

## - 1.3.2. Managing disks and drives -

When you get right down to it, storage defines what you can and can't do with Microsoft Windows.

A big hard disk (or two or three) makes it possible for you to download and store an enormous amount of digital music, photos, and video; manage large-scale, data-intensive projects; and keep your entire collection of digital resources safely backed up.

Using today's gigantic disks effectively, however, often entails partitioning them intelligently so that separate volumes can be assigned distinct purposes.

For various reasons, we recommend, for example, that you keep your operating system and personal data on separate volumes, that (if possible) you make a full image backup of the volume on which the Windows system files are stored, and that you make regular and frequent backups of your valuable data.

All of this requires some planning and some familiarity both with disk-management concepts and with management tools that Windows 10 provides.

### The Windows 10 disk-management tools

The principal disk-management tool in Windows 10 is the Disk Management console (Diskmgmt.msc).

For those who need to incorporate disk-management tasks in scripts (as well as for those who simply prefer carrying out administrative tasks at the command prompt), Windows also provides a powerful command-line program called DiskPart.

Everything you can do with Disk Management you can also do by using DiskPart; you just have to work harder and more carefully.

Accessing Windows Management Instrumentation (WMI) through Windows PowerShell provides another method for managing disks.

This method offers capabilities that are not available with the Disk Management console or DiskPart, and it has the additional advantage of custom programmability, which can be useful when you need to perform disk-management operations repeatedly on different computers.

Knowing when to use which tool is the secret of disk wizardry in Windows 10.

Disk Management, for example, is ideal for shrinking and expanding volumes, while the Clean command in DiskPart makes short work of preparing a disk to be formatted for a new role.

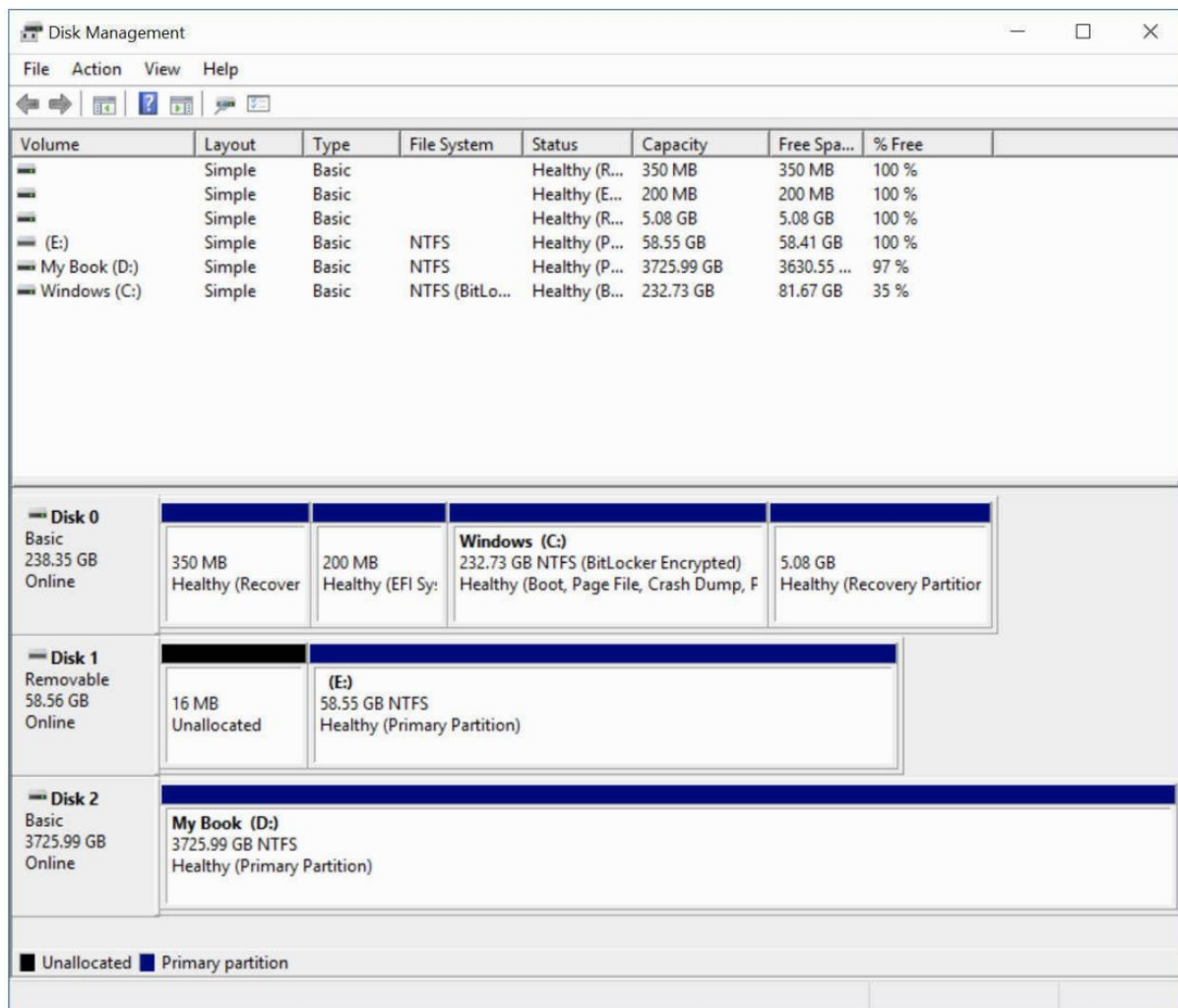
That command has no counterpart in Disk Management.

## Running Disk Management

To run Disk Management, type `diskmgmt.msc` at a command prompt, or press Windows key+X (or right-click the Start button) and then click Disk Management.

You need administrative credentials to run Disk Management.

The next figure illustrates the Disk Management console:



Disk Management provides a wealth of information about physical disks and the volumes, partitions, and logical drives in place on those disks. You can use this utility to perform the following disk-related tasks:

- Check the size, file system, status, and other properties of disks and volumes.
- Create, format, and delete partitions, logical drives, and dynamic volumes.
- Assign drive letters to hard disk volumes, removable disk drives, and optical drives.

- Create mounted drives.
- Convert basic disks to dynamic disks and vice versa.
- Create spanned and striped volumes.
- Extend or shrink partitions.

Disk Management displays information in two panes.

In its default arrangement, the upper pane lists each volume on your system and provides information about the volume's type, status, capacity, available free space, and so on.

You can carry out commands on a volume by right-clicking in the first column of this pane (the column labeled Volume) and choosing a command.

In the lower pane, each row represents one physical device.

In the headings at the left of each row, you see the name by which the device is known to the operating system (Disk 0, Disk 1, and so on), along with its type, size, and status.

To the right are areas that display information about the volumes of each device.

Note that these areas are not by default drawn to scale.

To change the scaling used by Disk Management, click View and then Settings.

You'll find various options on the Scaling tab of the Settings dialog box.

Right-clicking a heading at the left in the lower pane displays commands pertinent to an entire storage device.

Right-clicking an area representing a volume provides a menu of actions applicable to that volume.

## Understanding disk-management terminology

The current version of Disk Management has simplified somewhat the arcane language of disk administration.

Nevertheless, it's still important to have a bit of the vocabulary under your belt.

The following terms and concepts are the most important:

- Volume. A volume is a disk or subdivision of a disk that is formatted and available for storage. If a volume is assigned a drive letter, it appears as a separate entity in File Explorer. A hard disk can have one or more volumes.
- Format. To format a disk is to prepare it for storage by using a particular file system (such as NTFS).

- File system. A file system is a method for organizing folders (directories) and files on a storage medium. Windows 10 supports the following file systems: FAT (File Allocation Table), NTFS, exFAT (Extended File Allocation Table; optimized for use with flash drives), CDFS (Compact Disc File System; also sometimes identified as ISO-9660), and UDF (Universal Disk Format). Windows 10 does not currently support the new Resilient File System (ReFS, for short) but this support is likely to arrive in a future update.
- Basic disk and dynamic disk. The two principal types of hard-disk organization in Windows are called basic and dynamic:
  - A) A basic disk can be subdivided into as many as four partitions. Disks that have been initialized using a GUID Partition Table can have more than four. All volumes on a basic disk must be simple volumes. When you use Disk Management to create new simple volumes, the first three partitions it creates are primary partitions. The fourth is created as an extended partition using all remaining unallocated space on the disk. An extended partition can be organized into as many as 2,000 logical disks. In use, a logical disk behaves exactly like a primary partition.
  - B) A dynamic disk offers organizational options not available on a basic disk. In addition to simple volumes, dynamic disks can contain spanned or striped volumes. These last two volume types combine space from multiple disks.
- Simple volume. A simple volume is a volume contained entirely within a single physical device. On a basic disk, a simple volume is also known as a partition.
- Spanned volume. A spanned volume is a volume that combines space from physically separate disks, making the combination appear and function as though it were a single storage medium.
- Striped volume. A striped volume is a volume in which data is stored in 64-KB strips across physically separate disks to improve performance.
- MBR and GPT disks. MBR (master boot record) and GPT (GUID Partition Table) are terms describing alternative methods for maintaining the information regarding a disk's subdivisions. GPT disks support larger volumes (up to 18 exabytes) and more partitions (as many as 128 on a basic disk). You can convert a disk from MBR to GPT (or vice versa) only before a disk has been partitioned for the first time (or after all partitions have been removed). GPT is required on drives that contain the Windows partition on UEFI-based systems.
- Active partition, boot partition, and system partition. The active partition is the one from which an x86-based computer starts after you power it up. The first physical hard disk attached to the system (Disk 0) must include an active partition. The boot partition is the partition where the Windows system files are located. The system partition is the partition that contains the bootstrap files that Windows uses to start your system and display the boot menu.

