Zakho Technical Institute / IT

Operation System - Practical

3. Boot Process and partition manager

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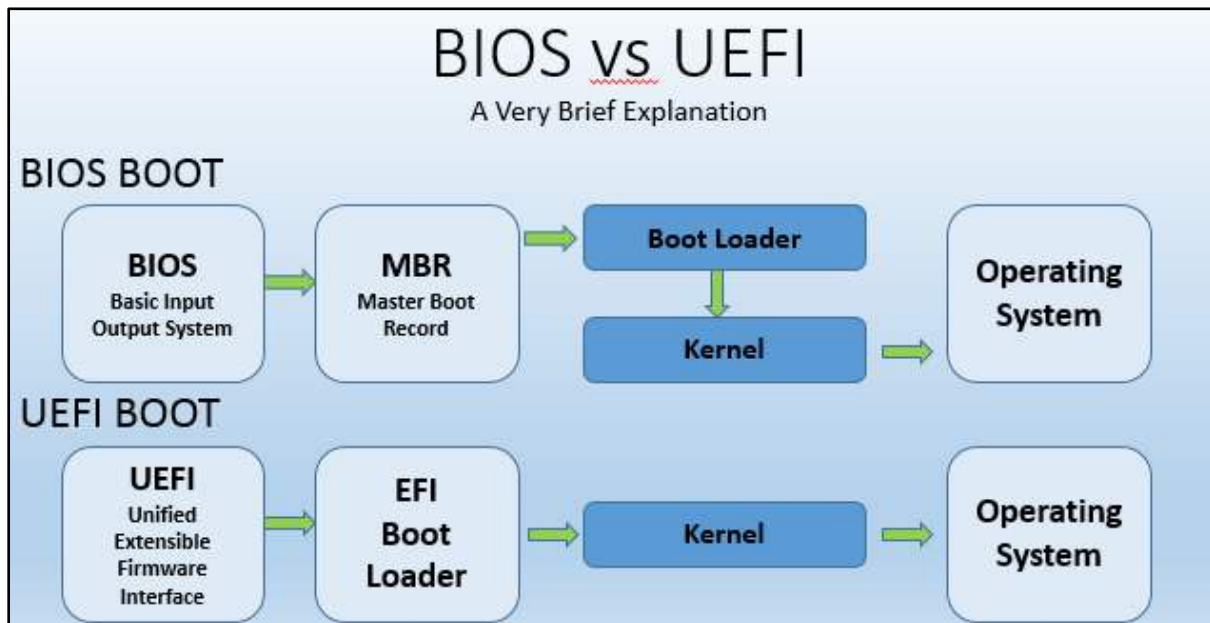
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Booting Process

Figure 1show bios and uefi booting process

bios and UEFI

BIOS and UEFI are two of a kind, but completely different from each other. They serve one major purpose: booting the machine and they do it in different ways and with different options. Without them, all your hardware and the very machine you're reading this blog on, wouldn't even start. But what are the differences? And why are they mutually exclusive?

BIOS

BIOS stands for **Basic Input Output System**. It is a special type of software called firmware stored on the motherboard. When the power button is pressed BIOS is the first software that runs.

It is responsible for mainly 3 things:

1. Performing POST (Power On Self Test)
2. Basic IO
3. Booting

BIOS still works in the 16-bit realm. Most BIOS can only boot from an [MBR](MBR)(Master Boot Record) partitioned disk. MBR only supports up to 2TB partitions. This means it won't

recognize the disk past 2TB. We can use GPT(GUID Partition Table) for disks bigger than 2TB. The only problem is that most BIOS does not support GPT.

This means if we have a 3TB disk, we will not be able to completely use it with BIOS.

UEFI

Unified Extensible Firmware Interface in short UEFI, is low-level software that starts when you boot your PC before booting your operating system like BIOS. It aims to resolve what BIOS could not.

A UEFI can (in addition to what a BIOS can):

1. Performing POST (Power On Self-Test)
2. Basic IO
3. Booting
4. Can Boot from a disk larger than 2 TB using GPT.
5. Provides the user with a graphical user interface, which is easy to use than the old terminal interface in BIOS
6. Provide mouse support. (BIOS cannot do this)

the technical advantages of using UEFI are:

- **Secure Boot:** UEFI Secure Boot is an optional setting that enforces signature checking of the boot process. When the PC starts, the firmware checks the signature of each piece of boot software, including UEFI firmware drivers, EFI applications, and the operating system. If the signatures are valid, the PC boots and the firmware gives control to the operating system. In this way, a system can guard against malicious attacks, rootkits, and unauthorized software updates that could happen prior to the OS launching.

- **GUID Partition Table (GPT):** Support GPT replaces the obsolete Master Boot Record (MBR) partition scheme. GPT allows for storage media boot partitions greater than 2 TB in size, more than 4 partitions (up to 128), and the use of newer storage media such as PCI Express devices. It also improves data integrity through redundant disk layout structures.

- **Platform and Architecture Independence**: UEFI supports x86, x86_64, ARM, ARM64, PowerPC, Itanium, and other architectures. UEFI can also be emulated via

hypervisors like Hyper-V, VMware, Xen, KVM, and others. UEFI simplifies device management through a homogeneous firmware experience.

- **Consistent Variables and Services:** A standardized set of variables, services, and drivers are common to all UEFI implementations regardless of the host device. UEFI on a desktop PC features the same core set of UEFI capabilities found on a device such as a smartphone. Application developers can create software tools without worrying about platform-specific firmware quirks commonly found with BIOS. Firmware developers can isolate platform-specific code through modularization.

- **Modular and Extensible:** UEFI firmware modules can be added, removed, or updated by vendors and device owners. New modules can be created to extend the capabilities of a device's firmware. Modules may interact with device resources (e.g. network adapters, RAID controllers), UEFI environment variables, and kernel-mode drivers.

- **Improved Boot Performance:** UEFI can run in 32-bit or 64-bit mode and has more addressable address space than BIOS, which means your boot process is faster. It also means that UEFI setup screens can be slicker than BIOS settings screens, including graphics and mouse cursor support. Not only this, some of the UEFI modules and drivers can be loaded in parallel, rather than legacy sequential, to reduce boot time.

Drawbacks of UEFI

The biggest problem with UEFI is hardware and software support. In order for it to work properly, the hardware and operating system must both support the appropriate specification. This isn't as much of a challenge with the current Windows or macOS but older operating systems such as Windows XP do not support it.

What is MBR and GPT?

