-, 200-, or 204-pin versions for 64-bit transfers.

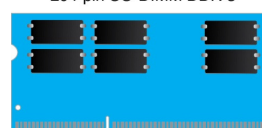
200-pin SO-DIMM DDR



200-pin SO-DIMM DDR 2



204-pin SO-DIMM DDR 3

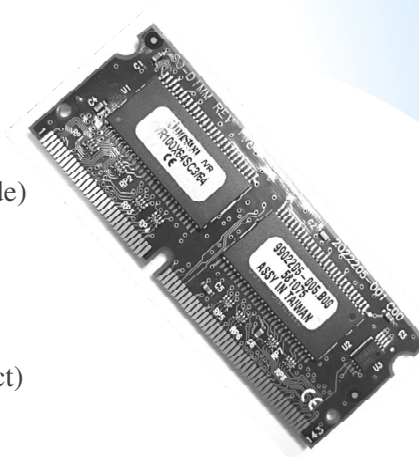


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Memory Features

- Parity
- Non-parity
- ECC (Error Correcting Code)
- Unbuffered Memory
- Registered Memory
- Fully Buffered Memory
- SPD (Serial Presence Detect)
- Single-sided Memory
- Double-sided Memory



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Memory Features

Feature	Explanation	
parity	A method for checking the accuracy of data going into or out of memory chips.	fully buffered memory
non-parity	Chips that do not use any error checking. Most memory modules today are non-parity because the memory controller circuitry provides error correction.	
ECC (error correcting code)	An alternative to parity checking that uses a mathematical algorithm to verify data accuracy. ECC can detect up to four-bit memory errors and correct one-bit memory errors. ECC is used in higher-end computers and network servers.	
unbuffered memory	The opposite of registered memory, used in low- to medium-powered computers. Unbuffered memory is faster than registered or fully buffered memory.	SPD (serial presence detect)
registered memory	Registered memory modules have extra chips (registers) near the bottom of the chip that, unlike unbuffered DDR or DDR2 modules, delay all data transfers by one clock tick to ensure accuracy. They are used in servers and high-end computers and tend to be taller than unbuffered memory modules. If you install a registered memory module into a system that allows both registered and unbuffered memory, all installed memory must be registered modules.	single-sided memory
		double-sided memory

A technology used in network servers and Apple computers. Requires a special memory controller. Fully buffered memory buffers the data pins from the channel and uses point-to-point serial signaling connections similar to PCIe. These chips are sometimes advertised as FBDIMMs.

Memory modules that have an extra EEPROM that holds information about the DIMM such as capacity, voltage, refresh rates, and so on. The BIOS can read and use this data to adjust motherboard timing for the best performance.

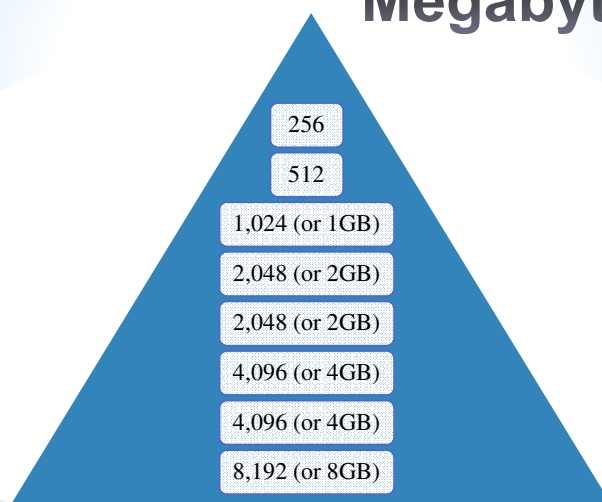
A memory module that has one "bank" of memory and 64 bits are transferred out of the memory module to the CPU. A better term for single-sided memory is single-banked memory. The module may or may not have all of its "chips" on one side.

