AL FURAT AL AWSAT TECHNICAL UNIVERSITY

NAJAF COLLEGE OF TECHNOLOGY

DEPARTMENT OF TECHNICAL COMMUNICATIONS ENGINEERIN

PC MAINTENANCE

3rd CLASS

2016/2017

Lecture#5

Lecturer

HAYDER S. RASHID

Hard Drive Technologies and Interface Standards

A **hard disk drive (HDD)**, most often called a **hard drive**, comes in two sizes for personal computers: the 2.5" size is used for laptop computers and the 3.5" size is used for desktops. See Figure (1). In addition, a smaller 1.8" size hard drive (about the size of a credit card) is used in some low-end laptops and other equipment such as MP3 players.

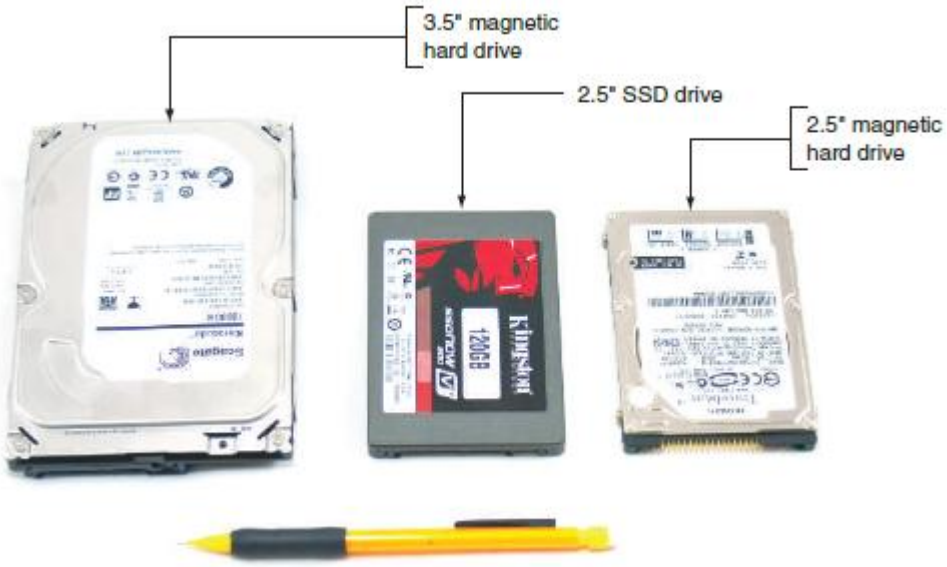


Figure (1) A hard drive for a desktop is larger than those used in laptops

1- Technologies Used inside a Hard Drive

The two types of hardware technologies used inside the drive are solid-state and magnetic. In addition, some drives use a combination of both technologies. Here are important details about each:

1.1 Solid-state drive.

A **solid-state drive (SSD)**, also called a **solid-state device (SSD)**, is called solid-state because it has no moving parts. The drives are built using non-volatile memory, which is similar to that used for USB flash drives. Recall that this type of memory does not lose its data even after the power is turned off.

In an SSD drive, flash memory is stored on EEPROM (Electronically Erasable Programmable Read-Only Memory) chips inside the drive housing. The chips contain grids of rows and columns with two transistors at each intersection that hold a 0 or 1 bit. One of these transistors is called a floating gate and accepts the 0 or 1 state according to a logic test called NAND (stands for “Not AND”). Therefore, the memory in an SSD is called **NAND flash memory**. EEPROM chips are limited as to the number of times transistors can be reprogrammed.

Therefore, the life span of an SSD drive is based on the number of write operations to the drive. (The number of read operations does not affect the life span.) For example, one SSD manufacturer guarantees its SSD drives for 20 GB of write operations per day for three years. For normal use, a drive would not be used that much and would last much longer.

Because flash memory is expensive, solid-state drives are much more expensive than magnetic hard drives, but they are faster, more reliable, last longer, and use less power than magnetic drives. Figure (2) shows two sizes of solid-state drives (2.5" and 1.8") and what the inside of an SSD hard drive looks like. The 1.8" drives are used in some laptops and other small mobile devices.

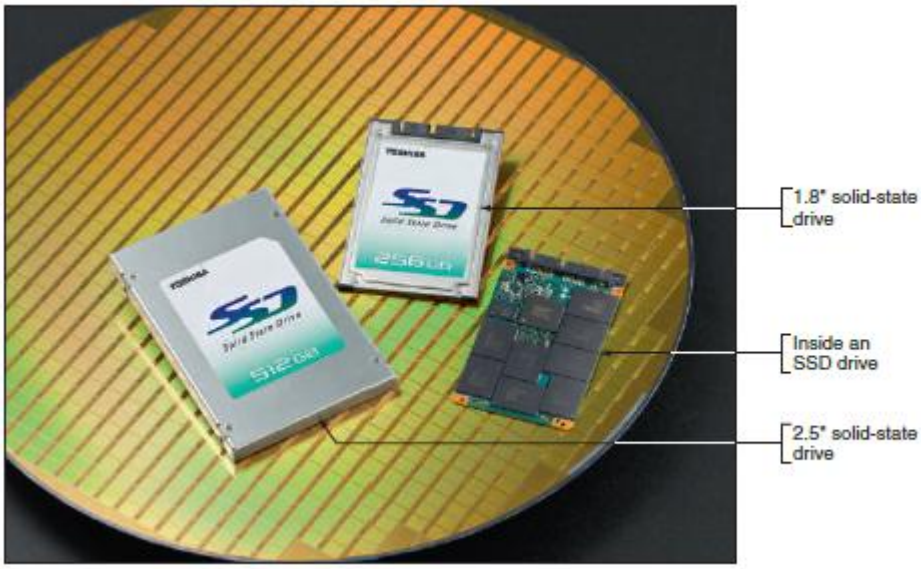


Figure (2) Solid-state drives by Toshiba

Notes Many solid-state drive manufacturers reserve blocks on the drive that are used when blocks begin to prove they are no longer reliable. Also, a technique called **wear leveling** assures that the logical block addressing does not always address the same physical blocks in order to distribute write operations more evenly across the device.

1.2 Magnetic hard drive.

A **magnetic hard drive** has one, two, or more platters, or disks, that stack together and spin in unison inside a sealed metal housing that contains firmware to control reading and writing data to the drive and to communicate with the motherboard. The top and bottom of each disk have a **read/write head** that moves across the disk surface as all the disks rotate on a spindle (see Figure 3). All the read/write heads are controlled by an actuator, which moves the read/write heads across the disk surfaces in unison. The disk surfaces are covered with a magnetic medium that can hold data as magnetized spots. The

spindle rotates at 5400, 7200, or 10,000 RPM (revolutions per minute). The faster the spindle, the better performing the drive.