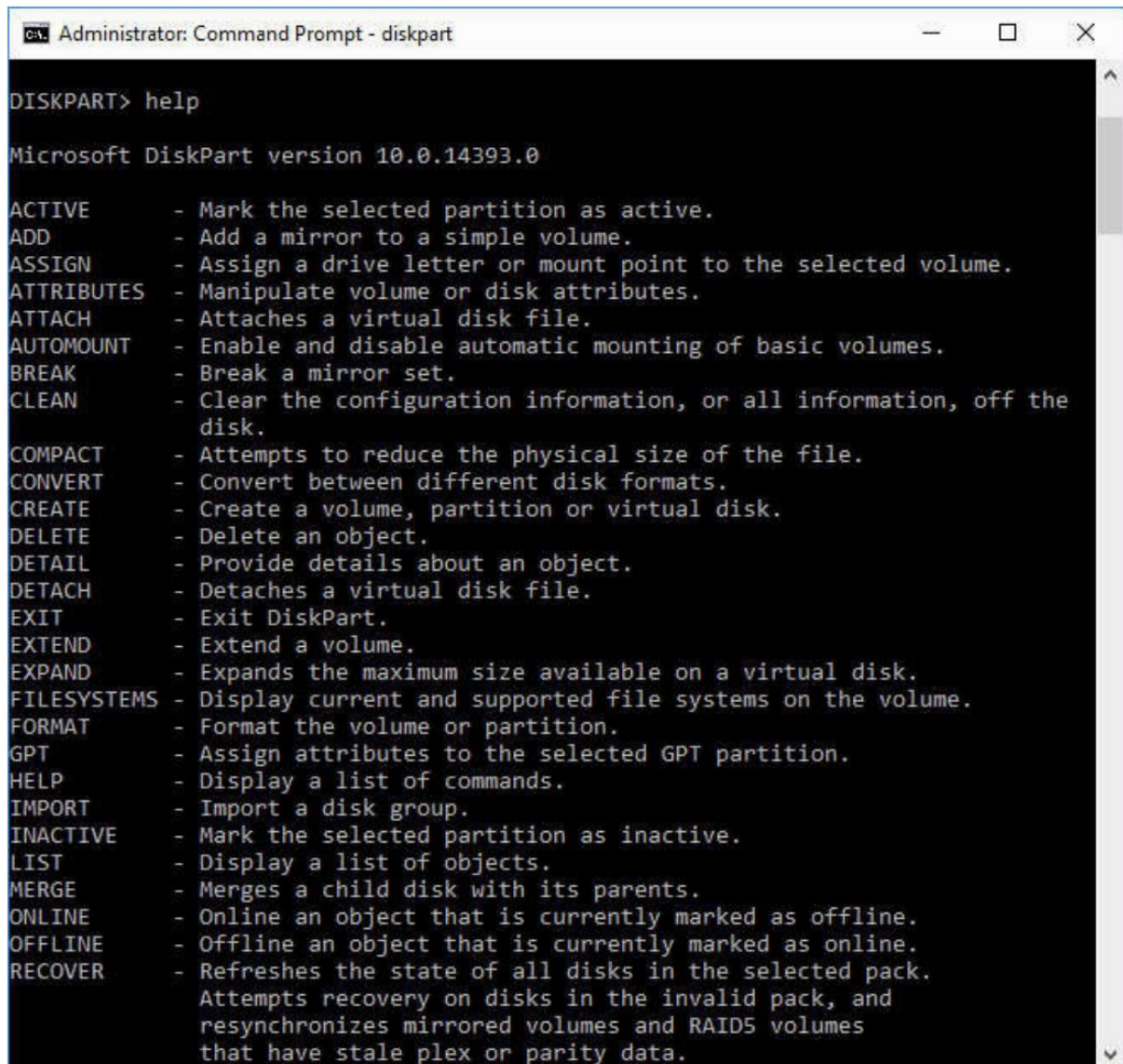
## Managing disks from the command prompt

To use DiskPart, start by running Cmd.exe with elevated privileges.

You can do that by pressing Windows key+X and then clicking Command Prompt (Admin).

When you run DiskPart, it switches to a command interpreter, identified by the DISKPART> prompt.

If you type help and press Enter, you see a screen that lists all available commands, like the one shown next:

A screenshot of a Windows Command Prompt window titled "Administrator: Command Prompt - diskpart". The window has a black background with white text. The prompt "DISKPART>" is followed by the command "help". Below the command, the text "Microsoft DiskPart version 10.0.14393.0" is displayed. A list of commands and their descriptions follows, each preceded by a hyphen. The commands listed are: ACTIVE, ADD, ASSIGN, ATTRIBUTES, ATTACH, AUTOMOUNT, BREAK, CLEAN, COMPACT, CONVERT, CREATE, DELETE, DETAIL, DETACH, EXIT, EXTEND, EXPAND, FILESYSTEMS, FORMAT, GPT, HELP, IMPORT, INACTIVE, LIST, MERGE, ONLINE, OFFLINE, and RECOVER. The descriptions for each command are provided in a concise manner. The window includes standard Windows window controls (minimize, maximize, close) in the top right corner.

```
Administrator: Command Prompt - diskpart
DISKPART> help

Microsoft DiskPart version 10.0.14393.0

ACTIVE          - Mark the selected partition as active.
ADD             - Add a mirror to a simple volume.
ASSIGN          - Assign a drive letter or mount point to the selected volume.
ATTRIBUTES      - Manipulate volume or disk attributes.
ATTACH          - Attaches a virtual disk file.
AUTOMOUNT       - Enable and disable automatic mounting of basic volumes.
BREAK           - Break a mirror set.
CLEAN           - Clear the configuration information, or all information, off the
                  disk.
COMPACT         - Attempts to reduce the physical size of the file.
CONVERT         - Convert between different disk formats.
CREATE          - Create a volume, partition or virtual disk.
DELETE          - Delete an object.
DETAIL          - Provide details about an object.
DETACH         - Detaches a virtual disk file.
EXIT            - Exit DiskPart.
EXTEND         - Extend a volume.
EXPAND         - Expands the maximum size available on a virtual disk.
FILESYSTEMS     - Display current and supported file systems on the volume.
FORMAT         - Format the volume or partition.
GPT            - Assign attributes to the selected GPT partition.
HELP           - Display a list of commands.
IMPORT         - Import a disk group.
INACTIVE       - Mark the selected partition as inactive.
LIST           - Display a list of objects.
MERGE          - Merges a child disk with its parents.
ONLINE         - Online an object that is currently marked as offline.
OFFLINE        - Offline an object that is currently marked as online.
RECOVER        - Refreshes the state of all disks in the selected pack.
                  Attempts recovery on disks in the invalid pack, and
                  resynchronizes mirrored volumes and RAID5 volumes
                  that have stale plex or parity data.
```

Even if you don't prefer the command line and don't intend to write disk-management scripts, you should know about DiskPart, because if you ever find yourself needing to manage hard disks from the Windows Recovery Environment (Windows RE), you will have access to DiskPart but you won't have access to the Disk Management console.

Windows RE is a special environment you can use for system-recovery purposes if a major hardware or software problem prevents you from starting Windows.

Windows also includes a second command-line tool for file-system and disk management, called Fsutil.

You can use this utility to find files by security identifier (SID), change the short name of a file, and perform other esoteric tasks.

### Caution!

Fsutil and DiskPart are not for the faint of heart or casual experimentation.

Both are intended primarily to be incorporated into scripts rather than for interactive use.

DiskPart in particular is dense and cryptic, with a complex structure that requires you to list and select objects before you act on them.

## Setting up a new hard disk

Whether you're installing Windows on a brand new hard disk or simply adding a new disk to an existing system, you should consider how you want to use the new storage space before you begin creating volumes.

If your goal is to set up a large space for backup or media storage, for example, you might want to devote the entire disk to a single volume.

On the other hand, if your plan is to establish two or more separate volumes—perhaps one for each family member on a shared home computer—decide how many gigabytes you want to assign to each partition.

You can change your mind later, but it's easiest to adjust the number of volumes on a disk and their relative sizes before you put a lot of data on the platter.

### Installing Windows on a new disk

When you run the Windows 10 setup program on a computer with a single, raw hard disk, you're presented with a screen identifying the disk and its size.

If you want to create a single volume encompassing the entire disk, you can click Next to proceed.

Otherwise, you can click New, and then in the same screen you can choose the size of the volume you want to create for your Windows installation.



If you decide not to use the entire disk for Windows, you can create additional volumes from within the Setup program.

But there's no particular need to do this.

After you install Windows, you can use Disk Management to create one or more additional volumes in the unallocated space remaining on the disk.

### Adding a new disk to an existing Windows installation

In the graphical view pane of Disk Management, a new hard disk, whether internal or external, appears like this:



To make this disk available for storage, you need to create one or more volumes, assign drive letters, label the volumes (if you don't want them to be identified in File Explorer as simply "New Volume"), and format them.

You can carry out all these steps from the New Simple Volume Wizard.

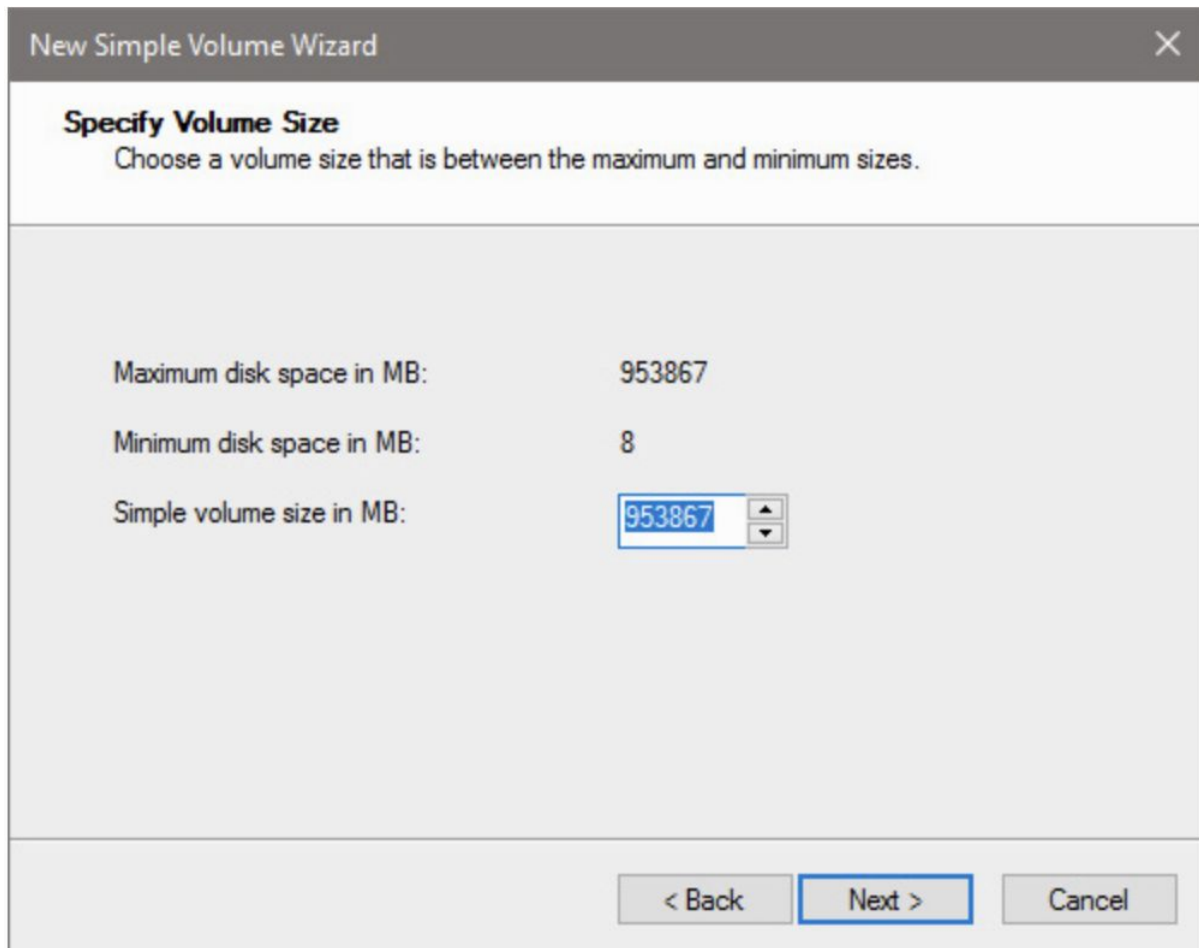
### Specifying volume capacity

To begin, right-click anywhere in the area marked Unallocated and then click New Simple Volume.