MBR is short for **master boot record**, and GPT is **GUID partition table**. They are 2 partition tables that are used to describe partitions on the disk. Windows can quickly retrieve a file from numerous data according to the partition table.

The 2 different partition table format comes with different features. General speaking, GPT is a new table. It supports 9 .4ZB space at most. And it is more resilient to error, got higher security. And it works well with new Windows OSes, like Windows 10, 8, 7. While MBR only supports TB. If you find your storage device is onlY- show 2 TB, you may need to convert it to GPT.

Here, you can refer to the following table to know the difference between MBR and GPT partition table.

|	MBR	GPT
Maximum Partition Capacity	2TB	9.4ZB(1 ZB is 1 billion terabytes)
Maximum Partition Number	4 primary partitions(or 3 primary partitions+an infinite number of logical partitions)	128 primary partitions
Firmware Interface Support	BIOS	UEFI
Operating System Support	Windows 7 and older systems like Windows 95/98, Windows XP 32-bit, Windows 2000, Windows 2003 32-bit	new systems like Windows 10 32-bit, Windows 8/8.1/10 64-bit

If the disk contains the system, the determinant what the boot mode your PC support. MBR with BIOS boot mode, and GPT with UEFI boot mode are must for system disk.

So, you have known what partition table your disk should be initialized. Here are the steps of setting up a disk.
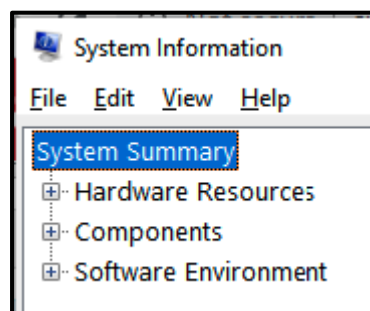
Check if Windows has EFI/UEFI or Legacy BIOS firmware interface

Information

1. Launch a Windows virtual machine.

2. Click the **Search** icon on the Taskbar and type in `msinfo32`, then press **Enter**.
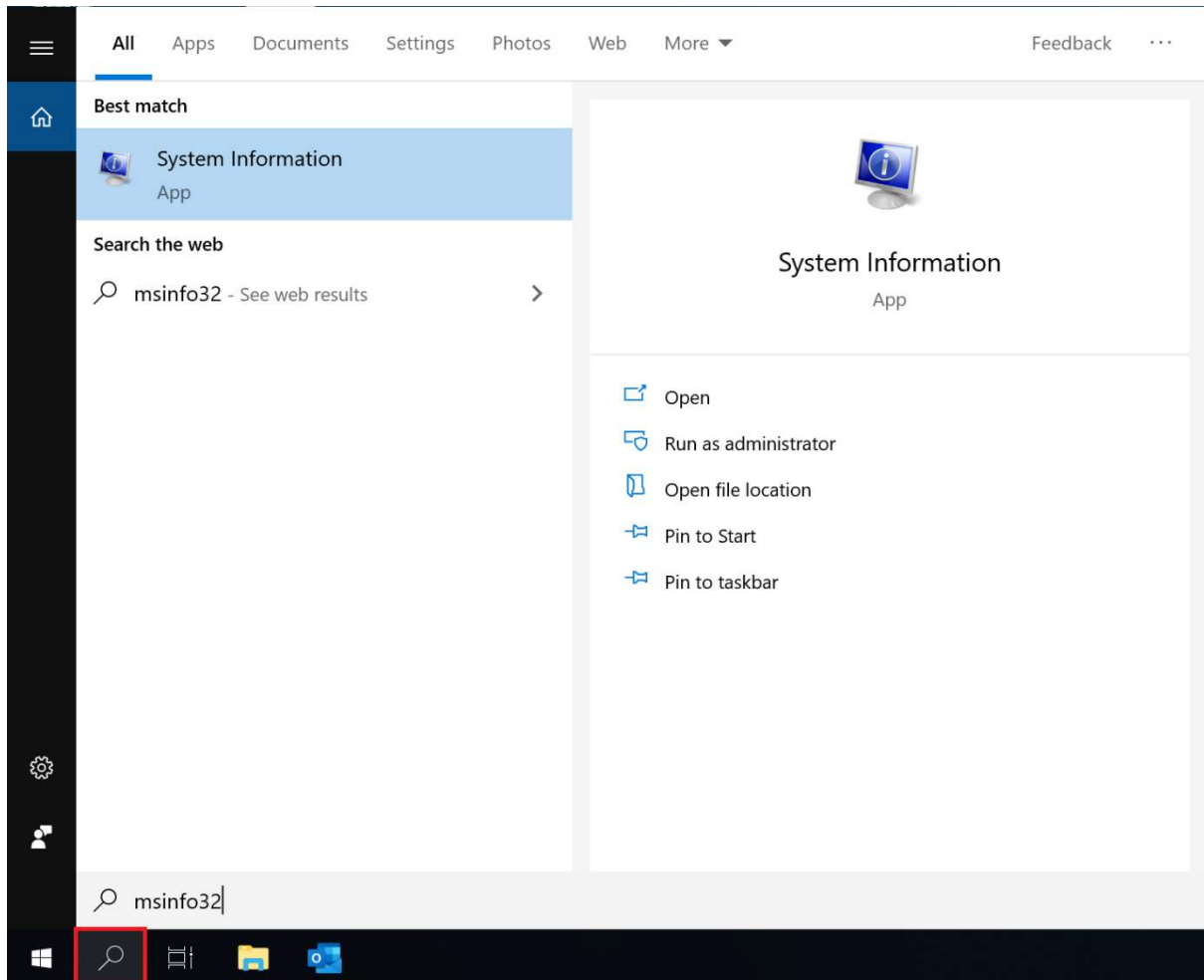
3. **System Information** window will open. Click on the **System Summary** item.

Then locate **BIOS Mode** and check the type of BIOS, Legacy or UEFI.

Item	Value
OS Name	Microsoft Windows 10 Pro
Version	10.0.18362 Build 18362
Other OS Description	Not Available
OS Manufacturer	Microsoft Corporation
System Name	DESKTOP-5KL5317
System Manufacturer	Parallels Software International Inc.
System Model	Parallels Virtual Platform
System Type	x64-based PC
System SKU	Undefined
Processor	Intel(R) Core(TM) i5-6500 CPU @ 3.20GHz, 3192 Mhz, 2 Core(s), 2 Logical Pro...
BIOS Version/Date	Parallels Software International Inc. 15.0.0 (46967), 8/1/2019
SMBIOS Version	2.7
Embedded Controller Version	15.00
BIOS Mode	UEFI
BaseBoard Manufacturer	Parallels Software International Inc.
BaseBoard Product	Parallels Virtual Platform

File System

File System in an operating system provides a way to organize files and manage the drives. It specifies how data will be stored in the form of file and folders and provides the metadata about the files like name, permission, size and other attributes.