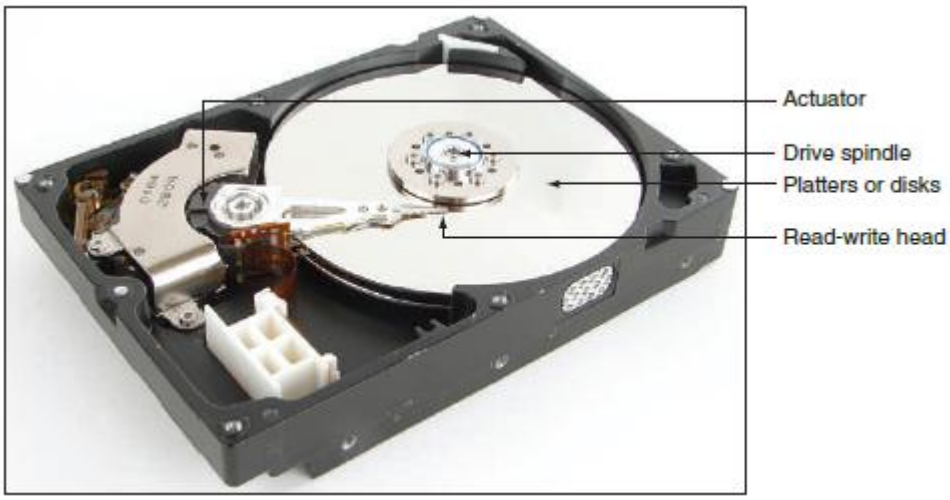


Figure (3) Inside a magnetic hard drive

Data is organized on a magnetic hard drive in concentric circles called tracks (see Figure 4). Each track is divided into segments called sectors (also called records). Older hard drives used sectors that contained 512 bytes. Most current hard drives use 4096-byte sectors.

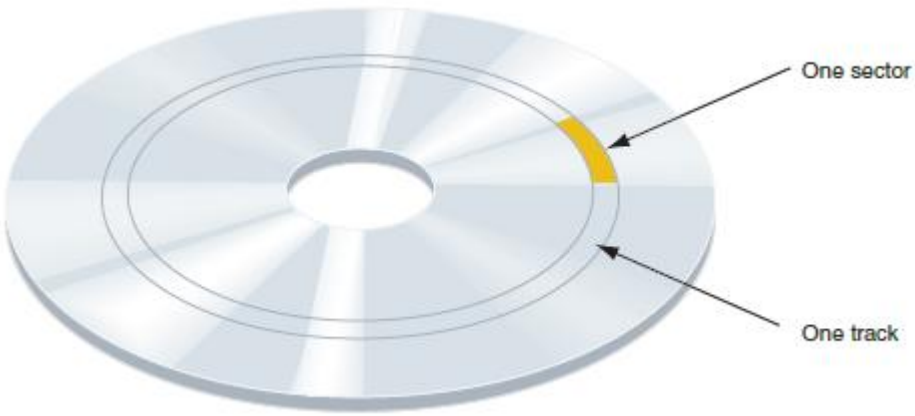


Figure (4) A hard drive is divided into tracks and sectors; several sectors make one cluster

1.3 Hybrid hard drives.

A **hybrid hard drive (H-HDD)**, sometimes called a solid-state hybrid drive (SSHD), uses both technologies. The flash component serves as a buffer to improve drive performance. Some hybrid drives perform just as well as an SSD drive. For a hybrid drive to function, the operating system must support it.

Before a magnetic drive leaves the factory, sector markings are written to it in a process called **low-level formatting**. (This formatting is different from the high-level formatting that Windows does after a drive is installed in a computer.) The hard drive firmware, UEFI/BIOS on the motherboard, and the OS use a simple sequential numbering system called logical block addressing (LBA) to address all the sectors on the drive. SSD drives are marked into blocks, which are communicated to the motherboard and OS, which read/write to the drive in blocks just as with magnetic drives.

The size of each block and the total number of blocks on the drive determine the drive capacity. Today's drive capacities are usually measured in GB (gigabytes) or TB (terabytes, each of which is 1024 gigabytes). Magnetic drives are generally much larger in capacity than SSD drives. You need to be aware of one more technology supported by both SSD and magnetic hard drives called **S.M.A.R.T. (Self-Monitoring Analysis and Reporting Technology)**, which is used to predict when a drive is likely to fail. System UEFI/BIOS uses S.M.A.R.T. to monitor drive performance, temperature, and other factors. For magnetic drives, it monitors disk spin-up time, distance between the head and the disk, and other mechanical activities of the drive. Many SSD drives report to the UEFI/BIOS the number of write operations, which is the best measurement of when the drive might fail. If S.M.A.R.T. suspects a drive failure is about to happen, it displays a warning message. S.M.A.R.T. can be enabled and disabled in UEFI/BIOS setup.

Notes Malware has been known to give false S.M.A.R.T. alerts.

2- SATA Interface Standards Used by a Hard Drive

All hard drives in today's personal computers use the SATA interface standards to connect to the motherboard. The **serial ATA** or **SATA** (pronounced "*say*-ta") standard uses a serial data path, and a SATA data cable can accommodate a single SATA drive (see Figure 5).

External hard drives can connect to a computer by way of external SATA (eSATA), FireWire, or USB. Be sure the port provided by the computer uses the same standard that the external drive uses, for example, SuperSpeed USB 3.0 or eSATA III. If the port is not fast enough, you can install an expansion card to provide faster ports.

A consortium of manufacturers, called the Serial ATA International Organization (SATA-IO; see *sata-io.org*) and led by Intel, developed the SATA standards, and

the standards also have the oversight of the T13 Committee (*t13.org*). SATA has had three major revisions, which are summarized in Table (1).

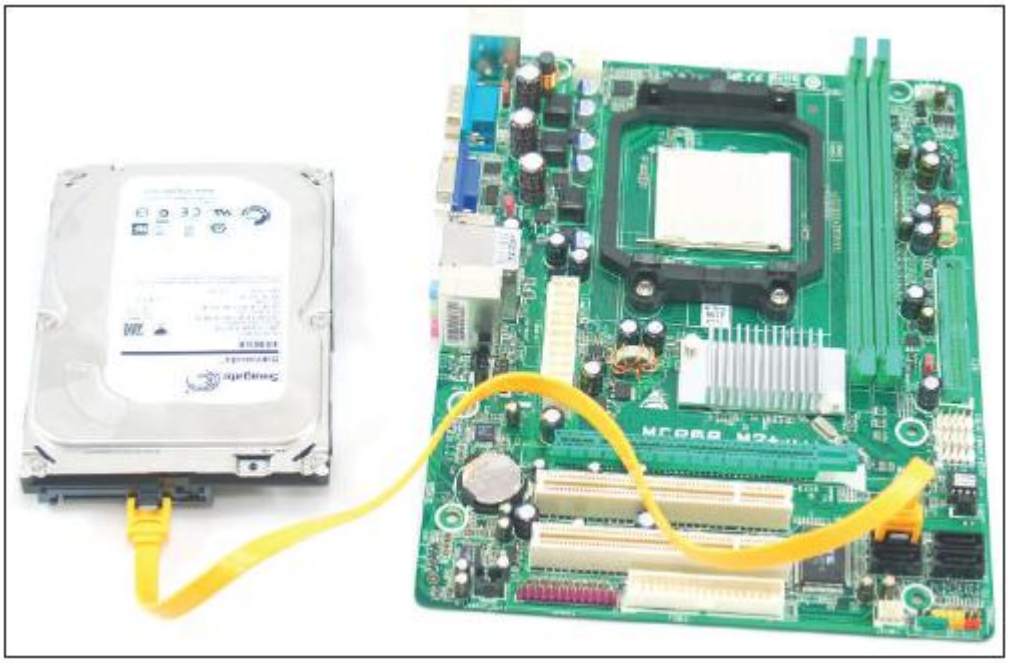


Figure (5) A SATA cable connects a single SATA drive to a motherboard SATA connector