The New Simple Volume Wizard appears.

Click Next to get past the welcome page.

On the Specify Volume Size page, you're shown the maximum and minimum amounts of space you can devote to the new volume:



The screenshot shows a Windows 'New Simple Volume Wizard' window. The title bar reads 'New Simple Volume Wizard' with a close button. The main heading is 'Specify Volume Size' with a subtitle 'Choose a volume size that is between the maximum and minimum sizes.' Below this, there are three rows of information: 'Maximum disk space in MB:' with the value '953867', 'Minimum disk space in MB:' with the value '8', and 'Simple volume size in MB:' with a text box containing '953867' and up/down arrow controls. At the bottom right, there are three buttons: '< Back', 'Next >' (which is highlighted with a blue border), and 'Cancel'.

The wizard doesn't give you the option of designating volume space as a percentage of unallocated space, so if your goal is to create two or more volumes of equal size, you might want to do a bit of arithmetic before going on.

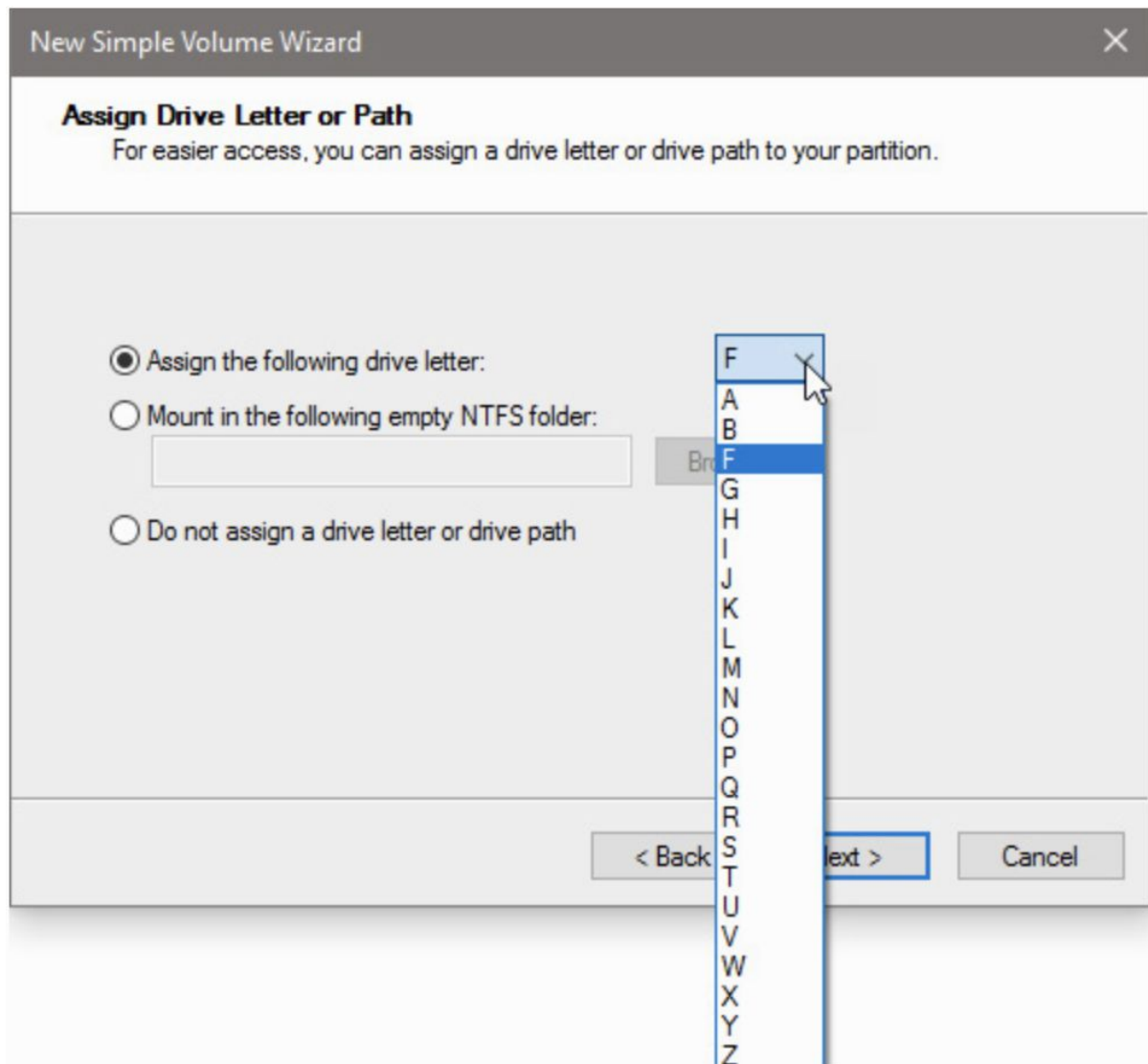
In this example, if you want to split the disk into two nearly equal partitions, you enter 476933 in the Simple Volume Size In MB box.

### Assigning a drive letter

After you specify the volume size in megabytes and click Next, you are given the opportunity to assign a drive letter to the new volume.

Note that the letters A and B, which used to be reserved for floppy disks, are no longer reserved:





## Formatting the new volume

The Format Partition page, which follows the Assign Drive Letter Or Path page, gives you a chance to do just that, but it does not require that you do so.

If you prefer to wait, you can always do the formatting later (by right-clicking the area for the volume in the graphical view pane of Disk Management and then clicking Format).

The next figure illustrates the Format Partition page:

The screenshot shows the 'New Simple Volume Wizard' window, specifically the 'Format Partition' step. The window title is 'New Simple Volume Wizard' with a close button (X) in the top right corner. Below the title bar, the text 'Format Partition' is displayed in bold, followed by the instruction 'To store data on this partition, you must format it first.' The main area contains the instruction 'Choose whether you want to format this volume, and if so, what settings you want to use.' There are two radio button options: 'Do not format this volume' (unselected) and 'Format this volume with the following settings:' (selected). Under the selected option, there are three settings: 'File system:' set to 'NTFS' (dropdown menu), 'Allocation unit size:' set to 'Default' (dropdown menu), and 'Volume label:' set to 'New Volume' (text box). There are two checkboxes: 'Perform a quick format' (checked) and 'Enable file and folder compression' (unchecked). At the bottom right, there are three buttons: '< Back', 'Next >' (highlighted with a blue border), and 'Cancel'.

Your choices are as follows:

- File System. For hard disk volumes larger than 4 GB (4,096 MB), your only options are NTFS (the default) and exFAT. If you're formatting removable media such as USB flash drives or a writable optical disc, other file systems are available.
- Allocation Unit Size. The allocation unit size (also known as the cluster size) is the smallest space that can be allocated to a file. The Default option, in which Windows selects the appropriate cluster size based on volume size, is the best choice here.
- Volume Label. The volume label identifies the drive in File Explorer. The default label is "New Volume." It's a good idea to give your new volume a name that describes its purpose.

Select the Perform A Quick Format check box if you want Disk Management to skip the sometimes lengthy process of checking the disk media.

Select Enable File And Folder Compression if you want all data on the new volume to use NTFS compression.

This option, which you can also apply later, is available only on NTFS volumes.

The wizard's final page gives you one more chance to review your specifications.

You should actually take a moment to read this display before you click Finish.

After Disk Management has done its work and disk formatting is complete, a dark blue bar appears over the new volume in the console's graphical view pane:



If your disk still has unallocated space (as the disk in this example does), you can add another volume by right-clicking that part of the display and then clicking New Simple Volume again.

## Choosing a file system

Whether you're setting up a new disk or reformatting an existing one, the process of formatting entails choosing a file system.

The choices available to you depend on the type of media you're formatting.

With hard disks, the only options made available by Disk Management are NTFS and exFAT.

If you want to format a hard disk in FAT32, you need to use the Format command with the /FS switch at the command prompt.

Type `format /?` at the command prompt for details.

The only good reason to do this, however, is for the sake of compatibility with devices running non-Microsoft operating systems that don't natively support NTFS.

If you're formatting a USB flash drive, on the other hand, FAT32 or exFAT is a reasonable choice.

Because NTFS is a journaling file system, reading and writing files on NTFS disks involves more disk input/output than similar operations on FAT32 and exFAT disks.

Flash drives can perform a finite number of reads and writes before they need to be replaced—hence, they might have a longer life expectancy under FAT32 or exFAT than under NTFS.

On UEFI systems, FAT32 is required for bootable installation media.

For a tabular comparison of file systems, see <https://bit.ly/file-systemcomparison>.

## The advantages of NTFS

NTFS offers a number of important advantages over the earlier FAT and FAT32 file systems:

- **Security.** On an NTFS volume, you can restrict access to files and folders by using permissions. You can add an extra layer of protection by encrypting files if your edition of Windows 10 supports it. On a FAT or FAT32 drive, anyone with physical access to your computer can access any files stored on that drive.
- **Reliability.** Because NTFS is a journaling file system, an NTFS volume can recover from disk errors more readily than a FAT32 volume. NTFS uses log files to keep track of all disk activity. In the event of a system crash, Windows 10 can use this journal to repair file-system errors automatically when the system is restarted. In addition, NTFS can dynamically remap clusters that contain bad sectors and mark those clusters as bad so that the operating system no longer uses them. FAT and FAT32 drives are more vulnerable to disk errors.
- **Expandability.** Using NTFS-formatted volumes, you can expand storage on existing volumes without having to back up, repartition, reformat, and restore.
- **Efficiency.** On partitions greater than 8 GB, NTFS volumes manage space more efficiently than FAT32. The maximum partition size for a FAT32 drive created by Windows 10 is 32 GB; by contrast, you can create a single NTFS volume of up to 16 terabytes (16,384 GB) using default settings, and by tweaking cluster sizes you can ratchet the maximum volume size up to 256 terabytes.
- **Optimized storage of small files.** Files on the order of a hundred bytes or less can be stored entirely within the Master File Table (MFT) record, rather than requiring a minimum allocation unit outside the MFT. This results in greater storage efficiency for small files.

