5.1.3 Disk Facts

A *file system* is a means for organizing and storing data on a storage device. The file system and the operating system work together to ensure data availability, integrity, and accessibility. The following table describes the four main components of a file system:

Component	Description
Partition	A *partition* is a logical division of the storage space on a storage device (e.g., a hard disk drive). Several partitions can be created on a single storage device, and each partition is assigned a unique drive letter. Multiple drive letters do not always indicate multiple storage devices; they simply indicate multiple partitions. Consider the following reasons for partitioning a storage device: • Using one partition for operating system files and another for data files can sometimes help the system run more smoothly and minimize damage in the event of a system crash. • Creating multiple partitions allow for the creation of a dual-boot system, where one operating system is installed on one partition and a second operating system is installed on a second partition. Unallocated space is space on a storage device that that has not been assigned to a partition. Data cannot be stored or read in unallocated space.
Volume	A *volume* is a single storage area within a file system. Depending on how it is configured, a volume can encompass a single partition or span multiple partitions. Volumes are identified by drive letters (for example, C:, D:, or F:).
Folder	A *folder*, or *directory*, is a container in a volume that holds files or additional folders. Folders are used to logically sort and organize data--in other words, they keep related files grouped together. Most operating systems use a hierarchal filing structure.
File	A *file* is a one-dimensional stream of bits that are treated as a logical unit. Files are the most basic component of a file system and are used to organize raw bits of data on the storage device. A complete filename is made up of the base file's name and the directory path to the file. An extension can also be added to the filename to identify the file type and program used to create, view, and modify the file.

When managing disks on a Windows server, you can choose from two different partition formats:

Partition Format	Description

Master Boot Record (MBR)	A storage device using MBR partitioning can have a single partition or multiple partitions. The most common partitioning scheme divides a disk into the following two partition types:
	
	• A *primary* partition is used to store both data and the operating system. Primary partitions:
	  • Can hold operating system boot files.
	  • Can be formatted with a file system.
	  • Cannot be further subdivided into logical drives.
	
	  On a single hard disk drive, there can be a maximum of four primary partitions or three primary partitions and one extended partition.
	
	• An *extended* partition is an optional partition that contains logical partitions. Because an operating system cannot be booted from a logical partition within an extended partition, this type of partition is not bootable. Extended partitions:
	  • Can be further subdivided into a large number of logical partitions.
	  • Cannot be directly formatted with a file system. However, logical partitions within an extended partition can be formatted with a file system.
	
	  Only one extended partition can exist on a single hard disk drive.
	
	The MBR partition format has been in use since the 1980s. Because of its age, the MBR partition format has many limitations.
	
	• The master boot record must be installed in the first 512 bytes of the hard disk.
	• Only four standard partitions can be created on a storage device.
	• The default block size of 512 bytes limits partitions to a maximum size of 2 TB.
	
	To address these limitations, several MBR workarounds have been implemented over the years.
	
	• *Logical block addressing* (LBA) allows the use of larger hard disks.
	• Use of 4,096-byte sectors increases the maximum partition size on a disk.

	▪ Extended partitions can contain many logical partitions.
GUID Partition Table (GPT)	The GPT partition format was created as a replacement for the legacy MBR partition format. GPT has the following advantages over MBR: ▪ Only one type of partition is used (there are no primary, extended, or logical partitions). ▪ Extremely large storage devices and partitions are supported. ▪ Up to 128 partitions on a storage device are allowed. ▪ Identical copies of the partition table are stored in both the first and last sectors of the storage device. If one copy gets corrupted, then the redundant copy can be used instead. ▪ Partition table integrity is verified using a *cyclic redundancy check* (CRC). ▪ Each storage device and partition is assigned a unique ID. Whenever possible, consider using GPT partitioning to set up a new drive. When implementing GPT partitioning, be aware of the following: ▪ Windows can only boot from a GPT partition on UEFI-based computers running 64-bit versions of Windows. All 64-bit versions of Windows 7 and later can use GPT drives for storing data, but they cannot boot from them without UEFI firmware on the motherboard. ▪ If you need to ensure compatibility with older operating systems so you have the ability to boot Windows on a computer with a traditional BIOS, you'll need to use MBR partitioning instead of GPT. You can convert disks between MBR and GPT formats. For example, you can convert a GPT partition to an MBR partition and store operating systems files on it.

Formatting is the process of preparing a partition to store data. This is accomplished by installing a file system on the partition. The file system ensures the following concerning data:

▪ Consistent saving
▪ Well-organized and easy to locate
▪ Quickly retrievable
▪ Preserved integrity

Be aware of the following facts regarding formatting:

▪ When formatting a disk, you identify the file system type and identify the cluster size used to store data.
▪ Formatting removes the existing file system (if present) and installs the new file system type. Formatting a drive removes file and folder entries for all existing data on the partition.
▪ If a storage device will be accessed by different operating systems, be sure to select a file system that is supported by all operating systems.
▪ When using NTFS on removable storage devices, the Safely Remove Hardware utility must be used before removing the device in order to prevent file corruption.

When configuring your hard drive, you must choose a file system to implement on your computer. The following table explains the characteristics of each file system supported by the Windows operating system:

Property	FAT32*	NTFS	ReFS
Partition Size	2 terabytes	256 terabytes	1 yobibyte
Volume Size	2 terabytes	256 terabytes	1 yobibyte
Filename Length	Long File Names (255 characters, spaces)	Unicode (255 characters, anything but /)	Unicode (255 characters, anything but /)
File Size	4 gigabytes	16 terabytes	16 exbibytes
Number of Files	268,435,437	4,294,967,295	18.4×10^{18}
ACL Support	No	Yes	Yes
Encryption Support	No	Yes	Yes
Compression Support	No	Yes	Yes
Quota Support	No	Yes	Yes

*Windows Server only supports the use of FA32 file systems on removable storage devices, such as flash drives.

The Extended File Allocation Table (exFAT) file system is another file system that is designed specifically for removable flash-based storage devices, such as USB flash drives. Using NTFS on flash drives is usually not a good idea. This is due to its high overhead and the risk of

corruption if the device is not stopped properly prior to removal. Microsoft introduced native exFAT support in Windows 7 to allow large removable flash storage devices to continue to use a FAT-type file system.