SATA Standard	Data Transfer Rate	Comments
SATA Revision 1.x* SATA I or SATA1 Serial ATA-150 SATA/150 SATA-150	1.5 Gb/sec	SATA, first introduced as an ATA/ATAPI-7 standard, was published as part of a revision to the older PATA standards managed by the T13 Committee (*t13.org*) that governed the PATA standards.
SATA Revision 2.x* SATA II or SATA2 Serial ATA-300 SATA/300 SATA-300	3 Gb/sec	The first SATA II standards were published by the T13 Committee (*t13.org*) within ATA/ATAPI-8; later revisions of SATA II were published by SATA-IO (*sata-io.org*), which now manages SATA standards. The standard first came out in 2006. Most motherboards used it by 2010.
SATA Revision 3.x* SATA III or SATA3 Serial ATA-600 SATA/600 SATA-600	6 Gb/sec	SATA III was first published by SATA-IO in 2009. Most new motherboards today use this standard.

*Name assigned by the SATA-IO organization

Table (1) SATA standards

Notes Years ago, hard drives used the Parallel ATA (PATA) standards, also called the IDE (Integrated Drive Electronics) standards, to connect to a motherboard. PATA allowed for one or two IDE connectors on a motherboard, each using a 40-pin data cable. Two drives could connect to one cable. In addition, a few personal computer hard drives used the SCSI (pronounced "scuzzy") interface standard.

Notes Interface standards for drives define data speeds and transfer methods between the drive controller, the UEFI/BIOS, the chipset on the motherboard, and the OS. The standards also define the type of cables and connectors used by the drive and the motherboard or expansion cards.

SATA interfaces are used by all types of drives, including hard drives, CD, DVD, Blu-ray, and tape drives. SATA supports hot-swapping, also called hot-plugging. With **hot-swapping**, you can connect and disconnect a drive while the system is running. Hard drives that can be hot-swapped cost significantly more than regular hard drives.

A SATA drive connects to one internal SATA connector on the motherboard by way of a 7-pin SATA data cable and uses a 15-pin SATA power connector (see Figure 6). An internal SATA data cable can be up to 1 meter in length. A motherboard might have two or more SATA connectors; use the connectors in the order recommended in the motherboard user guide. For example, for the four connectors shown in Figure 6 and 7, you are told to use the red ones before the black ones.

Figure (6) A SATA data cable and SATA power cable

Figure (7) This motherboard has two black and two red SATA II ports

In addition to internal SATA connectors, the motherboard or an expansion card can provide **external SATA (eSATA)** ports for external drives (see Figure 8). External SATA drives use a special external shielded SATA cable up to 2 meters long. Seven-pin eSATA ports run at the same speed as the internal ports using SATA I, II, or III standards. The eSATA port is shaped differently from an internal SATA connector so as to prevent people from using the unshielded internal SATA data cables with the eSATA port. When purchasing a SATA hard drive, keep in mind that the SATA standards for the drive and the motherboard need to match. If either the drive or the motherboard uses a slower SATA standard than the other device, the system will run at the slower speed. Other hard drive characteristics to consider when selecting a drive are covered later in the lecture.

Figure (8) Two eSATA ports on a motherboard

3- Setting up Hardware RAID

For most personal computers, a single hard drive works independently of any other installed drives. A technology that configures two or more hard drives to work together as an array of drives is called **RAID (redundant array of inexpensive disks** or **redundant array of independent disks)**. Two reasons you might consider using RAID are:

- To improve **fault tolerance**, which is a computer's ability to respond to a fault or catastrophe, such as a hardware failure or power outage, so that data is

not lost. If data is important enough to justify the cost, you can protect the data by continuously writing two copies of it, each to a different hard drive. This method is most often used on high-end, expensive file servers, but it is occasionally appropriate for a single-user workstation.

- To improve performance by writing data to two or more hard drives so that a single drive is not excessively used.

3.1 Types of RAID

Several types of RAID exist; the four most commonly used are RAID 0, RAID 1, RAID 5, and RAID 10. Following is a brief description of each, including another method of two disks working together, called spanning. The first four methods are diagrammed in Figure (9):

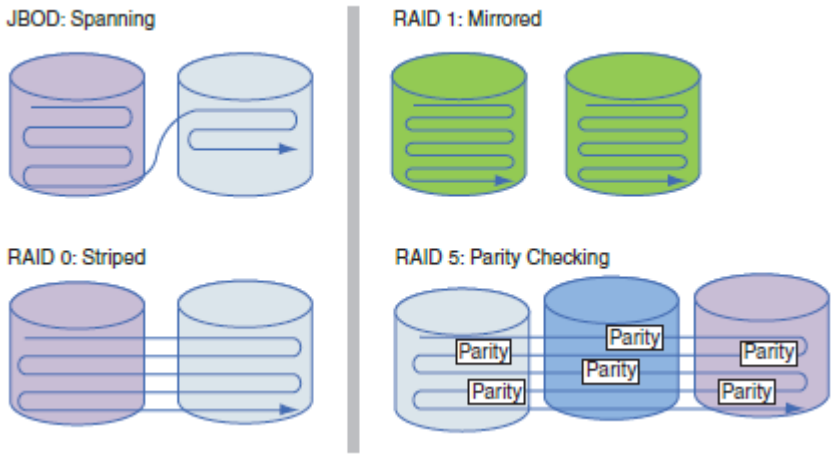


Figure (9) Ways that hard drives can work together

- **Spanning**, sometimes called JBOD (just a bunch of disks), uses two hard drives to hold a single Windows volume, such as drive E. Data is written to the first drive, and, when it is full, the data continues to be written to the second.
- **RAID 0** also uses two or more physical disks to increase the disk space available for a single volume. RAID 0 writes to the physical disks evenly across all disks so that no one disk receives all the activity and therefore improves performance. Windows calls RAID 0 a **striped volume**. To understand that term, think of data striped—or written across—several hard drives. RAID 0 is preferred to spanning.
- **RAID 1** is a type of mirroring that duplicates data on one drive to another drive and is used for fault tolerance. Each drive has its own volume, and the

two volumes are called mirrors. If one drive fails, the other continues to operate and data is not lost. Windows calls RAID 1 a **mirrored volume**.