FAT32, exFAT and NTFS are file systems used by the Windows Operating System. FAT32 is the oldest one, exFAT is a replacement of FAT32 and is compatible on multiple devices. NTFS is the latest file system.

What is FAT32?

FAT32 stands for **File Allocation Table 32**. It is the oldest file system available to [Windows operating systems](#). FAT32 was introduced in 1995 to replace the older FAT16 systems used by MS-DOS and Windows 3.

FAT32 file system has limitations of 4 GB maximum file size, and 8 TB maximum partition size. Therefore, a FAT32 partition would have to be less than 8 TB size. FAT32 file system is compatible with all versions of Windows, Mac, Linux, game consoles, and anything that comes with a USB port.

What is exFAT?

exFAT stands for **Extensible File Allocation Table**. It is a file system that was introduced by Microsoft in 2006. The exFAT file system is mainly optimized for flash memory drives like USB drives, SD cards, etc.

exFAT file system is best suited option where NTFS file system is a feasible option due to data structure overhead. exFAT file system can works with all versions of Windows, MAC OS X. But, it requires additional software on Linux.

What is NTFS?

NTFS stands for **New Technology File System**. NTFS is a modern file system used by Windows systems. It is a default file system for windows systems, it is because the system drive is formatted with NTFS file system when Windows OS is installed. NTFS file system was first seen in consumer versions of Windows XP; it was originally known as Windows NT.

NTFS file system has very high limits of file size and partition size, thus there are no chances of user running up against it. NTFS has advanced features that cannot be found on FAT32 and exFAT file systems. Also, it supports file permissions for security. Another important features that NTFS provide are shadow copies for backups, encryption, disk quota limits, and hard links. NTFS is compatible with all Windows versions, read-only compatible with Mac OS, and partially compatible with Linux distributions.

Difference between FAT32, exFAT, and NTFS

The following are some of the important differences between FAT32, exFAT, and NTFS File Systems −

Key	FAT32	exFAT	NTFS
Introduction	FAT32 was introduced with Windows 95 to replace older FAT16 file system used in DOS and Windows 3.	exFAT was introduced in 2006 with Windows XP and Vista.	NTFS was introduced with Windows NT and widespread usage happened with Windows XP.
Features	Easy to use and format. Quick to access.	Suited for Flash drives. Lightweight. Have features but no overhead of NTFS file system.	NTFS supports file permissions, change journal, helps quickly recover from error when computer crashes, shadows copies for backup, provides encryption, disk quota limits, hard linking, etc.
Compatibility	Works with all versions of Windows, MAC, Linux, etc. Any drive having USB port can use FAT32.	Works with all versions of Windows, MAC OS X. Requires additional software on Linux.	Compatible with all versions of Windows, Read-Only with MAC and some version of Linux
Limitation	Maximum file size 4 GB, Maximum partition file size 8 TB.	No file size or partition size limits.	No file size or partition size limits.
Ideal Use	Best for removable drives having max size of 8 TB	Best for flash drives	Best for Windows System and Internal Drive used by Windows.

How to Create Partition using MiniTool Partition Wizard Tutorial

There are times users need to create new partitions especially when they have got a new hard drive. MiniTool Partition Wizard tutorial shows users the best way to create new partition on Windows 10/8/7.

About Create Partition

Create Partition feature enables users to create a new volume with specified unallocated space. For users who have two partitions on the same drive, with one for the operating system and the rest one for personal data, perhaps the partitions can't meet their demands for data management. In this case, Create Partition feature make it easy to manage various data by category.

How to Create Partition on Windows 11/10/8/7

For Windows 10/8/7 user, they can use a free partition manager – MiniTool Partition Wizard to create partition easily. Step-by-step guide is shown below:

Step 1. Choose one of the following ways to activate **Create Partition** function:

- Click **Create Partition** from the left menu after selecting the unallocated space.
- Right-click on the unallocated space and choose **Create** option from drop-down menu.

Step 2: In this interface, you are expected to confirm parameters including Partition Label, Partition Type, Drive Letter, File System, Cluster Size, Partition Volume, Partition Location and Partition Alignment Method.

Kind Remind:

- The partition alignment option is only available when users are creating the first partition on an MBR disk.
- Aligning to cylinder is used in older OS versions like Windows XP and Windows Vista; newer Microsoft OS versions and Linux use the MB alignment by default.
- For a logical partition aligning to cylinder, there will be 8 MB unallocated space; but for a primary partition aligning to cylinder, there won't be 8 MB unallocated space.

