

## METHODS OF USING MICROSOFT WINDOWS FAMILY OPERATING SYSTEMS ON EXTERNAL SYSTEM DRIVE

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Computer's operating system is generally installed on its internal SSD (HDD). When user boot computer, the BIOS loads the boot loader from the internal SSD and the boot loader boots the installed operating system. A boot loader is a computer program that loads an operating system or some other system software for the computer after completion of the power-on self-tests. A boot loader is loaded into main memory from persistent memory. On modern general purpose computers, the boot up process can take tens of seconds, or even minutes, and typically involves performing a power-on self-test, locating and initializing peripheral devices, and then finding, loading and starting an operating system. Booting is complete when the normal, operative, runtime environment is attained.

I have Implemented a few methods of using Microsoft Windows family operating systems on external system drive.

*Keywords:* System drive, HDD, SSD, microSD card, operating system, installation files, WIM-file, DISM, Diskpart, BCDboot, Microsoft Windows

### **Introduction.**

An external drive is just a hard drive (HDD) or solid-state drive (SSD) or microSD card (via card reader or usb adapter) that is connected to a computer on the outside rather than on the inside.

Some external drives draw power over their data cable, which of course comes from the computer itself, while others may require an AC wall connection to derive power on their own.

One way to think of an external hard drive is as if it were a regular, internal hard drive that has been removed, covered in its own protective casing, and plugged into the outside of your computer.

Internal hard drives can even be converted into external hard drives via what's called a hard drive enclosure.

External hard drives come in varying storage capacities, but they all connect to a computer either by USB, FireWire, eSATA, or wirelessly.

External hard drives are sometimes called portable hard drives. A flash drive is one common, and very portable, type of external hard drive.

External hard drives are portable, easy to use, and can provide a large amount of storage whenever you need it. You can store the actual device any place you like, and carry a large number of files with you wherever you go.

Another advantage of owning an external drive is that you can move them from computer to computer, making them great for sharing large files.

Because of their usually large storage capacities (often in the terabytes), external hard drives are often used to store backed up files.

It's common to use a backup program to back up things like a music, video, or picture collection to an external drive for safe keeping, separate from the originals in case they're accidentally changed or deleted.

Even if not used for backup purposes, external hard drives provide an easy way to expand your existing storage without having to open up your computer, which is especially difficult if using a laptop.

External hard drive can also be used to provide additional storage to an entire network (though internal hard drives are usually more common in these scenarios). These kinds of network storage devices can be accessed by numerous users at once and often serve as a way for users to share files within a network to avoid emailing or uploading the data online.

Internal hard drives are connected directly to the motherboard, whereas external storage devices first run through the outside of the computer case, and then directly to the motherboard.

Operating systems and software installation files are generally installed to internal drives, while external hard drives are used for non-system files, like photos, videos, documents, and files of those types.

Internal hard drives draw power from the power supply inside a computer. External hard drives are powered either through their data cable or via dedicated AC power.

Data can be compromised much easier if it's stored on an external hard drive because they're generally located on a desk or table, making them very easy to pick up and steal. This is different than an internal hard drive where the entire computer has to be taken, or the hard drive removed from the inside, before someone can have physical access to your files.

External hard drives are also generally moved around more than internal ones, causing them to fail more easily due to mechanical damage. SSD based drives, like flash drives, are less prone to this sort of damage.

SSDs are dramatically coming into our computing life and more and more users are benefit from the new technology. SSDs tend to be with large capacity and affordable prices on the market. SSD manufacturers like Samsung, Intel, Toshiba, Kingston, SanDisk, and PNY are well-known SSD brands. For a period of time, replace HDD with SSD in desktop and laptop becomes a popular trend. This part of PC users mostly want to change old and slow traditional hard drive with new and fast solid state drive. Of course, some of them use SSD for OS and HDD for storage to fully take advantage of each disk.

SSD technology primarily uses electronic interfaces compatible with traditional block input/output (I/O) hard disk drives (HDDs), which permit simple replacements in common applications. New I/O interfaces like SATA Express and M.2 have been designed to address specific requirements of the SSD technology.

SSDs have no moving mechanical components. This distinguishes them from traditional electromechanical drives such as hard disk drives (HDDs) or floppy disks, which contain spinning disks and movable read/write heads. Compared with electromechanical drives, SSDs are typically more resistant to physical shock, run silently, have quicker access time and lower latency.

**Windows To Go**

Windows To Go is a feature in Windows 10 Enterprise and Windows 10 Education that enables the creation of a Windows To Go workspace that can be booted from a USB-connected external drive on PCs.

PCs that meet the Windows 7 or later certification requirements can run Windows 10 in a Windows To Go workspace, regardless of the operating system running on the PC. Windows To Go workspaces can use the same image enterprises use for their desktops and laptops and can be managed the same way. Windows To Go is not intended to replace desktops, laptops or supplant other mobility offerings. Rather, it provides support for efficient use of resources for alternative workplace scenarios. There are some additional considerations that you should keep in mind before you start to use Windows To Go:

- Differences between Windows To Go and a typical installation of Windows
- Roaming with Windows To Go
- Prepare for Windows To Go
- Hardware considerations for Windows To Go

Windows To Go workspace operates just like any other installation of Windows with a few exceptions. These exceptions are:

Internal disks are offline. To ensure data isn't accidentally disclosed, internal hard disks on the host computer are offline by default when booted into a Windows To Go workspace. Similarly if a Windows To Go drive is inserted into a running system, the Windows To Go drive will not be listed in Windows Explorer.

Trusted Platform Module (TPM) is not used. When using BitLocker Drive Encryption a pre-operating system boot password will be used for security rather than the TPM since the TPM is tied to a specific computer and Windows To Go drives will move between computers.