- **RAID 5** stripes data across three or more drives and uses parity checking, so that if one drive fails, the other drives can re-create the data stored on the failed drive by using the parity information. Data is not duplicated, and, therefore, RAID 5 makes better use of volume capacity. RAID-5 drives increase performance and provide fault tolerance. Windows calls these drives **RAID-5 volumes**.
- **RAID 10**, also called **RAID 1+0** and pronounced "RAID one zero" (*not* "RAID ten"), is a combination of RAID 1 and RAID 0. It takes at least four disks for RAID 10. Data is mirrored across pairs of disks, as shown at the top of Figure (10). In addition, the two pairs of disks are striped, as shown at the bottom of Figure (10). To help you better understand RAID 10, in the figure notice the data labelled as A, A, B, B across the first stripe. RAID 10 is the most expensive solution that provides the best redundancy and performance.

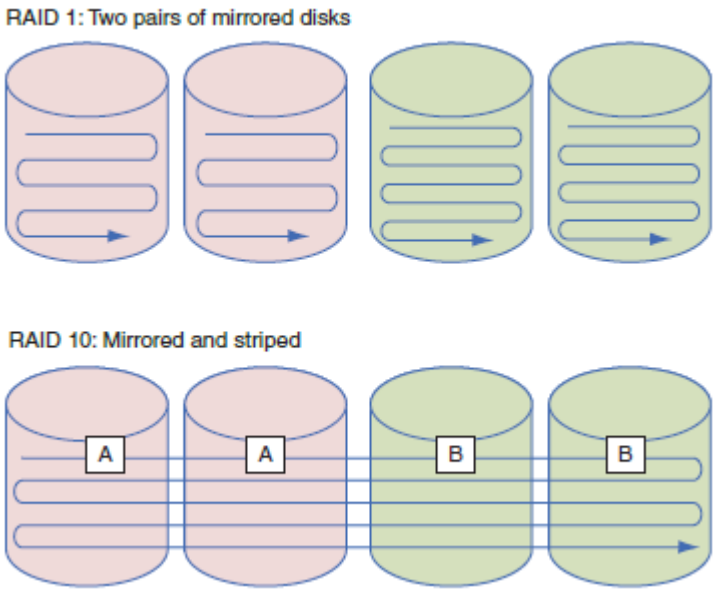


Figure (10) RAID 1 and RAID 10

All RAID configurations can be accomplished at the hardware level (called hardware RAID) or at the operating system level (called software RAID). Using Windows 7 to implement software RAID, the Disk Management utility is used to configure a group of hard drives in a RAID array. In Windows 8, you can use the Disk Management utility or the new Windows 8 Storage Spaces utility to implement software RAID. However, software RAID is considered an unstable solution and is not recommended by Microsoft. Configuring RAID at the

hardware level is considered best practice because if Windows gets corrupted, the hardware might still be able to protect the data. Also, hardware RAID is generally faster than software RAID.

3.1 How to Implement Hardware RAID

Hardware RAID can be set up by using a RAID controller that is part of the motherboard UEFI/BIOS or by using a RAID controller **storage card**. Figure (11) shows a RAID controller card by Sabrent that provides four SATA ports.

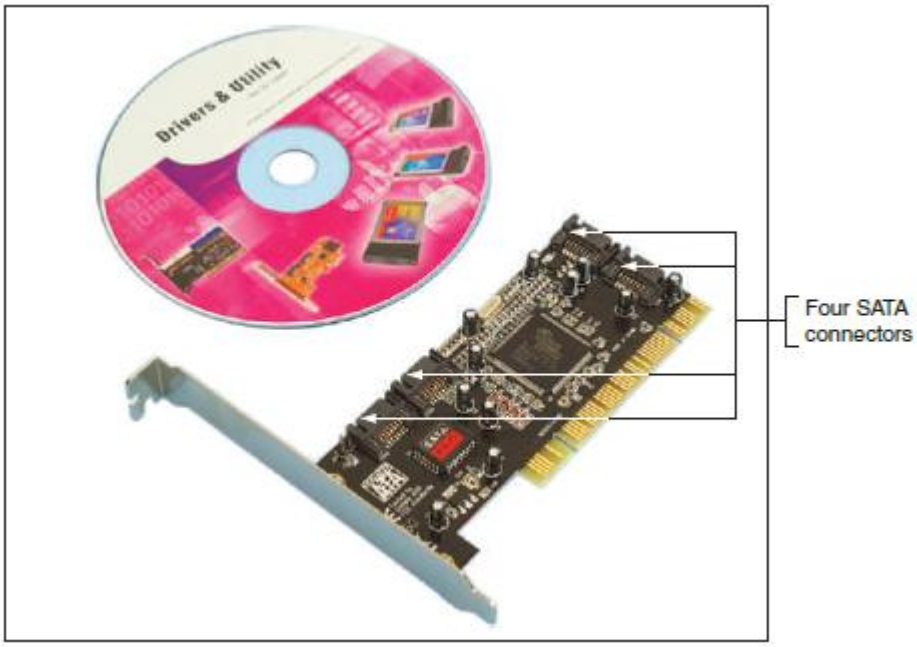


Figure (11) RAID controller card provides four SATA internal connectors

When installing a hardware RAID system, for best performance, all hard drives in an array should be identical in brand, size, speed, and other features. Also, if Windows is to be installed on a hard drive that is part of a RAID array, RAID must be implemented before Windows is installed. As with installing any hardware, first read the documentation that comes with the motherboard or RAID controller and follow those specific directions rather than the general guidelines given here. Make sure you understand which RAID configurations the board supports. For one motherboard that has six SATA connectors that support RAID 0, 1, 5, and 10, here are the general directions to install the RAID array using three matching hard drives in a RAID-5 array:

1. Install the three SATA drives in the computer case and connect each drive to a SATA connector on the motherboard (see Figure 12). To help keep the drives cool, the drives are installed with an empty bay between each drive.

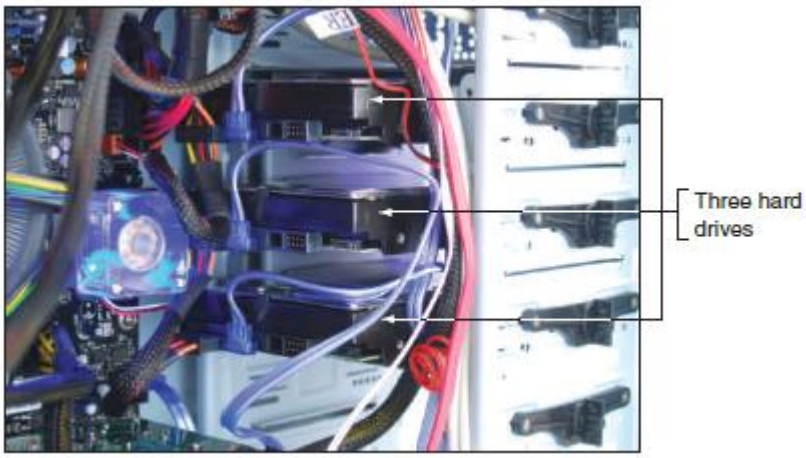


Figure (12) Install three matching hard drives in a system

2. Boot the system and enter UEFI/BIOS setup. On the Advanced setup screen, verify the three drives are recognized. Select the option to configure SATA and then select RAID from the menu (see Figure 13).