With no change here, all these parameters are kept by default. After that, click **OK** button to go back to the main interface of the software.
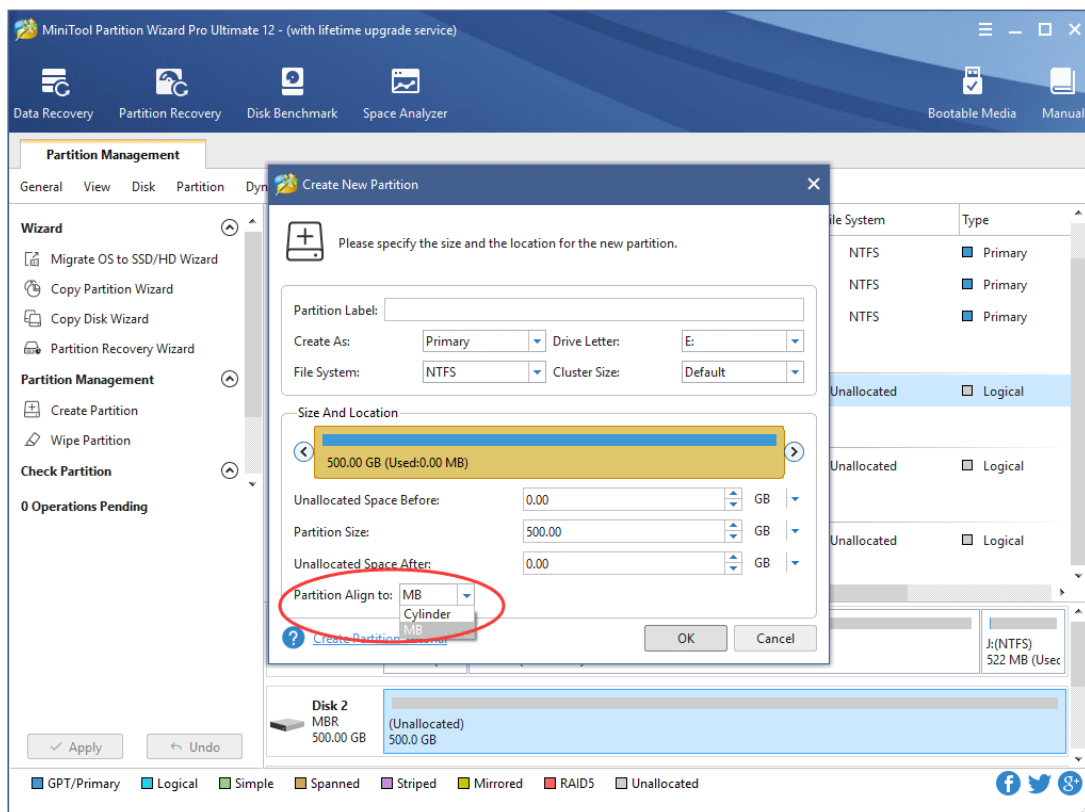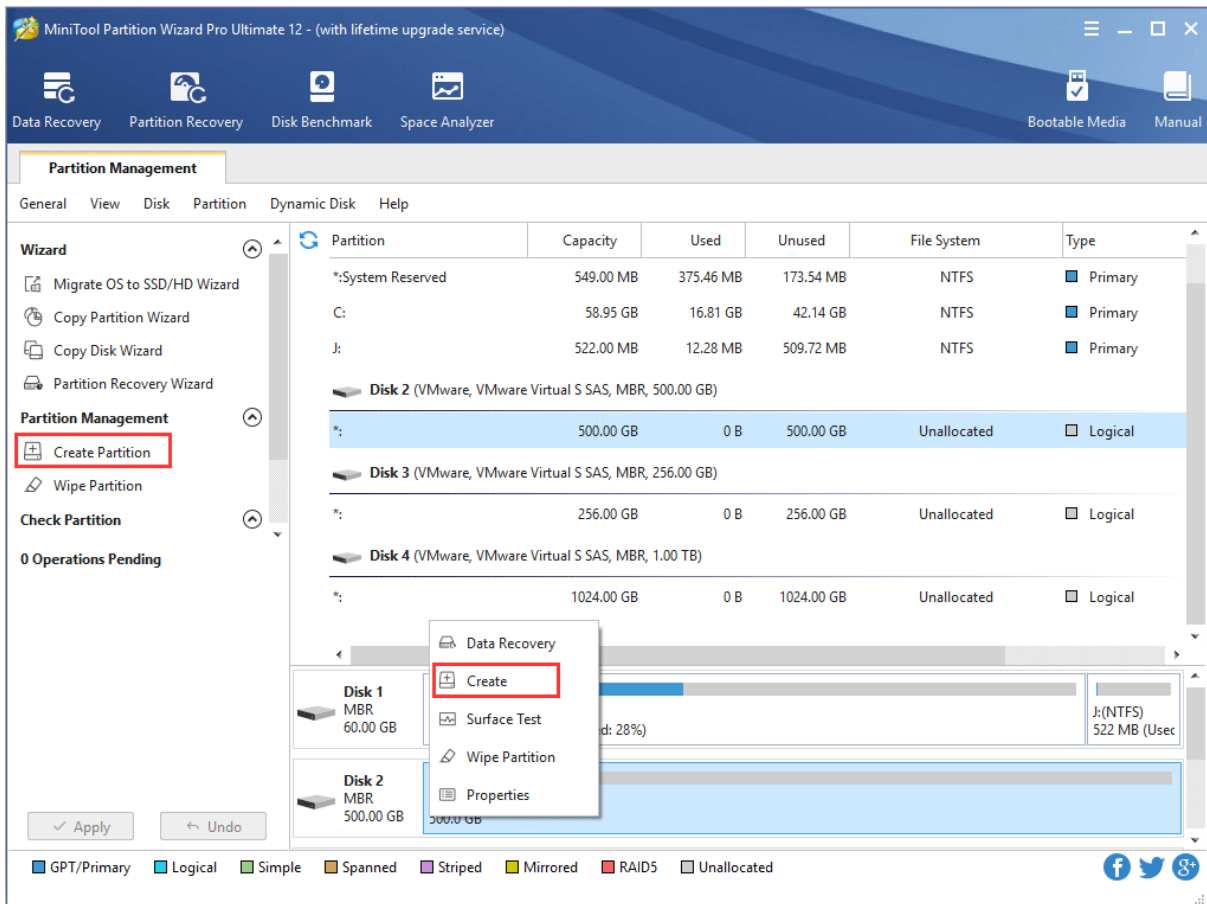