A single memory module developed in a special way that it actually contains two memory modules in one container (two banks). If the motherboard slot has been designed to accept this type of memory module, data is still sent to the CPU 64 bits at a time. This is a way for having more banks of memory on the motherboard without requiring more memory slots. These modules normally have memory chips on both sides, but all modules with chips on both side are not double-sided memory.

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Memory Capacity in Megabytes



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The Amount of Memory to Install

When you want to improve the performance of a computer, adding memory is one of the easiest upgrades.

The amount of memory you need depends on:

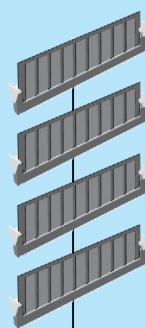
- what operating system you are using (Linux 64MB .. Windows 2GB)
- what applications you are using
- how many applications you want to have open at the same time
- the type of computer you are using
- the maximum amount allowed by your motherboard.

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Motherboard Memory Slots

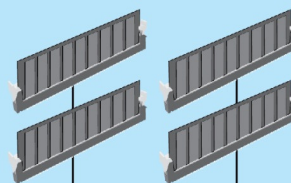
Single-channel memory



Channel A

Memory control hub

Dual-channel memory



Channel A

Channel B

Memory control hub

Single-channel memory

had one channel through which all data from the slots travelled.

Dual-channel memory

handles processing of memory requests more efficiently by handling two memory paths simultaneously.

E.g. four slots are divided into two channels with each channel having two slots each

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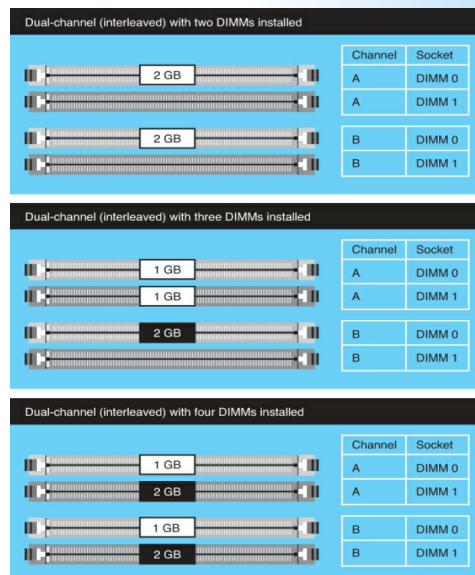
Dual-channeling

Dual-channeling increases a system's performance.

Note that on some motherboards:

- the memory modules on Channel A and Channel B do not have to be the same capacities
- but the total capacity of the memory modules installed in Channel A should match the total capacity of the memory modules in Channel B.

Some motherboards require this.



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Memory Safety Reminder



Before installing a memory module, power off the computer, disconnect the power cord from the back of the computer, and use proper antistatic procedures. Memory modules are especially susceptible to ESD. If ESD damages a memory module, a problem may not appear immediately and could be intermittent and hard to diagnose.

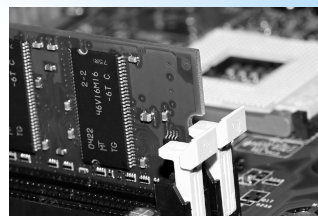
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Remove/Install Memory

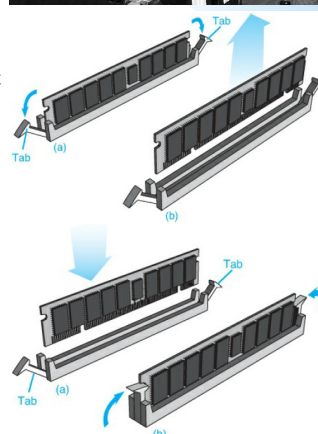
When removing a DIMM/RIMM:

- push down on the DIMM retaining tabs
- be careful not to overextend the tabs when pushing on them
- **If a plastic tab breaks, the only solution is to replace the motherboard.**



When installing a DIMM/RIMM:

- A DIMM/RIMM has one or more notches on the bottom, so it inserts into the memory socket only one way.
- The DIMM memory socket retaining tabs align with the DIMM notches. The DIMM will not insert into the memory socket unless oriented properly.
- A DIMM/RIMM is inserted straight down into the socket, not at a tilt like the SIMM or a SODIMM.
- Make sure the side tabs are pulled out before you insert the DIMM and close the tabs over the DIMM once it is firmly inserted into the socket.
- If the DIMM/RIMM does not go into the slot easily, do not force it and check the notch or notches for correct alignment.
- Once the DIMM is aligned correctly into the slot, push the DIMM firmly into the slot and the tabs should naturally close over the DIMM or on the sides of the DIMM.



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Windows Disk Caching

Virtual memory is a method of using hard disk space as if it were RAM.

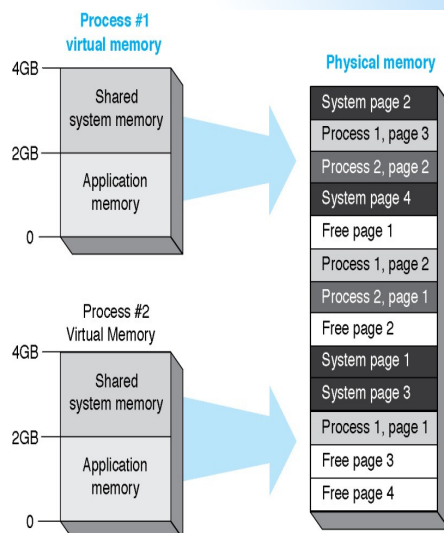
Virtual memory allows the operating system to run larger applications and manage multiple applications simultaneously.

The amount of hard disk space used is dynamic—it increases or decreases as needed.

A **swap file** is a block of hard drive space that applications use like RAM. Other names for the swap file include **page file** and **paging file**.

For optimum performance in Windows, set aside as much free hard disk space as possible for virtual memory and caching.

Keep your hard drive cleaned of temporary files and outdated files/applications.



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20

Troubleshooting Memory Problems

You can get “out of memory” errors, POST code errors, motherboard diagnostic lights or codes, system slowdowns, and application locking due to memory problems with any operating system.

With any of these problems, no matter which operating system is being used, check the amount of available memory and free space on the hard drive.

Sometimes you must close all applications, reboot the computer, and open only the application that was running when the out of memory error occurred because some applications do not release the memory space they hold.

Tips and troubleshooting steps :

- Add more RAM
- Use the Windows Memory Diagnostics Tool to thoroughly test your RAM.
- Delete files/applications that are no longer needed and close applications that are not being used.
- Empty the Recycle Bin.
- Adjust the size of the virtual memory.
- Do not put the swap file on multiple partitions that reside on the same hard drive. Use multiple hard drives, if necessary.
- Put the swap file on a hard disk partition that does not contain the operating system.
- Put the swap file on the fastest hard drive.
- Remove the desktop wallpaper scheme or use a plain one.
- Adjust your Temporary Internet Files setting for how much disk space is set aside for caching Web files.
- Defragment the hard drive.

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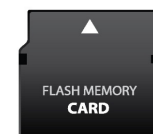
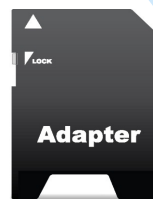
Flash Memory

Flash memory is a type of non-volatile, solid-state memory that holds data even when the computer power is off.

PCs use flash memory as a replacement for the BIOS chip. Network devices, smartphones, and tablets use flash memory to store the operating system and instructions. Some tablets can use external flash media for storage. Digital cameras use flash memory to store pictures; scanners use flash memory to store images; printers use flash memory to store fonts.

Flash memory does not have to be refreshed like DRAM and it does not need constant power like SRAM.