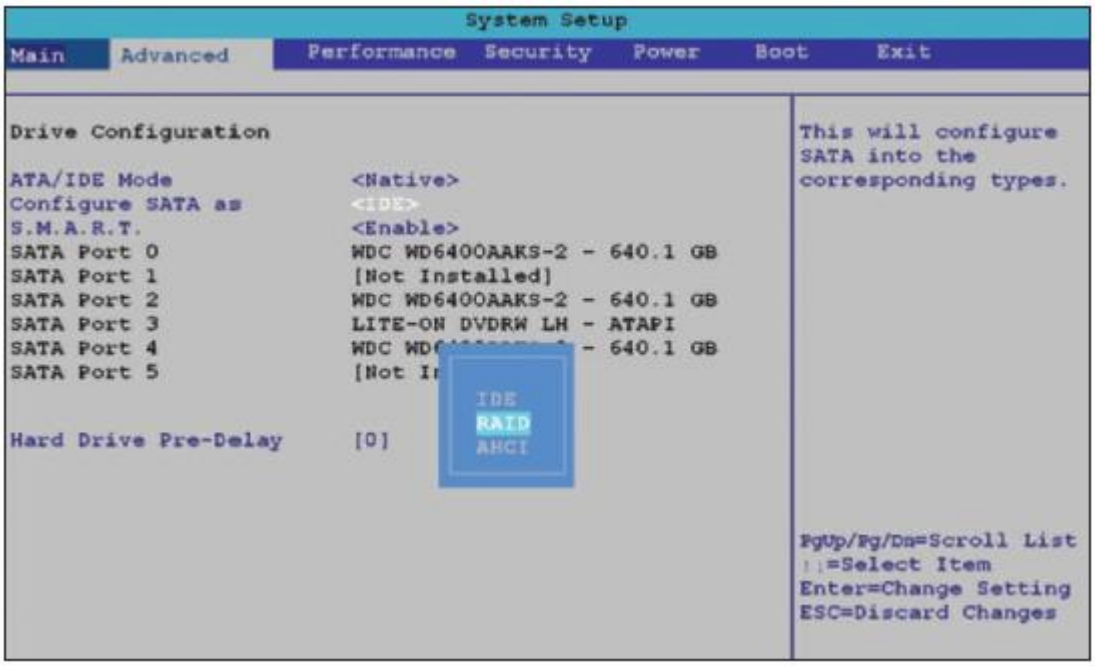


Figure (13) Configure SATA ports on the motherboard to enable RAID

3. Reboot the system and a message is displayed on screen: “Press <Ctrl+I> to enter the RAID Configuration Utility.” Press **Ctrl** and **I** to enter the utility (see Figure 14). Notice in the information area that the three drives are recognized and their current status is Non-RAID Disk.

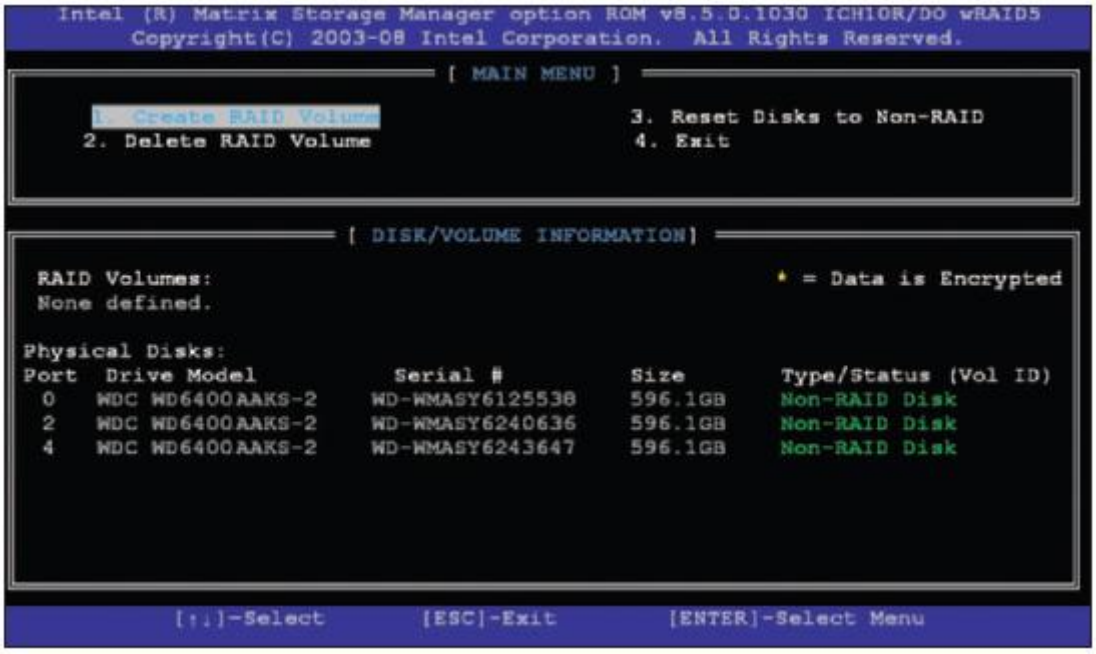


Figure (14) BIOS utility to configure a RAID array

4. Select option 1 to **Create RAID Volume**. On the next screen shown in Figure (15), enter a volume name (FileServer in our example).

Figure (15) Make your choices for the RAID array

5. Under RAID Level, select **RAID5 (Parity)**. Because we are using RAID 5, which requires three hard drives, the option to select the disks for the array is not available. All three disks will be used in the array.

6. Select the value for the Strip Size. (This is the amount of space devoted to one strip across the striped array. Choices are 32 KB, 64 KB, or 128 KB.)

7. Enter the size of the volume. The available size is shown in Figure 6-32 as 1192 GB, but you don't have to use all the available space. The space you don't use can later be configured as another array. (In this example, I entered 500 GB.)

8. Select **Create Volume** to complete the RAID configuration. A message appears warning you that if you proceed, all data on all three hard drives will be lost. Type **Y** to continue. The array is created and the system reboots.

You are now ready to install Windows. Windows 8/7/Vista have built-in hardware RAID drivers and, therefore, automatically "see" the RAID array as a single 500-GB hard drive. After Windows is installed on the drive, Windows will call it drive C:.