## exFAT vs. FAT32

exFAT's principal advantage over FAT32 is scalability.

The exFAT file system removes the 32-GB volume and 4-GB file-size limitations of FAT32.

It also handles more than 1,000 files per directory.

Its principal disadvantage is limited backward compatibility.

Some non-PC consumer electronics devices might be able to read earlier FAT systems but not exFAT.

If you're formatting a flash drive and you expect to store large video files on it, exFAT might be a good choice for the file system.

And if you're planning to take that flash drive to a photo kiosk at your local convenience store, FAT32 is definitely the way to go.

## Managing existing disks and volumes

No matter how well you plan, your approach to deploying storage resources is likely to change over time.

Disk Management can help you adjust to changing requirements.

You can expand volumes (assuming space is available), shrink volumes, reformat, relabel, assign new drive letters, and more.

### Extending a volume

Disk Management will be happy to make an NTFS volume larger for you, provided unallocated space is available on the same or another hard disk.

To accomplish the expansion, right-click the volume you want to expand and then click Extend Volume.

Click Next to move past the Extend Volume Wizard's welcome page.

The Select Disks page, shown in the next figure, appears:

The screenshot shows the 'Extend Volume Wizard' dialog box, specifically the 'Select Disks' step. The title bar reads 'Extend Volume Wizard' with a close button. Below the title bar, the section is titled 'Select Disks' with the instruction 'You can use space on one or more disks to extend the volume.' The main area is divided into two columns: 'Available:' on the left and 'Selected:' on the right. The 'Available:' column contains an empty list box. The 'Selected:' column contains a list box with one item, 'Disk 1 486933 MB', which is highlighted in blue. Between these two columns are three buttons: 'Add >', '< Remove', and '< Remove All'. Below the list boxes, there are three text input fields. The first is labeled 'Total volume size in megabytes (MB):' and contains the value '953866'. The second is labeled 'Maximum available space in MB:' and contains the value '486933'. The third is labeled 'Select the amount of space in MB:' and contains the value '486933' with up and down arrow buttons on its right side. At the bottom of the dialog box are three buttons: '< Back', 'Next >' (which is highlighted with a blue border), and 'Cancel'.

The Selected list, on the right side of this dialog box, initially shows the disk whose volume you intend to extend.

The Maximum Available Space In MB box shows you how much larger you can make the volume, assuming you want to confine your expansion to the current disk.

The Select The Amount Of Space In MB box, initially set to equal the maximum available space, is where you declare the number of megabytes you want to add to the volume, and the Total Volume Size In Megabytes (MB) box shows you how big your volume is about to become.

When you're ready to continue, click Next, review your orders on the ensuing page, and then click Finish.

If your volume resided on a basic disk to begin with, it remains basic after the expansion—provided that the space into which you expanded was contiguous with the original volume.

Note that no separate formatting step is required; the new territory acquires the same formatting as the original.

Volume extension is subject to the following limitations:

- Only NTFS-formatted volumes can be extended.

- A logical drive can be extended only within the extended partition that contains it.
- The system and boot partitions can be extended only into contiguous unallocated space.
- You cannot extend a striped volume.”

## Increase storage space with NTFS compression

If you're thinking of expanding a partition because you're short of space, consider compressing your files and folders instead.

You can compress individual files, particular folders, or entire volumes.

Items compressed in this manner are decompressed on the fly when you open them and compressed again when they are closed.

You won't achieve huge savings in storage space this way—less than you would get by using compressed (zipped) folders—but the convenience of NTFS is high and the cost, in terms of performance, is virtually unnoticeable.

To compress a volume, open This PC in File Explorer, right-click the volume, click Properties, and then, on the General tab of the properties dialog box, select Compress This Drive To Save Disk Space.

To compress a particular folder or file, right-click it in File Explorer, click Properties, and then click Advanced on the General tab of the properties dialog box.

In the Advanced Attributes dialog box, select Compress Contents To Save Disk Space.

Note that this form of compression is available only on NTFS volumes and that NTFS compression is incompatible with encryption that uses the Encrypting File System.

You can have one or the other, but not both.

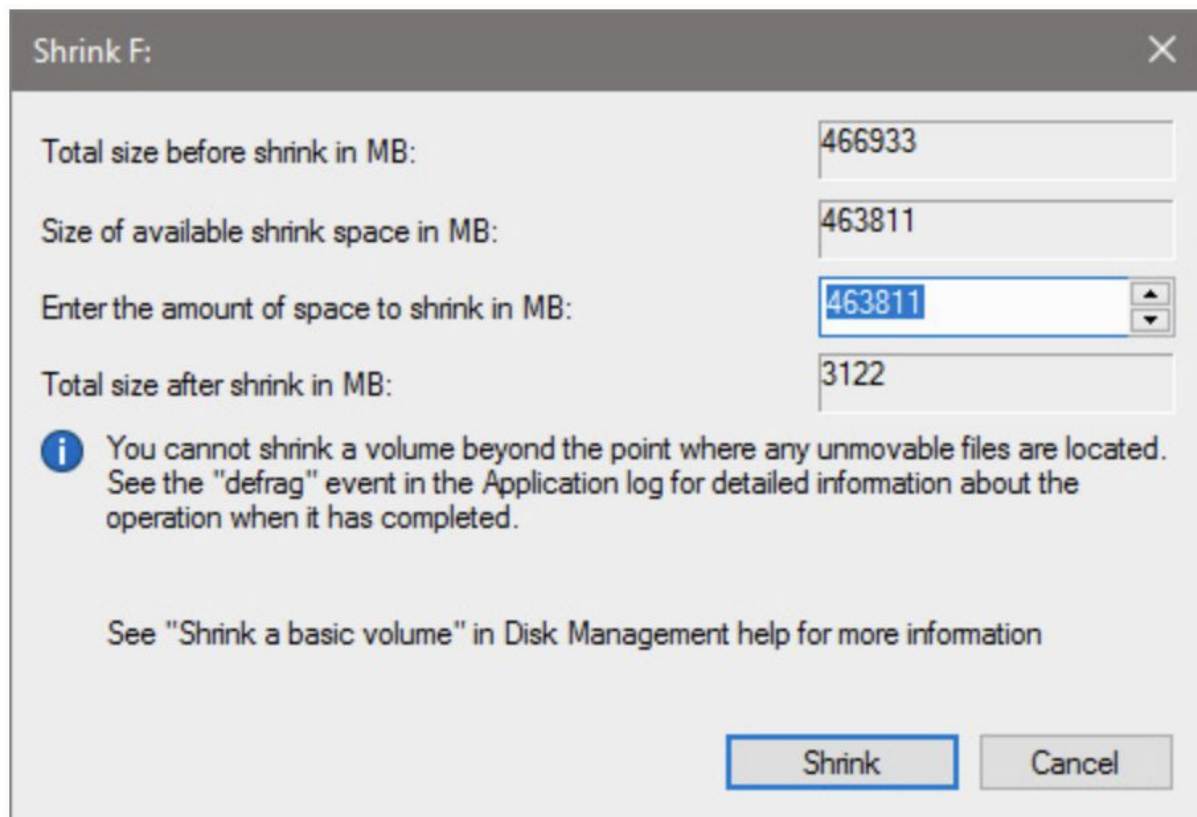
## Shrinking a volume

Provided space is available, you can shrink an NTFS-formatted volume to make more space available for other volumes.

To do this, right-click the volume in either the volume list or graphical view pane and then click Shrink Volume.

Disk Management responds by analyzing the disk, and then it reports the amount of shrinkage possible, as shown next:





Shrink F:

Total size before shrink in MB: 466933

Size of available shrink space in MB: 463811

Enter the amount of space to shrink in MB: 463811

Total size after shrink in MB: 3122

**i** You cannot shrink a volume beyond the point where any unmovable files are located. See the "defrag" event in the Application log for detailed information about the operation when it has completed.

See "Shrink a basic volume" in Disk Management help for more information

Shrink Cancel

Enter the number of megabytes by which you want to reduce your volume, and then click Shrink.

Disk Management defragments the disk, moving all its data to a contiguous block, and then performs the shrink.

Be aware that page files and volume shadow copy files cannot be moved during the defragmentation process.

This means you might not have as much room to shrink as you would like.

Microsoft also advises that the amount by which you can shrink a volume is "transient" and depends on what is happening on the volume at the time.

In other words, if you're trying to eliminate, say, 10 GB from the volume and Disk Management can manage only 7, take the 7 and then try for more later.

## Deleting a volume

Deleting a volume is easy—and irreversible.

All data is lost in the process, so be sure you have backed up or no longer need whatever the volume currently contains.

Then right-click the volume and click Delete Volume.

The volume reverts to unallocated space, and if it happens to have been the last volume on a dynamic disk, the disk itself is converted to basic.

## Converting a FAT32 disk to NTFS

To convert a FAT or FAT32 disk to NTFS, use the command-line Convert utility.

The essential syntax is:

**convert d: /fs:ntfs**

where d: is the drive letter you want to convert.

For information about optional parameters, type **convert /?** at the command prompt.

The Convert utility can do its work within Windows if the drive to be converted is not in use.

However, if you want to convert the system volume or a volume that holds a page file, you might see an error message when you run Convert.

In that case, you must schedule the conversion to occur the next time you start Windows.

After you restart the computer, you see a prompt that warns you that the conversion is about to begin.

You have 10 seconds to cancel the conversion.

If you allow it to proceed, Windows runs the Chkdsk utility and performs the conversion automatically.

During this process, your computer will restart twice.

## Assigning or changing a volume label

In Windows 10, as in previous versions of Windows, you can assign a descriptive text label to any volume.

Assigning a label is purely optional, but it's a good practice, especially if you have a multi-boot system or if you set up separate volumes to keep your data organized.

You can use Data as the label for your data drive, Music for the drive that holds your collection of digital tunes, and so on.

You can enter a volume label when you format a new volume, or you can do it at any time afterward by right-clicking a volume (in Disk Management or in File Explorer), clicking Properties, and entering text in the edit field near the top of the General tab.

## Assigning and changing drive letters

You can assign one and only one letter to a volume.

For all but the following volumes, you can change or remove the drive letter at any time:

- The boot volume.
- The system volume.
- Any volume on which the page (swap) file is stored.

To change a drive-letter assignment, right-click the volume in Disk Management and then click Change Drive Letter And Paths.

To replace an existing drive letter, select it and click Change.

To assign a drive letter to a volume that currently has none, click Add.

Select an available drive letter from the Assign The Following Drive Letter list, and then click OK twice.

## Checking the properties and status of disks and volumes

You can check the properties of any drive—including the volume label, file system, and amount of free space available—by right-clicking the drive in File Explorer's This PC folder and then clicking Properties.