- CompactFlash (CF)
- Secure Digital (SD) Cards
- MultiMediaCards (MMCs)
- Extreme Digital (xD) Cards
- USB Flash Drives



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Soft Skills - Teamwork

No matter how good you are at your job, you are still better to a company if you are part of a team than if you're on your own.

Technicians need to be good team players and see themselves as a reflection of their company when on the job.

Teamwork is part of the skill set that employers seek as much as they want you to have technical skills.

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A+ Certification Exam Tips

Review memory chips and modules right before the exam(s) in case you are asked to identify the memory type or DDRx name.

Review Windows operating system memory limitations, especially the Windows 7 and 32-bit Windows memory limitations.

Know how to calculate what memory is needed for an upgrade or a new install.

Be able to identify memory slots on a motherboard.

Know how to populate memory when dual- or triple-channeling is being implemented.

Be able to describe the difference between unbuffered and ECC memory.

Know that memory chips are especially susceptible to ESD and how to prevent ESD damage when installing or removing memory.

Review the troubleshooting symptoms and tips for the 220-802 exam.

Keep in mind that the following professionalism skills are part of the 220-801 exam: (1) maintain a positive attitude and (2) be on time (or, if late, contact the customer). You should not forget to review the professionalism skills.

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Chapter Summary

- Memory on a motherboard is SDRAM, a type of RAM that is cheaper and slower than SRAM, the type of memory inside the CPU and processor housing.
- A DDR module fits in a DDR slot; so do DDR2 and DDR3 modules.
- RIMMs use RDRAM and were developed by Rambus, Inc. C-RIMMs are inserted into empty memory slots.
- Unbuffered memory is the memory normally installed in computers.
- ECC is used for error checking and is commonly found in high-end computers and servers. An older method of error checking was called parity.
- The CL rating or the timing sequence first number shows how fast the processor can access data in sequential memory locations. The lower the first number, the faster the access.
- SPD is a technology used so the memory module can communicate specifications to the BIOS.

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Chapter Summary

- Double-sided memory is one module that acts like two modules (not that it has chips on both sides even though it most likely does). A motherboard must support using double-sided modules.
- Before installing memory, plan your strategy: read the manual to see the type of memory, determine the total amount of memory, determine if any memory is to be removed, determine the memory to purchase, and be mindful of getting the most out of your memory by implementing dual-, triple-, or even quadruple-channeling.
- When implementing dual-, triple-, or quadruple-channeling, buy matching memory modules.
- Any 32-bit operating system is limited to 4GB of memory.
- Particular versions of Windows have memory limitations. For example, Windows 7 Starter edition is limited to 2GB, but any of the other Windows 7 versions can go to 4GB for the 32-bit versions. 64-bit version limitations are as follows: XP is 128GB. Vista/7 Home Basic is 8GB. Vista/7 Home Premium is 16GB. Vista higher versions are limited to 128GB. Windows 7 higher versions are limited to 192GB.
- RAM is very susceptible to ESD events. Use proper antistatic handling procedures, including using an antistatic wrist strap.

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Chapter Summary

- Before removing or installing memory, disconnect the power cord and remove the battery on a mobile device.
- Laptops and netbooks can sometimes be upgraded with SO-DIMMs. Tablets and smartphones can sometimes be upgraded and have additional storage using flash memory cards.
- Having as much RAM in the system as possible is an important performance factor; so is having free hard drive space because hard drive space is used as memory. This is called virtual memory, and the information stored temporarily on a hard drive is stored in an area known as a page file, paging file, or swap file. The swap file should be on the newest drive that has the most free storage.
- Use Task Manager to monitor memory performance.
- Use POST, motherboard LED/display output codes, BIOS diagnostics, and the Windows Memory Diagnostic Tool to diagnose memory problems.
- Flash media is used to provide memory or additional storage space for computing devices and includes USB flash drives, CF cards, and smaller cards, such as SD, microSD, miniSD, and xD.
- A technician is part of a business and should contribute to the team. A technician should professionally represent a company.

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