Step 3: users can preview a new partition will be created. Click **Apply** button to confirm the creation.
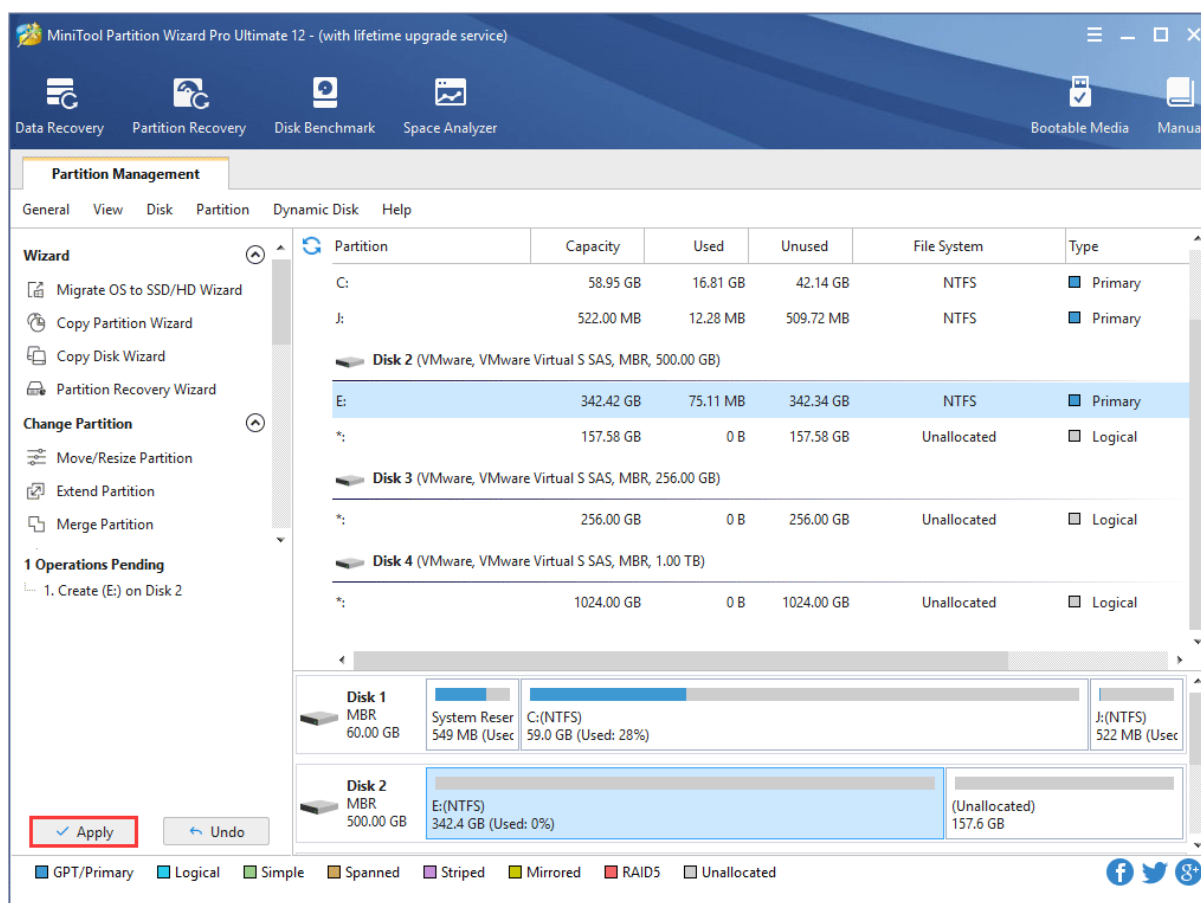
How to Move/Resize Partition | MiniTool Partition Wizard Tutorial