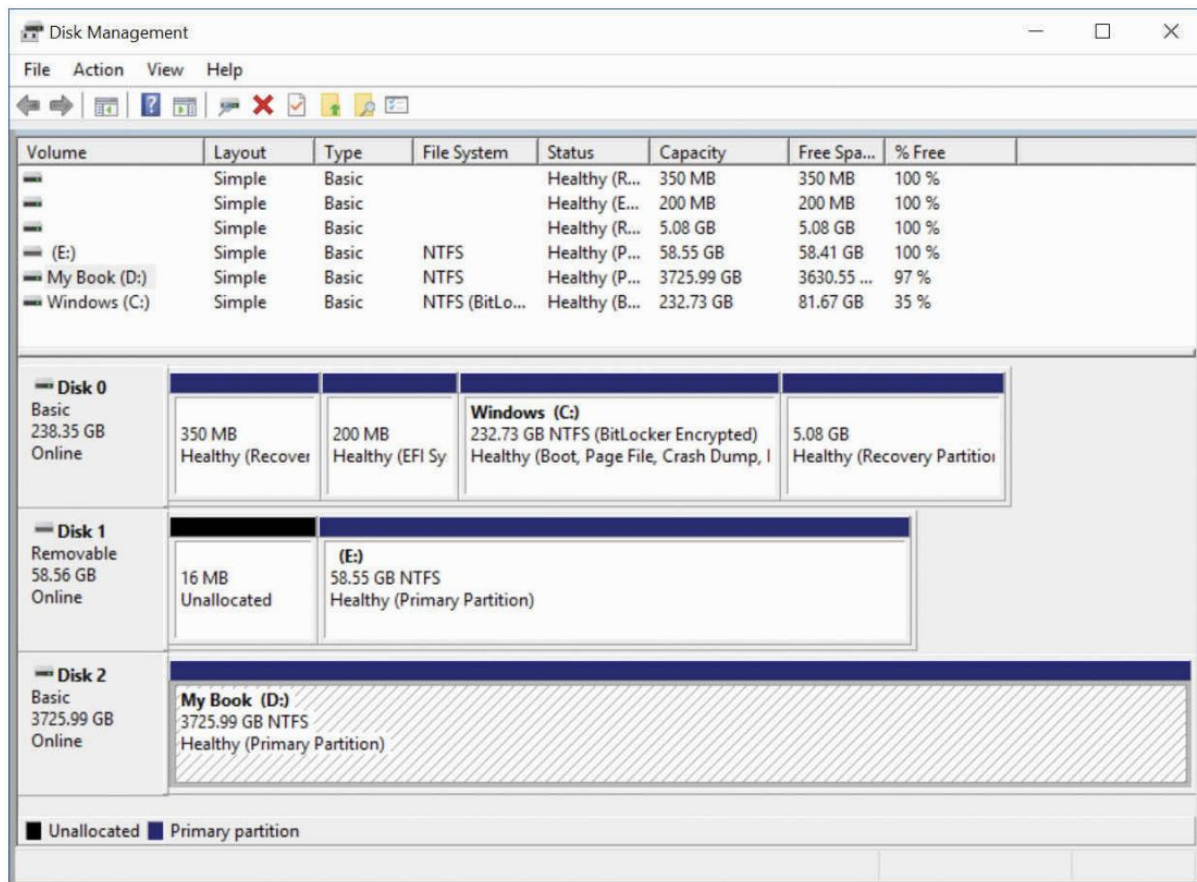
You can see the same details and more in Disk Management.

Most of the crucial information is visible in the volume list, the tabular pane that appears by default at the top of the Disk Management window.

Slightly less information is available in the graphical view at the bottom of the window.

Of particular interest is information about the status of a disk or volume.

The next image shows where to look for this information:



Under normal circumstances, the status information displayed here should report that each disk is online and each volume is healthy.

### Permanently wiping all data from a disk

Formatting a volume results in a root folder that appears to be empty.

However, as we mentioned earlier, someone with data-recovery tools might be able to restore deleted files even after you format the volume.

If you're discarding or recycling an old computer or hard disk, you don't want to risk the possibility of it landing in the hands of someone who might search it for recoverable data that can be used for identity theft or other nefarious purposes.

If your old disk is headed for the dumpster, you can ensure that the data can't be recovered by removing the disk drive from the computer and physically destroying the disk.

Using tools as varied as a power saw, drill, torch, or sledge hammer, you can render the disk inoperable.

Although this method is effective, it has several disadvantages: it takes time and considerable physical effort, and it has all the usual risks associated with tools.

Be sure you're wearing safety goggles.

Perhaps most important, you're left with a disk that can't be sold or donated to someone who can use it.

The Format command (with the /P switch) and the Cipher command (with the /W switch) can be used to overwrite everything on a disk, but these tools are impractical for cleaning the system partition.

A better solution is to use a third-party disk-wiping tool.

A free one that we like is Darik's Boot And Nuke (DBAN), which you can download from <http://www.dban.org>.

DBAN is a bootable disk that securely wipes a computer's hard disks.

If you're worried that DBAN or another purported disk-wiping utility might surreptitiously steal your data before destroying it, remove your concerns by disconnecting your computer from your network before using the program.

If your disk contains highly sensitive material and you want to be absolutely sure its data can't be recovered, search for a utility that conforms to the United States Department of Defense DoD 5220.22-M standard for clearing and sanitizing media.

This standard requires each sector to be overwritten with different characters several times, thus defeating even the most sensitive data-recovery tools.

Programs that meet the standard include Active@ KillDisk <http://www.killdisk.com> and BCWipe <https://www.jetico.com>.

## Working with virtual hard disks

Disk Management can create virtual hard disks in the VHD format used by the Windows 10 Hyper-V Manager program.

A .vhd file encapsulates all the characteristics of a simple disk volume in a single file.

Once created, initialized, and formatted, it appears as a disk drive in File Explorer and Disk Management, but you can copy it, back it up, and do anything else with it that you might do with an ordinary file.

To create a virtual hard disk, open Disk Management and click Action, Create VHD.

Disk Management responds with the Create And Attach Virtual Hard Disk dialog box:

Create and Attach Virtual Hard Disk

Specify the virtual hard disk location on the machine.

Location:

Browse...

Virtual hard disk size:  MB

Virtual hard disk format

☒ VHD  
Supports virtual disks up to 2040 GB in size.

☐ VHDX  
Supports virtual disks larger than 2040 GB in size (Supported maximum of 64 TB) and is resilient to power failure events. This format is not supported in operating systems earlier than Windows 8 or Windows Server 2012.

Virtual hard disk type

☒ Fixed size (Recommended)  
The virtual hard disk file is allocated to its maximum size when the virtual hard disk is created.

☐ Dynamically expanding  
The virtual hard disk file grows to its maximum size as data is written to the virtual hard disk.

OK Cancel

Specify a file name with a fully qualified path.

It's easiest to do this with the help of the Browse button, but note that the file cannot be stored in your %SystemRoot% (usually C:\Windows) folder.

If you want the disk to expand in size as you add files to it, select Dynamically Expanding.

Otherwise, select Fixed Size (Recommended).

Either way, you must also specify a size (that's a maximum size if you select Dynamically Expanding).

The minimum size is 3 MB; the maximum is the amount of free space available on your (real) disk.

New in Windows 10 is the option to create a virtual hard disk in either of two formats.

The VHD format supports disks up to 2 TB, which can be used on systems running Windows 7, Windows 8 or 8.1, or Windows 10.

The VHDX format supports much larger disks, up to 64 TB, but it's not supported by earlier versions of Windows.

The VHDX format was introduced with Windows Server 2012, and the option to create gigantic virtual disks is perhaps primarily of interest to server administrators.

VHD is still the default format in Windows 10.

However, because metadata in VHDX disks continuously tracks changes (a service not provided in VHD), they are, as the dialog box indicates, more resilient to power failures.

For that reason, you might prefer the newer format even if your size requirements are well under 2 TB.

Provided that you don't require interoperability with Windows 7 or Windows 8 or 8.1, we don't know of a good reason not to prefer VHDX.

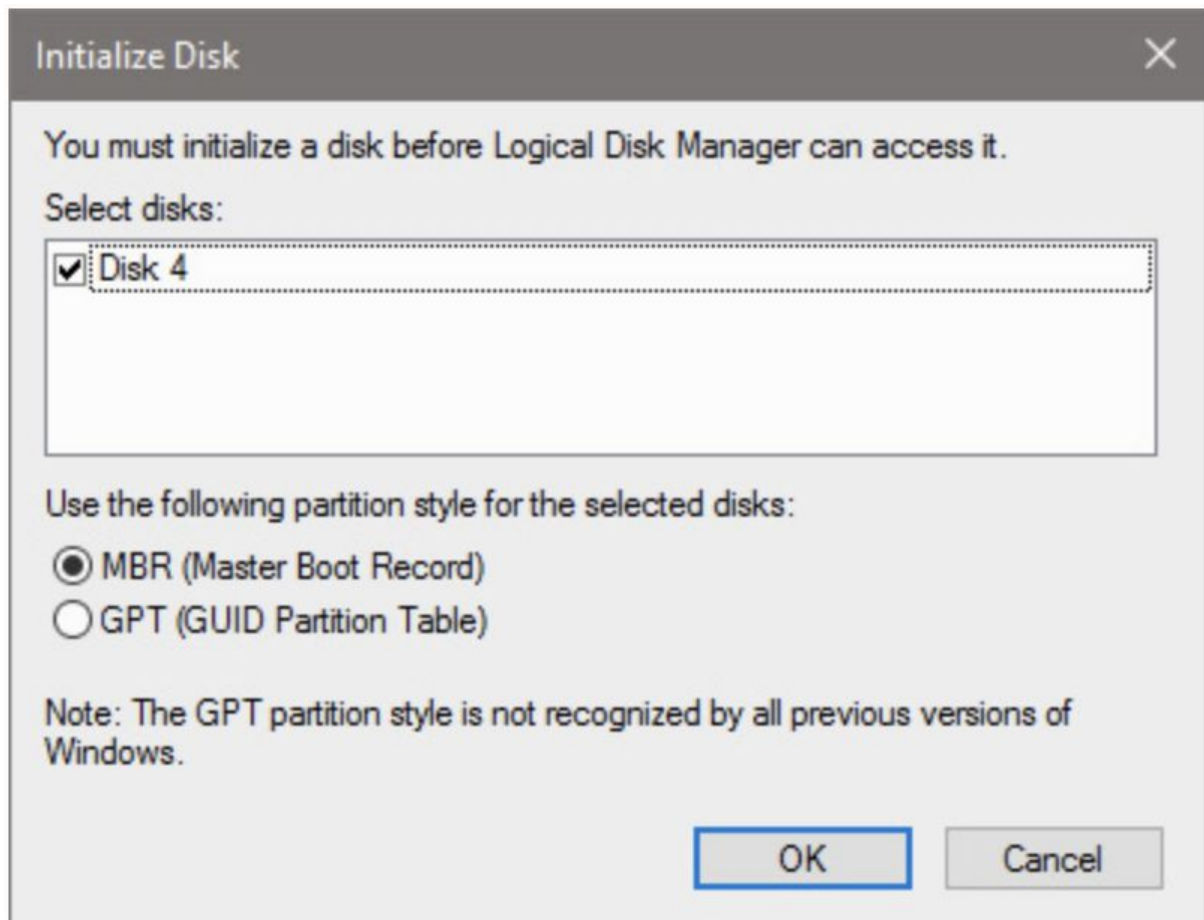
After you finish with the Create And Attach Virtual Hard Disk dialog box, Disk Management adds the new virtual disk to its graphical view pane as an unknown, uninitialized disk with unallocated space:



Right-click the area at the left side of this display (with the disk number), and then click Initialize Disk.