4- Other Types of Storage Devices

Before we explore the details of several other types of storage devices, including optical discs, USB flash drives, and memory cards, let's start with the file systems they might use.

4.1 File Systems Used by Storage Devices

A storage device, such as a hard drive, CD, DVD, USB flash drive, or memory card, uses a file system to manage the data stored on the device. A **file system** is the overall structure the OS uses to name, store, and organize files on a drive. In Windows, each storage device is assigned a drive letter. In Windows 8 File Explorer or Windows 7/Vista Windows Explorer, to see what file system a device is using, right-click the device and select **Properties** from the shortcut menu. The device Properties box appears, which shows the file system and storage capacity of the device (see Figure 16).

Installing a new file system on a device is called **formatting** the device, and the process erases all data on the device. One way to format a device is to right-click the device and select **Format** from the shortcut menu. In the box that appears, you can select the file system to use (see Figure 17). The New Technology file system (NTFS) is primarily used by hard drives. The exFAT file system is used by large-capacity removable storage devices such as large-capacity USB flash drives, memory cards, and some external hard drives. In addition, the older

FAT32 and FAT file systems are used by smaller-capacity devices. If you have problems with a device, make sure it's using a file system appropriate for your situation.

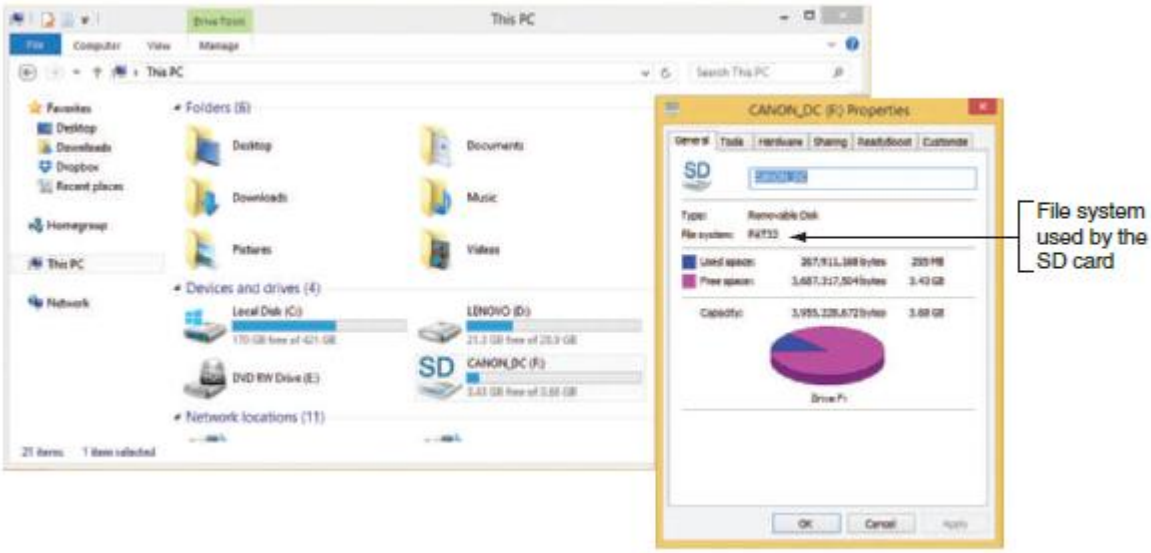


Figure (16) This 4-GB SD card is using the FAT32 file system

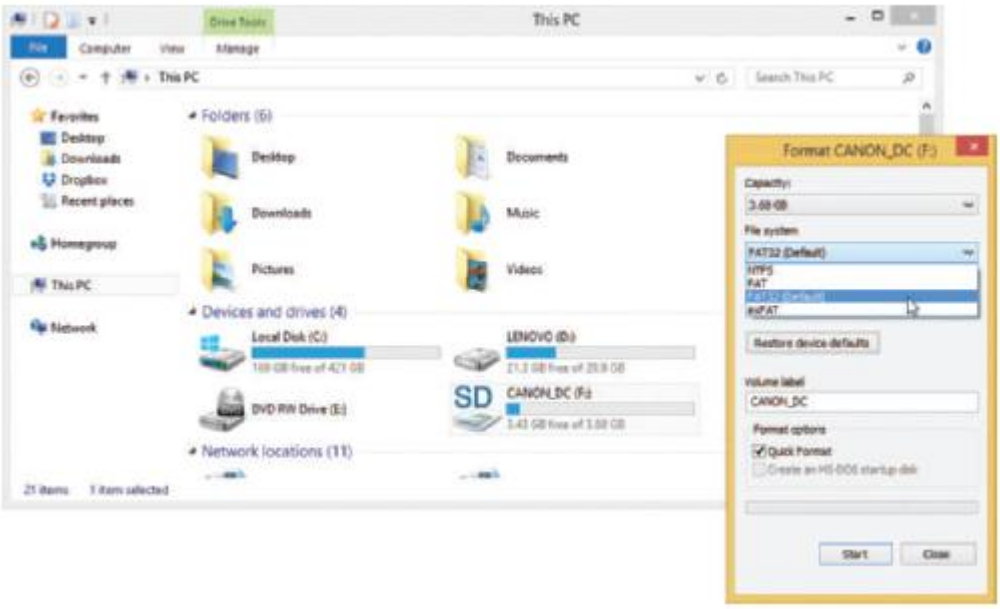


Figure (17) A storage device can be formatted using Windows Explorer

4.2 Standards Used by Optical Drives and Discs

CDs, DVDs, and Blu-ray discs use similar laser technologies. Tiny lands and pits on the surface of a disc represent bits, which a laser beam can read. This is why they are called optical storage technologies. **CD (compact disc)** drives use the

CDFS (Compact Disc File System) or the **UDF (Universal Disk Format) file system**, while **DVD (digital versatile disc** or **digital video disc)** drives and **Blu-ray Disc (BD)** drives use the newer UDF file system. Blu-ray drives are backward compatible with DVD and CD technologies, and DVD drives are backward compatible with CD technologies. Depending on the drive features, an optical drive might be able to read and write to BDs, DVDs, and CDs. An internal optical drive can interface with the motherboard by way of a SATA connection. An external drive might use an eSATA, FireWire, or USB port.

Data is written to only one side of a CD, but can be written to one or both sides of a DVD or Blu-ray disc. Also, a DVD or Blu-ray disc can hold data in two layers on each side. This means these discs can hold a total of four layers on one disc (see Figure 18). The breakdown of how much data can be held on CDs, DVDs, and BDs is shown in Figure (19). The capacities for DVDs and BDs depend on the sides and layers used to hold the data.