For some reasons, users need to move or resize partition sometimes. To more or resize partition in an effortless way, the professional partition manager MiniTool Partition Wizard is highly recommended.

About Move/Resize Partition

Move/Resize Partition is capable of changing partition size and location in Windows with ease. It helps:

1. Enlarge a small partition or shrink a large partition when Windows Disk Management tool does not offer E**xtend Volume** and **Shrink Volume** features.

2. Extend or shrink a FAT partition in Windows Vista, Windows 7, Windows Server 2008, etc.
3. Extend a partition to the left contiguous unallocated or free space.
4. Extend a primary partition to contiguous free space.
5. Move unallocated or free space to be contiguous to the partition users need to extend.

For different file systems, the partition size adjustment operations that MiniTool Partition Wizard can perform are as follows. To change the size of the bitlocker encrypted partition, please disable bitlocker encryption and restart the computer, and then turn on bitlocker encryption after the partition size adjustment operation is completed.

	Move Partition	Resize Partition (shrink/expand)	Extend Partition	Merge Partition	Split Partition
FAT(12/16)	√	√	√	×	×
FAT32	√	√	√	×	√
exFAT	√	×	×	×	×
NTFS	√	√	√	√	√
EXT(2/3/4)	√	×	×	×	×
Linux Swap	×	×	×	×	×
Unformatted	×	×	×	×	×
Other	×	×	×	×	×
Bitlocker Encrypted	×	×	×	×	×

How to Move/Resize Partition

In general, **Move/Resize Partition** contains 3 operations – shrink partition, extend partition, and move partition. Let's see these operations in detail.

Step 1. After successful installation, please launch MiniTool Partition Wizard to get its main interface.

Step 2. Select the partition to operate and activate **Move/Resize Partition** from the left action panel or choose **Move/Resize** from right-click menu.
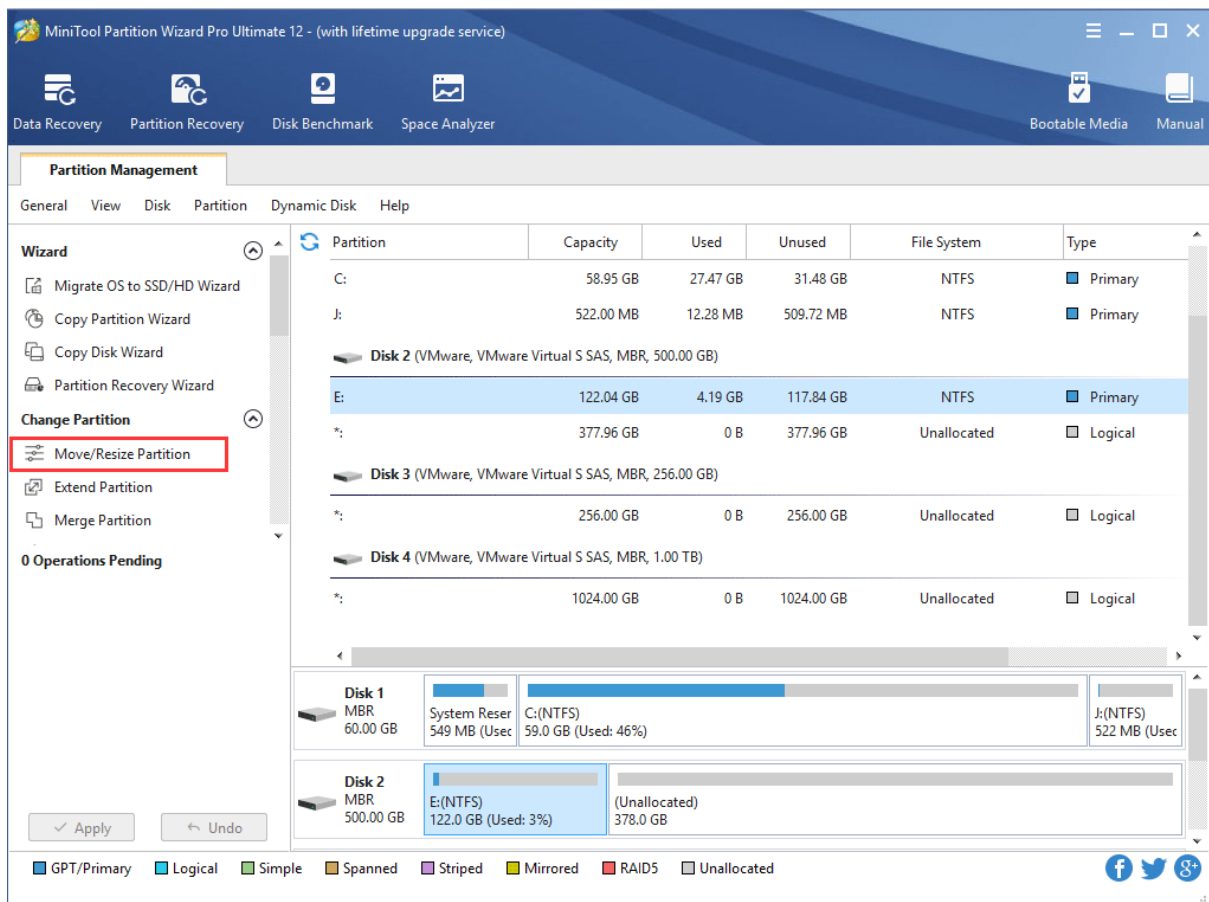

Step 3. The blue handle represents partition while the blank area means unallocated space. Do the followings and click **OK** to go back to the main interface.