The Initialize Disk dialog box that appears gives you the option of setting up a disk with a master boot record or a GUID Partition Table:





Select MBR (Master Boot Record) unless you're working with a very large disk.

After completing these steps, you can follow the procedures described earlier to create one or more volumes on the new disk.

After you have created a volume, formatted it, and assigned it a drive letter, the disk appears like any other in Disk Management and File Explorer.

To remove a virtual hard disk, right-click the disk-number box at the left side of Disk Management's graphical view pane, and then click Detach VHD.

Disk Management informs you that deleting the disk will make it unavailable until you reattach it.

The dialog box also reminds you of the location of the file that encapsulated your virtual hard disk.

To reattach a deleted virtual disk, click Action, Attach VHD in Disk Management.

Then type or browse to the location of the VHD or VHDX file.

## Checking disks for errors

Errors in disk media and in the file system can cause a wide range of problems, from an inability to open or save files to blue-screen errors and widespread data corruption.

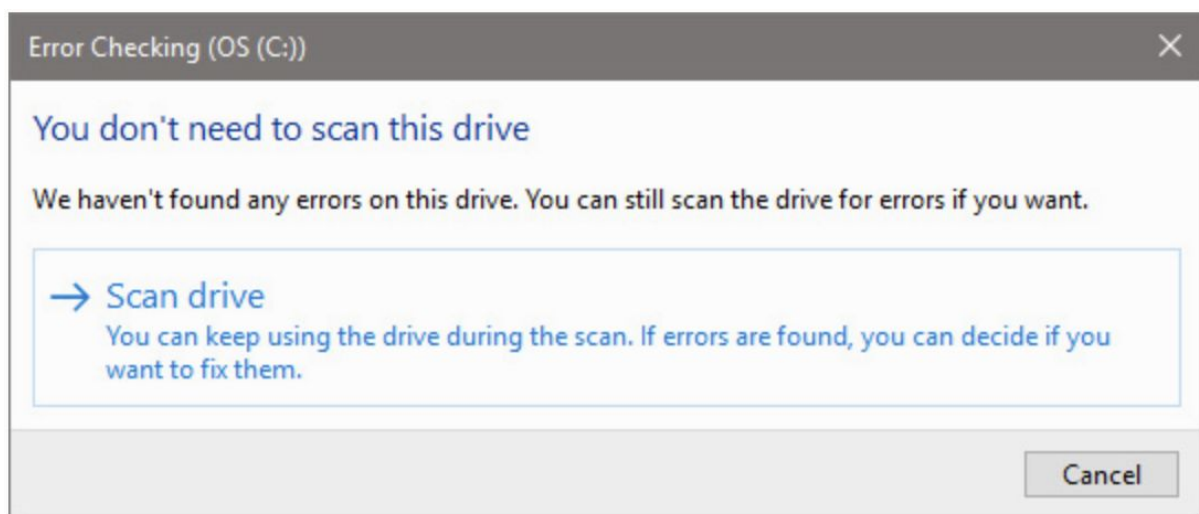
Windows is capable of recovering automatically from many disk errors, especially on drives formatted with NTFS.

To perform a thorough inspection for errors, you can run the Windows Check Disk utility (Chkdsk.exe).

Two versions of this utility are available—a graphical version that performs basic disk-checking functions, and a command-line version that provides a much more extensive set of customization options.

To check for errors on a local disk, follow these steps:

1. In File Explorer, open This PC, right-click the icon belonging to the drive you want to check, and then click Properties.
2. On the Tools tab, click Check. Unless Windows is already aware of problems with the selected disk, you're likely to see a message similar to the following:



3. If you want to go ahead and check the disk, click Scan Drive. Windows will perform an exhaustive check of the entire disk. If there are bad sectors, Windows will locate them and recover readable information where it can.

The command-line version of Check Disk gives you considerably more options.

You can also use it to set up regular disk-checking operations using Task Scheduler.

To run this command in its simplest form, open a Command Prompt window using the Run As Administrator option, and then type chkdsk at the prompt.

This command runs Chkdsk in read-only mode, displaying the status of the current drive but not making any changes.

If you add a drive letter after the command (chkdsk d:, for instance), the report applies to that drive.

To see descriptions of the command-line switches available with the Chkdsk command, type chkdsk /? .

Here is a partial list of the available switches:

- /F Instructs Chkdsk to fix any errors it detects. This is the most commonly used switch. The disk must be locked. If Chkdsk cannot lock the drive, it offers to check the drive the next time you restart the computer or to dismount the volume you want to check before proceeding. Dismounting is a drastic step; it invalidates all current file handles on the affected volume and can result in loss of data. You should decline the offer. When you do, Chkdsk makes you a second offer—to check the disk the next time you restart your system. You should accept this option. If you're trying to check the system drive, the only option you're given is to schedule a check at the next startup.
- /V On FAT32 volumes, /V displays verbose output, listing the name of every file in every directory as the disk check proceeds. On NTFS volumes, this switch displays cleanup messages (if any).
- /R Identifies bad sectors and recovers information from those sectors if possible. The disk must be locked. Be aware that this is a time-consuming and uninterruptible process.

The following switches are valid only on NTFS volumes:

- /I Performs a simpler check of index entries (stage 2 in the Chkdsk process), reducing the amount of time required.
- /C Skips the checking of cycles within the folder structure, reducing the amount of time required.
- /X Forces the volume to dismount, if necessary, and invalidates all open file handles. This option is intended for server administrators. Because of the potential for data loss, it should be avoided.
- /L [:size] Changes the size of the file that logs NTFS transactions. If you omit the size parameter, this switch displays the current size. This option is intended for server administrators. Because of the potential for data loss, it also should be avoided in normal use.
- /B Reevaluates bad clusters and recovers readable information.

## Optimizing disks for better performance

On a relatively new system with a speedy processor, plenty of physical memory, and a conventional hard disk drive with spinning platters, disk performance is the single biggest bottleneck in everyday operation.

Even with a zippy hard drive, it takes time to load large data files into memory so that you can work with them.

The problem is especially noticeable with movies, video clips, DVD-burning projects, databases, ISO image files, and virtual hard disks, which can easily take up multiple gigabytes, sometimes in a single file.

On a freshly formatted disk, files load fairly quickly, but performance can degrade over time because of disk fragmentation.

To understand how fragmentation works, it helps to understand the basic structure of a hard disk.

The process of formatting a disk divides it into sectors, each of which contains space for 512 bytes of data.

The file system combines groups of sectors into clusters, which are the smallest units of space available for holding a single file or part of a file.

On any NTFS volume greater than 2 GB in size, the cluster size is 4 KB.

Thus, when you save a 200-MB video clip, Windows divides the file into roughly 50,000 pieces.

When you save this file for the first time on a freshly formatted, completely empty hard disk, Windows writes it in contiguous clusters.

Because all the clusters that hold individual pieces of the file are physically adjacent to one another, the mechanical components of the hard disk can work very efficiently, scooping up data in one smooth operation.

As a bonus, the hard disk's onboard cache and the Windows disk cache are able to anticipate the need for data and fetch nearby clusters that are likely to contain other parts of the file, which can then be retrieved from fast cached memory rather than from the relatively slow disk.

Unfortunately, hard disks don't stay neatly organized for long.

When you add data to an existing file, the file system has to allocate more clusters for storage, typically in a different physical location on the disk.

As you delete files, you create gaps in the once-tidy arrangement of contiguously stored files.

As you save new files, especially large ones, the file system uses all these bits of free space, scattering the new files over the hard disk in many noncontiguous pieces.

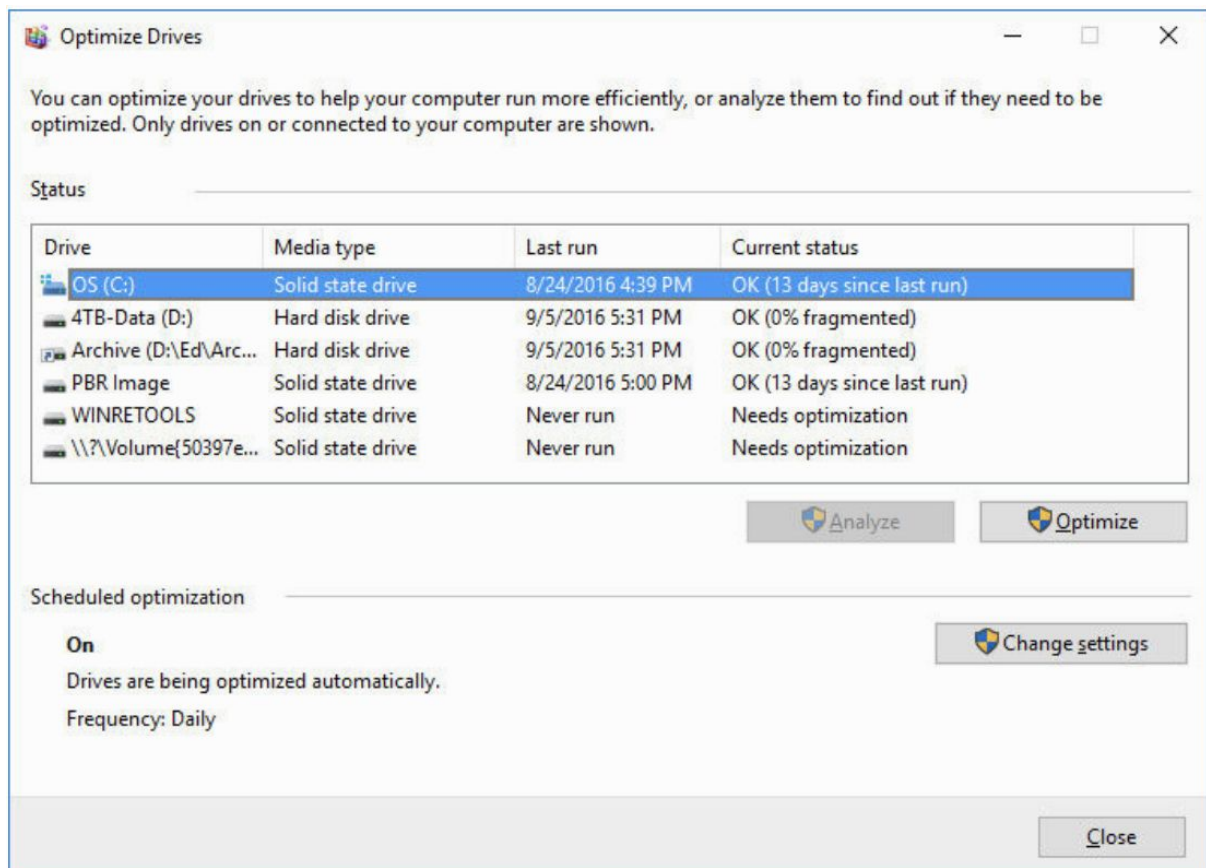
The resulting inefficiency in storage is called fragmentation; each time you open or save a file on a badly fragmented disk, disk performance suffers, sometimes dramatically, because the disk heads have to spend extra time moving from cluster to cluster before they can begin reading or writing data.