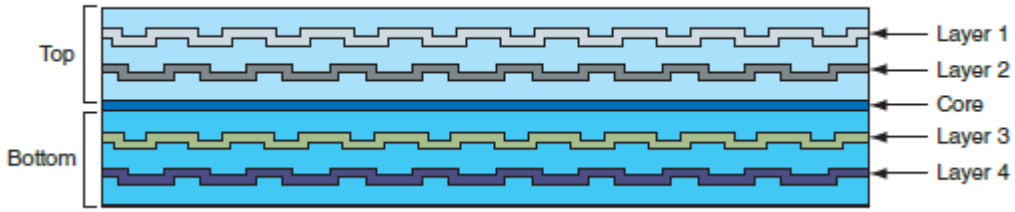


Figure (18) A DVD can hold data in double layers on both the top and bottom of the disc, yielding a maximum capacity of 17 GB

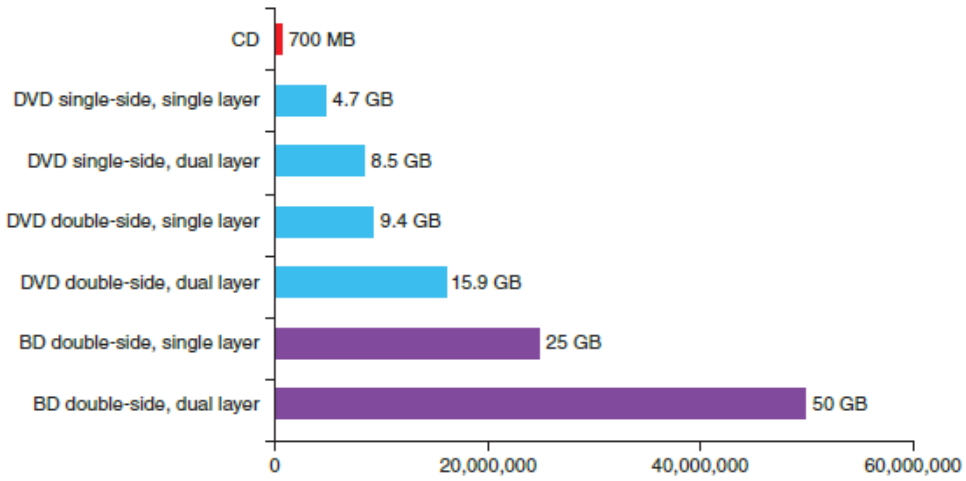


Figure (19) Storage capacities for CDs, DVDs, and BD discs

Notes The discrepancy in the computer industry between one billion bytes (1,000,000,000 bytes) and 1 GB (1,073,741,824 bytes) exists because 1 KB equals 1024 bytes. Even though documentation might say that a DVD holds 17 GB, in fact, it holds 17 billion bytes, which is only 15.90 GB.

To sort out the mix of disc standards, Table (2) can help. The table lists the popular CD, DVD, and Blu-ray disc standards.

Disc Standard	Description
CD-ROM disc or drive	*CD-read-only memory.* A CD-ROM disc burned at the factory can hold music, software, or other data. The bottom of a CD-ROM disc is silver. A CD-ROM drive can read CDs.
CD-R disc	*CD recordable.* A CD-R disc is a write-once CD.
CD-RW disc or drive	*CD rewriteable.* A CD-RW disc can be written to many times. A CD-RW drive can write to a CD-RW or CD-R disc and also overwrite a CD-RW disc.
DVD-ROM drive	*DVD read-only memory.* A DVD-ROM drive can also read CDs or DVDs.
DVD-R disc	*DVD recordable, single layer.* A DVD-R disc can hold up to 4.7 GB of data and is a write-once disc.
DVD-R DL disc	*DVD recordable in dual layers.* Doubles storage to 8.5 GB of data on one disc surface.
DVD-RW disc or drive	*DVD rewriteable.* A DVD-RW disc is also known as an erasable, recordable drive or a write-many disc. The speeds in an ad for an optical drive indicate the maximum speed supported when burning this type of disc, for example, DVD-RW 6X.
DVD-RW DL disc or drive, aka DL DVD drive	*DVD rewriteable, dual layers.* A DVD-RW DL disc doubles storage capacity to 8.5 GB.
DVD+R disc or drive	*DVD recordable.* Similar to but faster than DVD-R. Discs hold about 4.7 GB of data.
DVD+R DL disc or drive	*DVD recordable, dual layers.* Doubles disc storage to 8.5 GB on one surface.
DVD+RW disc or drive	*DVD rewriteable.* Faster than DVD-RW.
DVD-RAM disc or drive	*DVD Random Access Memory.* Rewriteable and erasable. You can erase or rewrite certain sections of a DVD-RAM disc without disturbing other sections of the disc, and the discs can handle many times over the number of rewrites (around 100,000 rewrites), compared with about a thousand rewrites for DVD-RW and DVD+RW discs. DVD-RAM discs are popular media used in camcorders and set-top boxes.
BD-ROM drive	*BD read-only memory.* A Blu-ray BD-ROM drive can also read DVDs, and some can read CDs.
BD-R disc or drive	*BD recordable.* A BD-R drive might also write to DVDs or CDs.
BD-RE disc or drive	*BD rewriteable.* A BD-RE drive might also write to DVDs or CDs.

Table (2) Optical discs and drive standards

Notes CDs, DVDs, and BDs are expected to hold their data for many years; however, you can prolong the life of a disc by protecting it from exposure to light.

4.3 Solid-state Storage

Types of solid-state storage include SSD hard drives, USB flash drives, and memory cards. USB flash drives currently for sale range in size from 128 MB to 1 TB and go by many names, including a flash pen drive, jump drive, thumb drive, and key drive. Several USB flash drives are shown in Figure (20). Flash drives might work at USB 2.0 or USB 3.0 speed and use the FAT (for small-capacity drives) or exFAT file system (for large-capacity drives). Windows 8/7/Vista has embedded drivers to support flash drives. To use one, simply insert the device in a USB port. It then shows in Windows 8 File Explorer or Windows 7/Vista Windows Explorer as a drive with an assigned letter.

Figure (20) USB flash drives come in a variety of styles and sizes

To make sure that data written to a flash drive is properly saved before you remove the flash drive from the computer, double-click the **Safely Remove Hardware** icon in the notification area of the Windows taskbar, the Safely Remove Hardware box opens. After you click the device listed, it is then safe to remove it.

Memory cards might be used in digital cameras, tablets, cell phones, MP3 players, digital camcorders, and other portable devices, and most laptops have memory card slots provided by a built-in **smart card reader**. If there is not a memory card slot included in the device, you can add an external smart card reader that uses a USB connection. The most popular memory cards are **Secure Digital (SD) cards**, which follow the standards of the SD Association (*sdcard.org*), and are listed in Table (3). The three standards used by SD cards are 1.x (regular SD), 2.x (SD High Capacity or SDHC), and 3.x (SD eXtended Capacity or SDXC). In addition, these cards come in three physical sizes.