- To shrink a partition, shorten the handle by dragging the triangles.
- To extend a partition, lengthen the handle to occupy more unallocated space.
- Alternatively, users can manually type specified partition size in MB, GB, or TB.
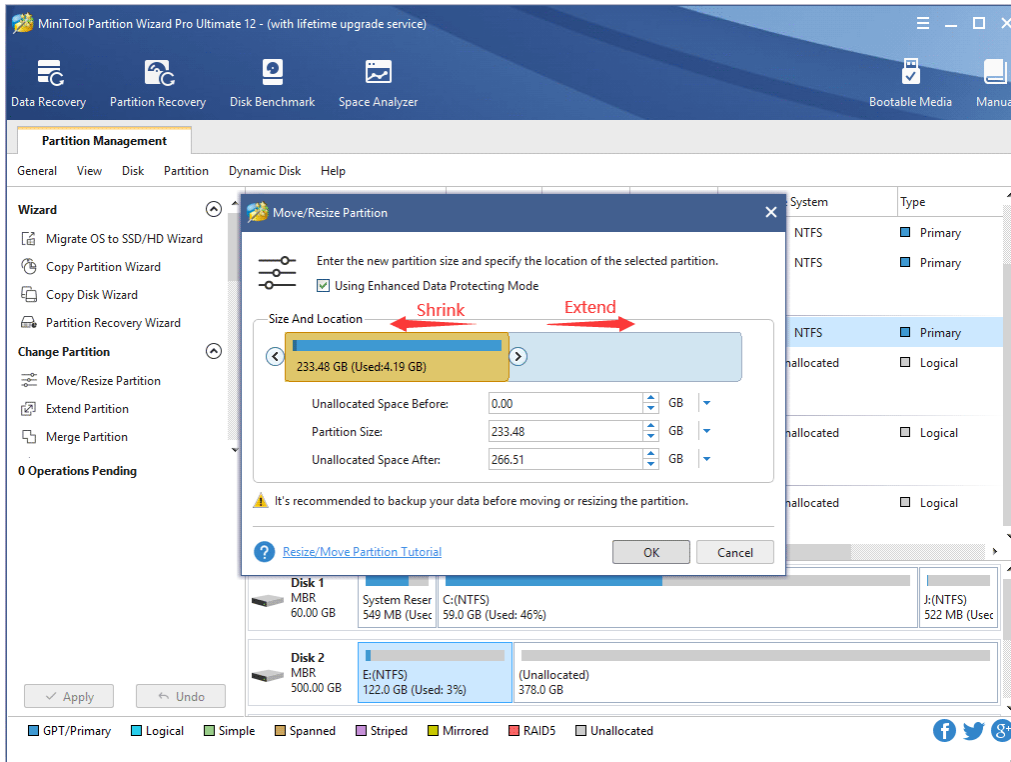
To move a partition, drag the whole partition handle towards unallocated space or manually define unallocated space before or after the partition.
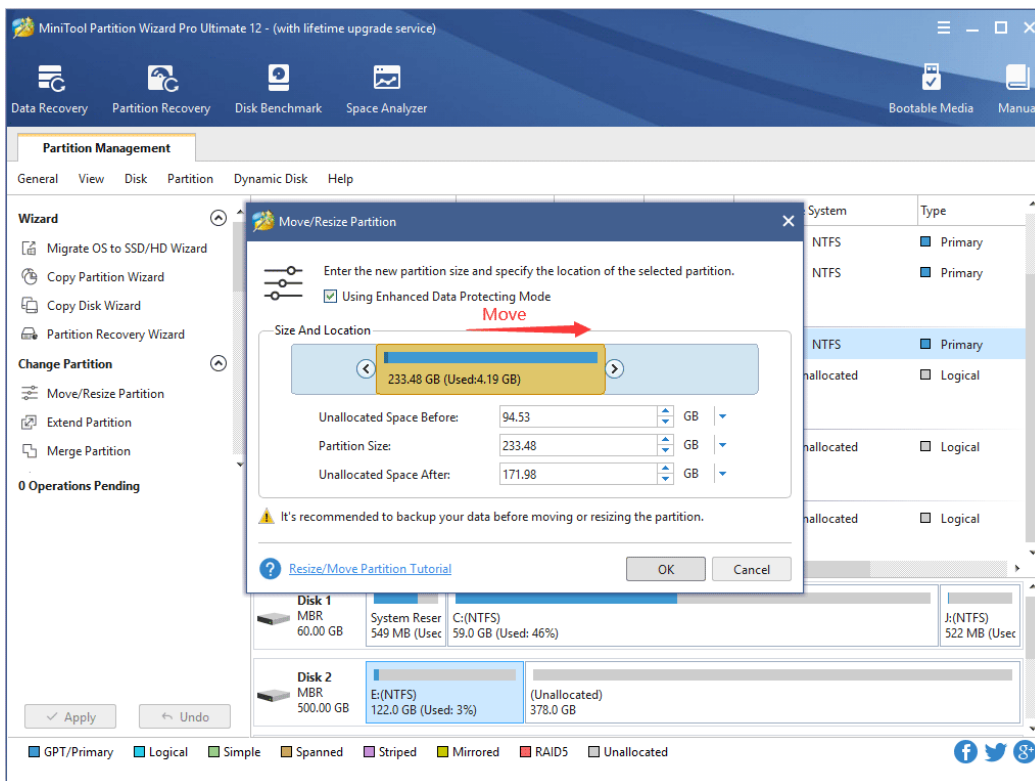
Step 4. From the main interface, users can preview that the selected partition has changed its position. At this time, please click **Apply** button to apply the change.
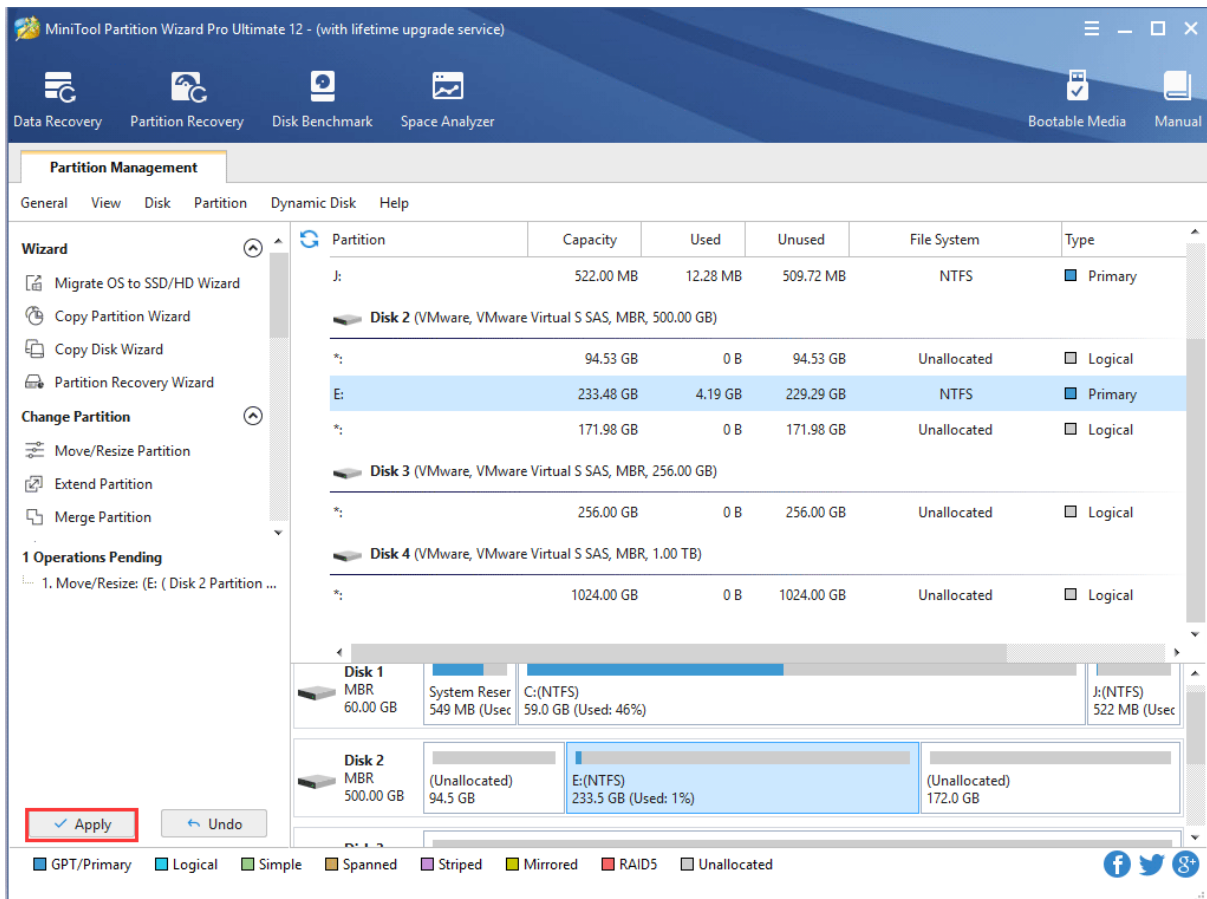
This is the end of the tutorial on **Move/Resize Partition** feature in MiniTool Partition Wizard.