The Optimize Drives service in Windows 10 runs as a low-priority background task that defragments your disks at regularly scheduled intervals.

By default, the program kicks off once a week in the middle of the night, without requiring any attention from you.

If you would like a different schedule, or if you want to optimize certain disks and not others, type `dfrgui` at a command prompt.

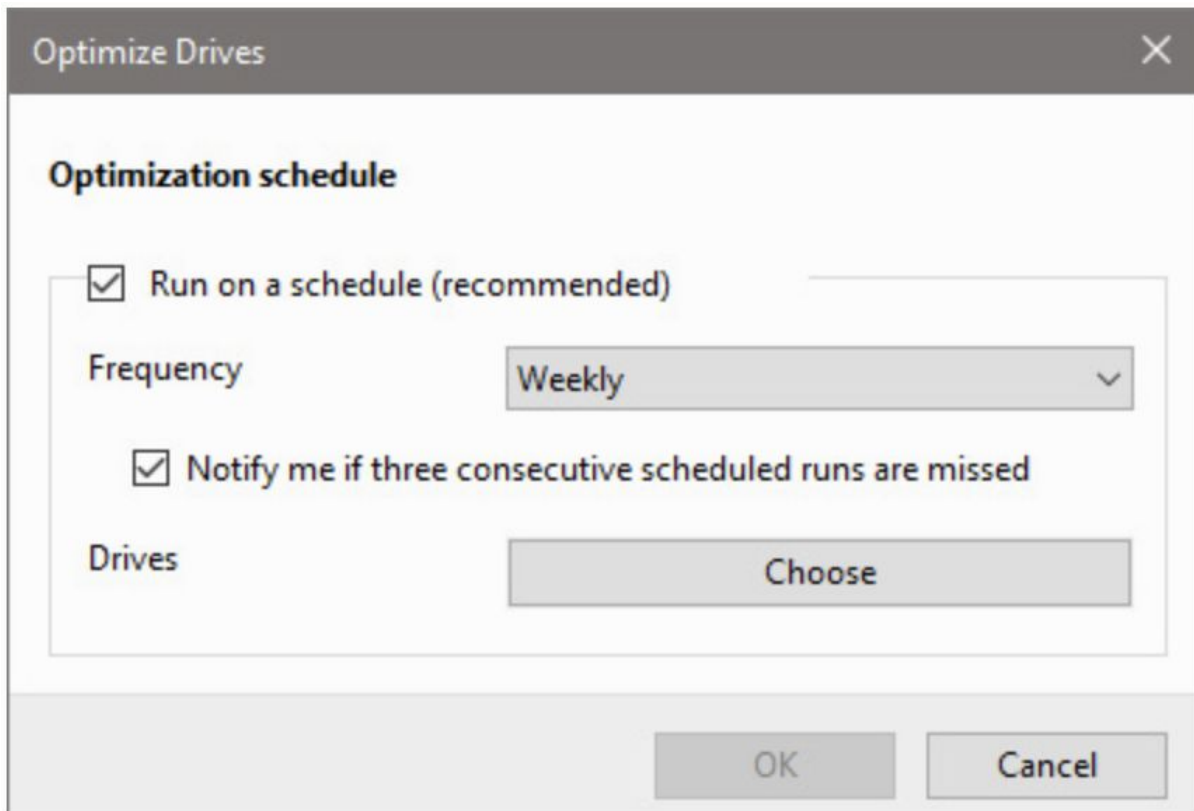
The Optimize Drives dialog box appears:



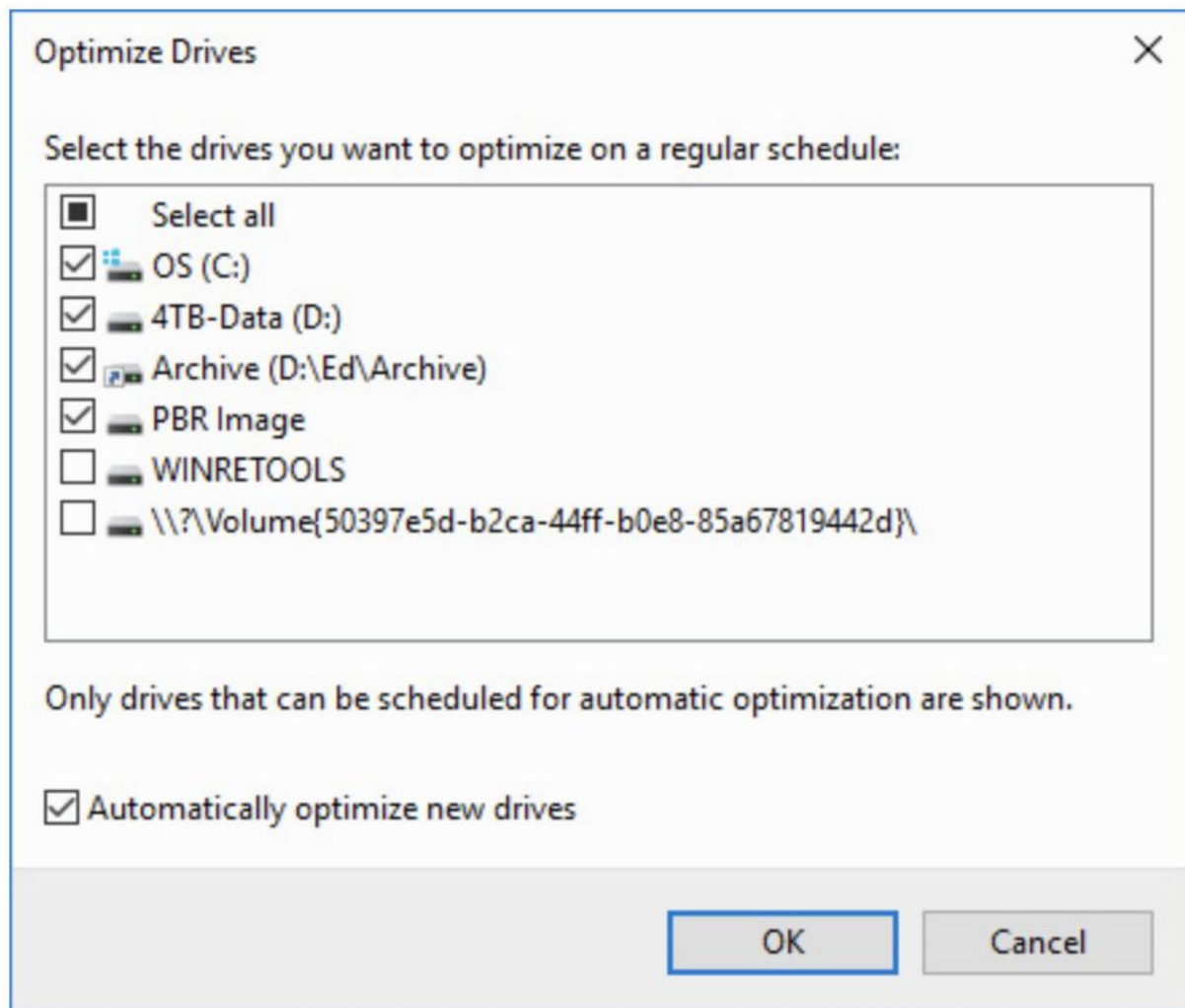
Here you can analyze the fragmentation level of particular disks, optimize a disk ad hoc, or reconfigure the system's background defragmentation schedule.

To reconfigure, click Change Settings.

The frequency options are Daily, Weekly, and Monthly:



By clicking the Choose button, you can turn optimization on or off for particular drives:



## Working with Solid State Drives (SSD)

Many newer computers are equipped with a Solid State Drive (SSD), which is a chunk of flash memory instead of a spinning magnetic disk coupled with an onboard disk controller and the requisite power and data connectors.

Such drives can provide improved performance, increased battery life, better durability, reduced likelihood of damage caused by drops and shocks, faster startup times, and reductions in noise, heat, and vibration.

These benefits come at a price: SSDs typically cost more and have less storage capacity than current hard disk drive (HDD) models, although the gap is closing.

Conventional hard disk drives are typically the biggest performance bottleneck in any computing environment.

If you can speed up disk activity, especially reads, the effects on system startup and application launch times can be breathtaking.



On very recent hardware, with the latest generation of SSDs, we routinely see boot times of less than 15 seconds.

Although the underlying technology in SSDs and HDDs is completely different, for the most part the devices are treated identically by Windows, and you don't need to concern yourself with the differences.

Behind the scenes, Windows does several things differently on SSDs, including the following:

- SuperFetch, ReadyBoost, ReadyBoot, and ReadyDrive, features designed to overcome hard disk bottlenecks, are unnecessary and are disabled by default on most SSDs. Windows analyzes disk performance and disables these features only on SSDs that are fast enough to make these features superfluous.
- When creating a partition on an SSD, Windows properly aligns the partition for best performance.
- Windows 10 supports the TRIM command. SSDs have to erase blocks of data before those blocks can be reused; they can't write directly over deleted data as rotating disks can. The TRIM command makes this process more efficient by reclaiming deleted space in the background.