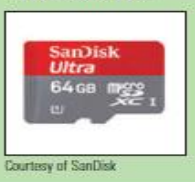
	Full-size SD	MiniSD	MicroSD
SD SD 1.x Holds up to 2 GB	SD card 	MiniSD card 	MicroSD card 
SD High Capacity SD 2.x Holds 2 GB to 32 GB	SDHC card 	MiniSDHC 	MicroSDHC card 
SD eXtended Capacity SD 3.x Holds 32 GB to 2 TB	SDXC card 	N/A	MicroSDXC card  Courtesy of SanDisk

Table (3) Flash memory cards that follow the SD Association standards

SDHC and SDXC slots are backward compatible with earlier standards for SD cards. However, you cannot use an SDHC card in an SD slot, and you cannot use an SDXC card in an SDHC slot or SD slot. Only use SDXC cards in SDXC slots. SD and SDHC cards use the FAT file system, and SDXC cards use the exFAT file system. Windows 8/7/ Vista support both file systems, so you should be able to install an SD, SDHC, or SDXC card in an SD slot on a Windows 8/7/Vista laptop with no problems (assuming the slot supports the SDHC or SDXC card you are using). Memory cards other than SD cards are shown in Table (4). Some of the cards in Table (4) are now obsolete.

Flash Memory Device	Example
The Sony Memory Stick PRO Duo is about half the size of the Memory Stick PRO but is faster and has a higher storage capacity (up to 2 GB). You can use an adapter to insert the Memory Stick PRO Duo in a regular Memory Stick slot.	
Compact Flash (CF) cards come in two types, Type I (CFI) and Type II (CFII). Type II cards are slightly thicker. CFI cards will fit a Type II slot, but CFII cards will not fit a Type I slot. The CF standard allows for sizes up to 137 GB, although current sizes range up to 32 GB. UDMA CompactFlash cards are faster than other CompactFlash cards. UDMA (Ultra Direct Memory Access) transfers data from the device to memory without involving the CPU.	
MultiMediaCard (MMC) looks like an SD card, but the technology is different and they are not interchangeable. Generally, SD cards are faster than MMC cards.	
Embedded MMC (eMMC) is internal storage used instead of using an SSD drive in inexpensive mobile devices such as cell phones, tablets, and laptops.	 Courtesy of SanDisk
The Memory Stick is used in Sony cameras and camcorders. A later version, the Memory Stick PRO, improved on the slower transfer rate of the original Memory Stick.	
The xD-Picture Card has a compact design (about the size of a postage stamp), and currently holds up to 2 GB of data. You can use an adapter to insert this card into a PC Card slot on a laptop computer or a CF slot on a digital camera.	

Table (4) Flash memory cards

Figure (21) shows several flash memory cards together so you can get an idea of their relative sizes. Sometimes a memory card is bundled with one or more adapters so that a smaller card will fit a larger card slot.

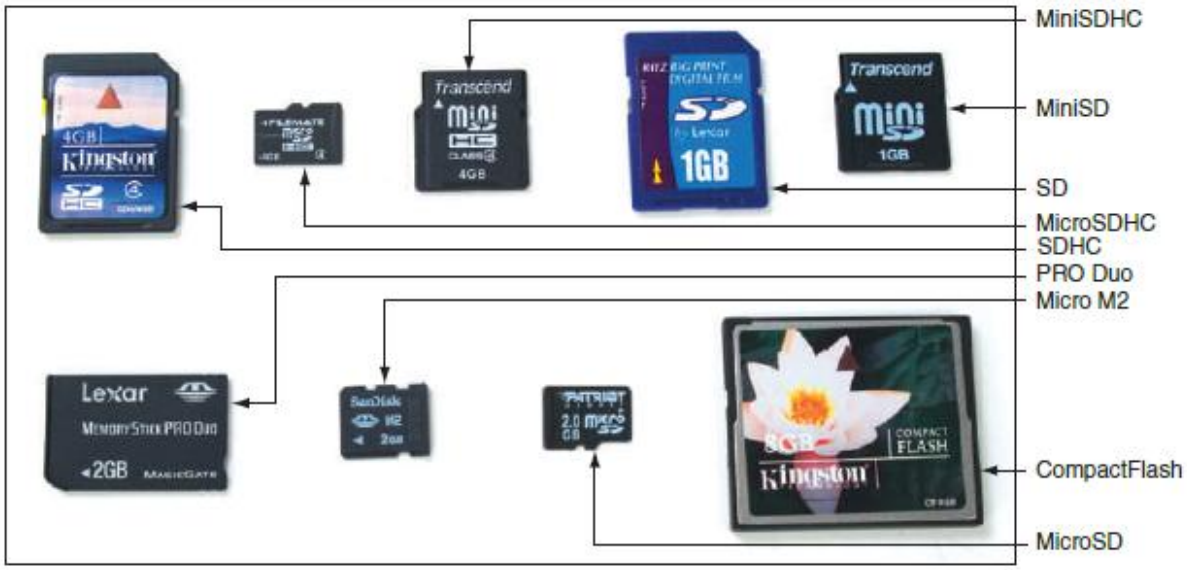


Figure (21) Flash memory cards

LEACTURE SUMMARY

- A hard disk drive (HDD) comes in three sizes: 3.5" for desktop computers and 2.5" and 1.8" for laptops.
- A hard drive can be a magnetic drive, a solid-state drive, or a hybrid drive. A solid-state drive contains flash memory and is more expensive, faster, more reliable, and uses less power than a magnetic drive.
- Most hard drives, tape drives, and optical drives use the SATA interface standards. External SATA ports are called eSATA ports.
- Three SATA standards provide data transfer rates of 1.5 Gb/sec (using SATA I), 3.0 Gb/sec (using SATA II), and 16.0 Gb/sec (using SATA III).
- S.M.A.R.T. is a self-monitoring technology whereby the UEFI/BIOS monitors the health of the hard drive and warns of an impending failure.
- RAID technology uses an array of hard drives to provide fault tolerance and/or improvement in performance. Choices for RAID are RAID 0 (striping using two drives), RAID 1 (mirroring using two drives), RAID 5 (parity checking using three drives), and RAID 10 (striping and mirroring combined using four drives).
- Hardware RAID is implemented using the motherboard UEFI/BIOS or a RAID controller card. Software RAID is implemented in Windows. Best practice is to use hardware RAID rather than software RAID.

- File systems a storage device might use in Windows include NTFS, exFAT, FAT32, and FAT.
- CDs, DVDs, and BDs are optical discs with data physically embedded into the surface of the disc. Laser beams are used to read data off the disc by measuring light reflection.
- Optical discs can be recordable (such as a CD-R disc) or rewriteable (such as a DVD-RW disc).
- Flash memory cards are a type of solid-state storage. Types of flash memory card standards by the SD Association include SD, MiniSD, MicroSD, SDHC, MiniSDHC, MicroSDHC, SDXC, and MicroSDXC. Other memory cards include Memory Stick PRO Duo, Memory Stick PRO, Sony Memory Stick Micro M2, CompactFlash I and II, eMMC, and xD-Picture Card.