How to Convert MBR Disk to GPT Disk

Step 1. Choose the MBR disk that users want to convert.

Step 2. Select **Convert MBR Disk to GPT Disk** function through following three ways.

- Click it under the **Convert Disk** list.
- Choose it from the drop-down list of **Disk** menu at the top.
- Right-click the target disk and choose it from the pop-up list.
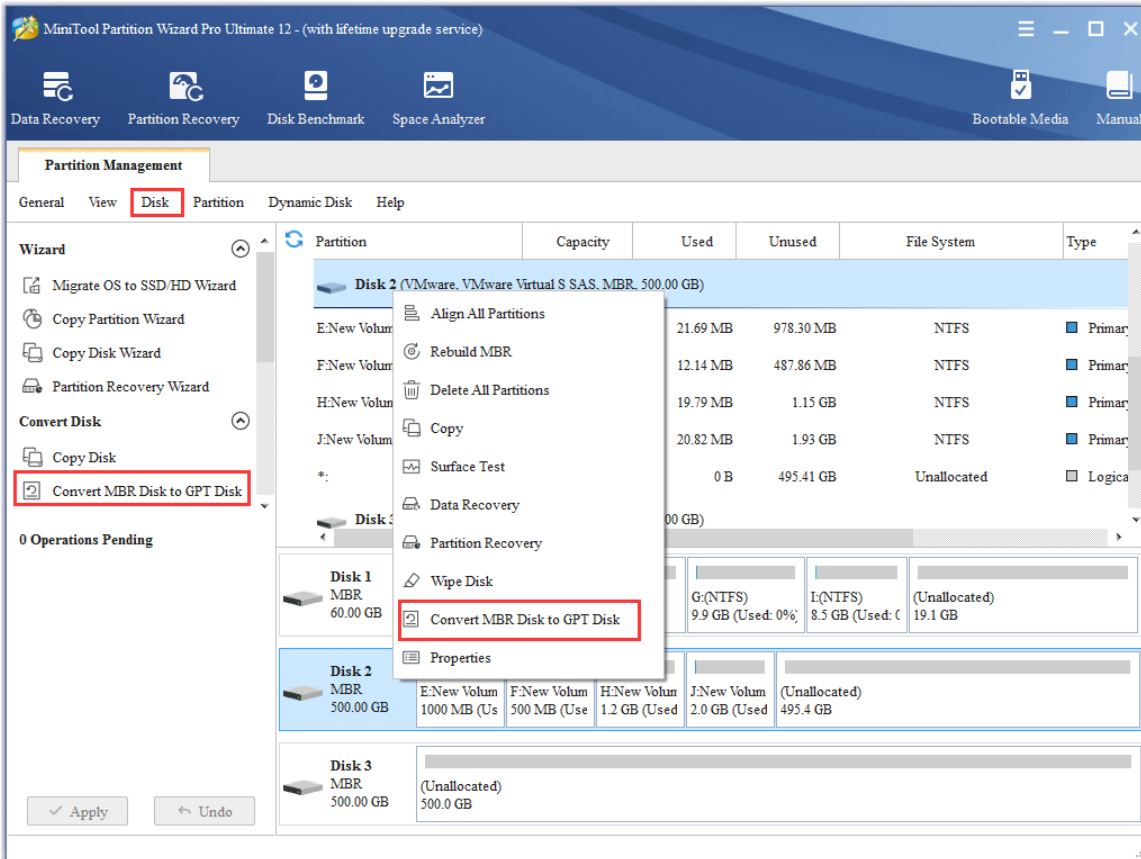
Step 3. Click on **Apply** button in order to carry out pending operations.
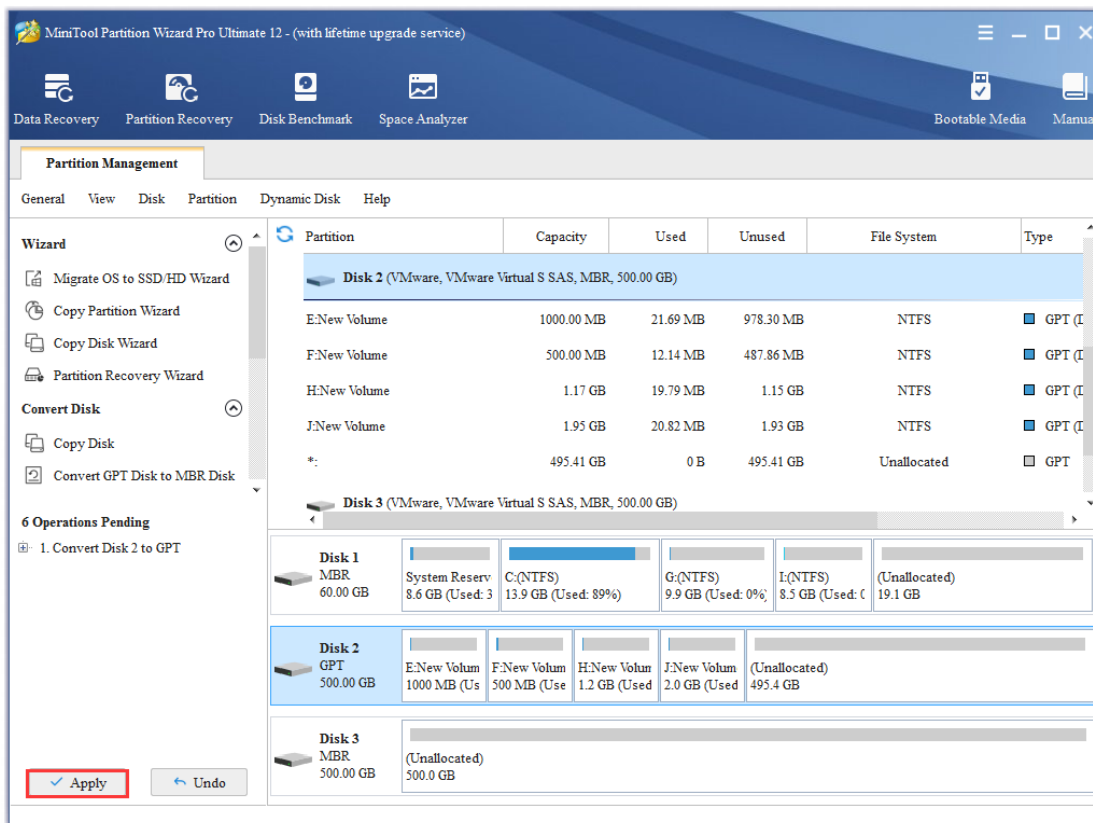
Step 4. Choose **Yes** in the pop-up prompt window to start converting a disk from MBR to GPT.
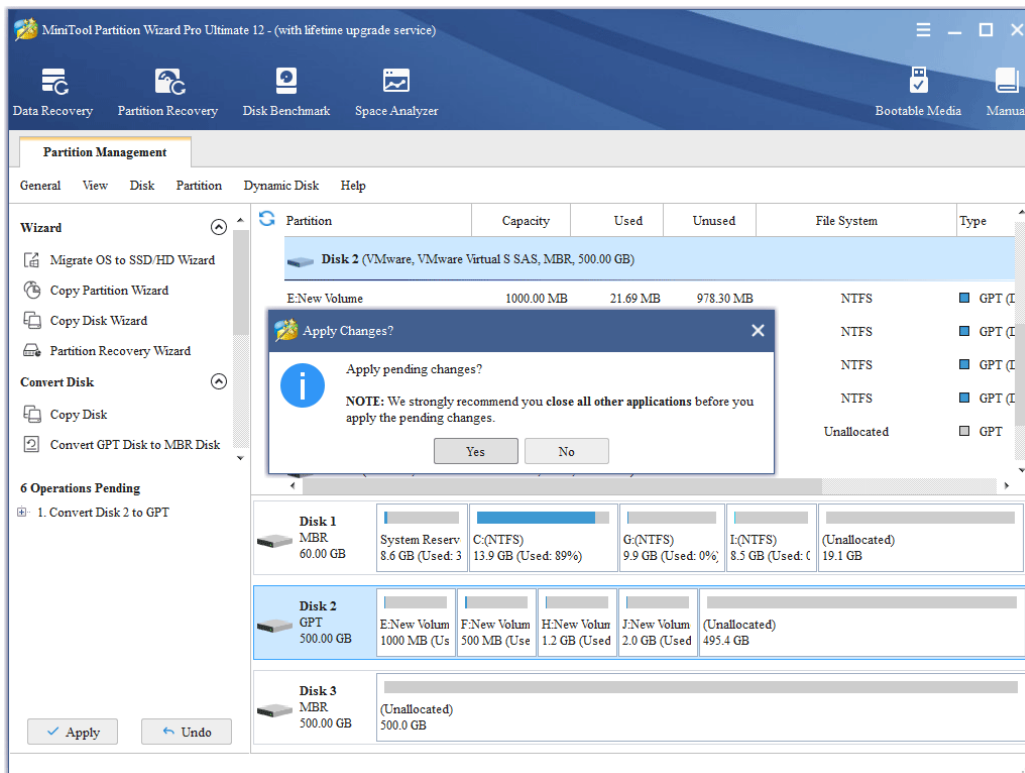
Step 5. Click **OK** button at the end of conversion to end the process.