## Optimizing solid state drives

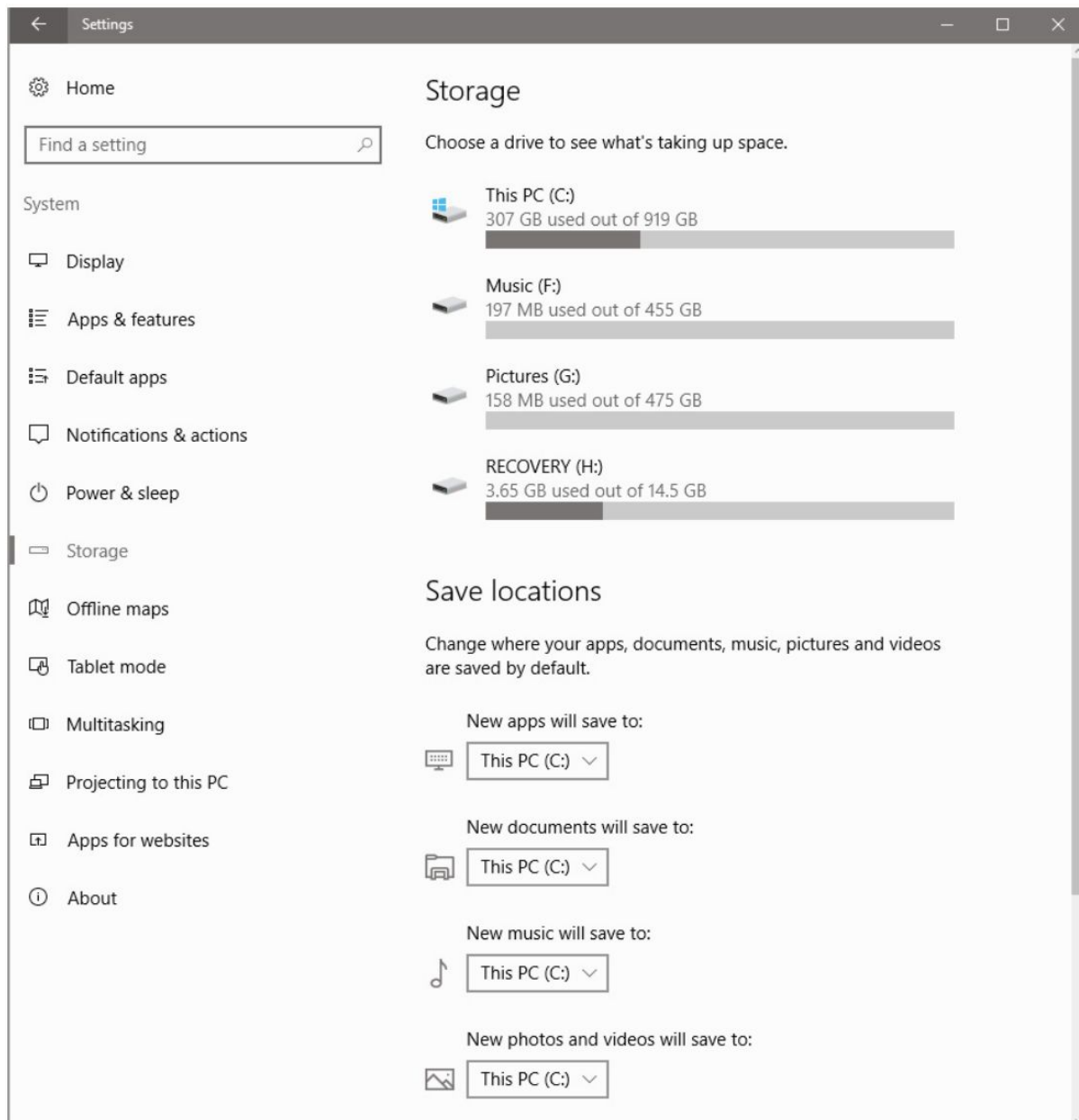
If your system includes one or more SSDs and you have read that defragmentation is inappropriate with such drives, you might be surprised to see that SSDs are listed in the Optimize Drives dialog box.

Rest assured that the optimization that Windows performs automatically at (by default) weekly intervals is primarily retrimming, not defragmenting.

## Monitoring disk usage

The Windows 10 Storage page lets you see at a glance how your various storage assets are being consumed.

Go to Settings, System, click on Storage in the list of subsections at the left, and you're presented with a display comparable to the following:



This initial display shows a bar graph for each volume, letting you see at a glance how much storage is in use and how much remains.

The controls below the bar graphs provide an easy way to change the default storage locations for various categories of files—documents, music, pictures, and so on.

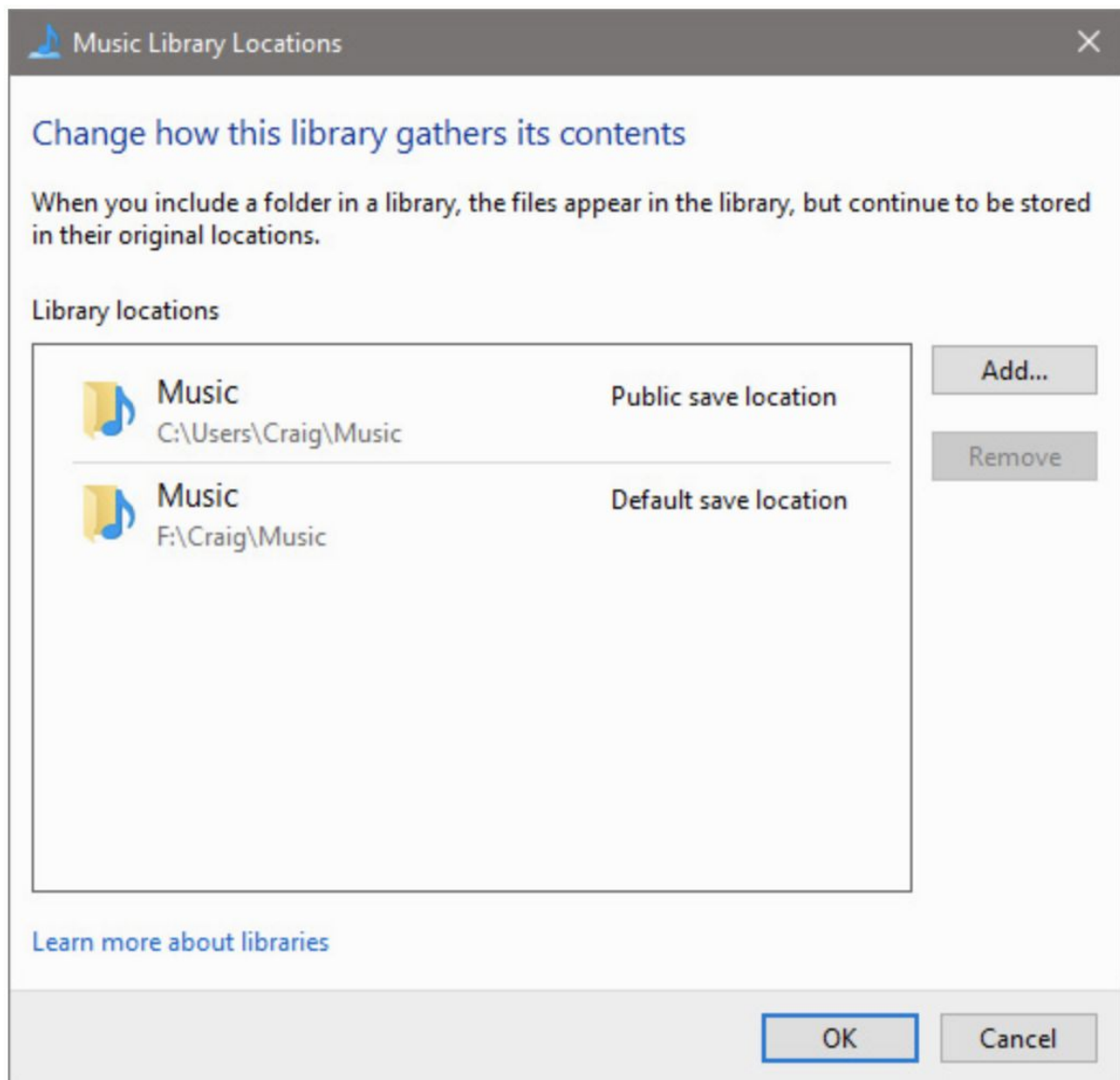
### Changing default save locations

In the Save Locations section of the initial Storage display, you'll find a set of drop-down lists for various categories of files—apps and games, documents, music, pictures, and videos.

Using these controls, you can change the locations where new items are saved by default.

All these categories, except for apps and games, represent libraries, and changing the default storage location simply adds a new location to the library.

Opening the Save New Music To list and switching from This PC to Music (F:), for example, expands the Music Library to include drive F, as the next figure show:



Note that if the volume to which you redirect new saves does not already include an appropriate folder for the selected document type, Windows creates the folder.

In the previous image, for example, the folder F:\Craig\Music did not exist before we changed the default save location for music.

Also note that the previous save folder (in this case, C:\Users\Craig\Music) becomes a public save location.

If you subsequently change the default save location again, the previous save location remains in the library (and, of course, the folder and its contents also remain).

You can change the library locations by selecting a library in the Navigation pane and then selecting Library Tools > Manage Library.

## - Exercises - 1. 3. 2. Managing disks and drives -

Open the following Google Document that you have created in a previous sub-unit:

### "1. 3. System maintenance and troubleshooting - Apellidos, Nombre"

being "Apellidos, Nombre" your Last Name and Name.

Inside this Google Document you are going to copy and answer all the "Exercises" of this sub-unit:

1. Right click on the Windows button and select "Disk Management". Check your disks, volumes, types, sizes, file systems, capacity, free space, % free...
2. Turn your Windows 10 virtual machine off. Add a new 20 GB hard drive (GPT) in Virtual Box ("dynamic"). Turn your virtual machine on. Open "Disk Management". Create two NTFS volumes ("quick format") in this new hard drive: one volume of 12 GB (labelled "BACKUP" and with the "K" drive letter), and other volume of 5 GB (labelled "DATA2" and with the "H" drive letter). There should be 3 GB of unallocated space in the new hard drive.
3. Which are the advantages of NTFS?
4. Using the "Disk Management" tool, extend the "DATA2" volume from 5 GB to 6 GB, using 1 GB of the 3 GB of unallocated space.
5. Compress the "DATA2" volume.
6. Is the NTFS compression compatible with the Encrypting File System (EFS) of Windows 10?
7. Using the "Disk Management" tool, shrink the "DATA2" volume from 6 GB to 4 GB, leaving the unallocated space in 4 GB.
8. Run a Scan Drive to your "DATA2" volume.
9. Open a CMD as an administrator, and type "chkdsk /f /r d:" to run a Check Disk of your "DATA" volume (being "d:" the drive letter of the "DATA" volume).
10. Search in the Windows Search Box the "Defragment and Optimise Drives" app and open it. Click on the "Optimise" button to optimise the performance of one of your volumes.
11. Go to Settings -> System -> Storage and click on every volume to see the details of how much capacity is occupied by the operative system, apps, games, documents, pictures, music, videos, mail, OneDrive...