Hibernate is disabled by default. To ensure that the Windows To Go workspace is able to move between computers easily, hibernation is disabled by default. Hibernation can be re-enabled by using Group Policy settings.

Windows Recovery Environment is not available. In the rare case that you need to recover your Windows To Go drive, you should re-image it with a fresh image of Windows.

Refreshing or resetting a Windows To Go workspace is not supported. Resetting to the manufacturer's standard for the computer doesn't apply when running a Windows To Go workspace, so the feature was disabled.

Upgrading a Windows To Go workspace is not supported. Older Windows 8 or Windows 8.1 Windows To Go workspaces cannot be upgraded to Windows 10 workspaces, nor can Windows 10 Windows To Go workspaces be upgraded to future versions of Windows 10. For new versions, the workspace needs to be re-imaged with a fresh image of Windows.

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Windows To Go drives can be booted on multiple computers. When a Windows To Go workspace is first booted on a host computer it will detect all hardware on the computer and install any needed drivers. When the Windows To Go workspace is subsequently booted on that host computer it will be able to identify the host computer and load the correct set of drivers automatically.

Enterprises install Windows on a large group of computers either by using configuration management software (such as Microsoft Endpoint Configuration Manager), or by using standard Windows deployment tools such as DiskPart and the Deployment Image Servicing and Management (DISM) tool [1].

#### **DiskPart. DISM. BCDboot**

DiskPart is a text-mode command interpreter in Windows OS that enables you to manage objects, such as disks, partitions, or volumes by using scripts or direct input at a command prompt.

DiskPart can be found under the %WINDIR%\System32\ folder. DiskPart is also included in a typical Windows Preinstallation Environment (Windows PE).

Before you can use DiskPart commands on a disk, partition, or volume, you must first list and then select the object to give it focus. When an object has the focus, any DiskPart commands that you type act on that object.

You can list the available objects and determine the number or drive letter of an object by using the list disk, list volume, and list partition commands. The list disk and list volume commands display all disks and volumes on the computer. However, the list partition command displays only partitions on the disk that have the focus. When you use the list commands, an asterisk (\*) appears next to the object that has the focus. You select an object by its number or drive letter, such as disk 0, partition 1, volume 3, or volume C.

When you select an object, the focus remains on that object until you select a different object. Some commands automatically change the focus.

You can give focus only to a partition on the selected disk. When a partition has the focus, the related volume (if any) also has the focus. When a volume has the focus, the related disk and partition also have the focus if the volume maps to a single specific partition. If this is not the case, the focus on the disk and partition is lost.

When using the DiskPart command as a part of a script, it is recommended to complete all the DiskPart operations together as part of a single DiskPart script. You can run consecutive DiskPart scripts. However, you must allow for at least 15 seconds between each script for a complete shutdown of the previous execution before you run the DiskPart command again in

successive scripts. Otherwise, the successive scripts might fail. You can add a pause between consecutive DiskPart scripts by adding the time-out /t 15 command to your batch file together with your DiskPart scripts [2].

The Deployment Image Servicing and Management (DISM) platform is used to mount and service Windows images before deployment. A subset of DISM commands can be used on online Windows images. You can use DISM tools to mount, and get information about, Windows image (.wim) files or virtual hard disks (.vhd or .vhdx). You can also use it to install, uninstall, configure, and update Windows features, packages, and drivers in a Windows image or to change the edition of a Windows image.

The DISM platform also includes a command-line tool, DISM.exe, and the DISM API [3].

The DISM commands can be used to mount, unmount, capture, append, and delete and query .wim, .vhd and .vhdx files. These options are not case sensitive.

For WIM, the DISM / Apply-Image command applies a Windows image file (.wim) or a split Windows image (.swm) files to a specified partition. Beginning with Windows 10, version 1607, DISM can apply and capture extended attributes (EA).

This option doesn't support applying an image from a virtual hard disk (VHD), though you can use this command to apply images to a .vhdx file that's been attached, partitioned, and formatted.

Arguments for WIM:

```
DISM.exe/Apply-Image /ImageFile:<path_to_image_file> [/SWMFile:<pattern>]
/ApplyDir:<target_directory> {/Index:< image_index> | /Name:<image_name>}
[/CheckIntegrity] [/Verify] [/NoRpFix] [/ConfirmTrustedFile] [/WIMBoot (deprecated)]
[/Compact] [/EA]
```

Examples:

```
Dism /apply-image /imagefile:install.wim /index:1 /ApplyDir:D:\
```

```
Dism/apply-image/imagefile:install.swm/swmfile:install.swm/index:1/applydir:D: [4].
```

The BCDboot tool is a command-line tool that enables you to manage system partition files. You can use the tool in the following scenarios:

- setting up a system partition when you deploy new computers. For more information, see Capture and Apply Windows Images;
- setting up Windows® to boot to a virtual hard disk. For instructions, see Walkthrough: Deploy a Virtual Hard Disk for Native Boot;
- repairing the boot environment located on the system partition. If the system partition has been corrupted, you can use BCDboot to replace the system partition files with new copies of these files from the Windows partition.

To configure the system partition, BCDboot copies a small set of boot-environment files from the installed Windows image to the system partition. Next, BCDboot creates a Boot Configuration Data (BCD) store on the system partition that instructs the computer to boot to the Windows partition.

BCDboot uses the %WINDIR%\System32\Config\BCD-Template file to create a new BCD store and initialize the BCD boot-environment files on the system partition. You can define specific BCD settings in the BCD-Template file. The BCDboot tool also copies the most recent versions of boot-environment files from the operating-system image %WINDIR%\boot folder to the system partition.

BCDboot can update an existing boot environment on the system partition:

- BCDboot copies newer versions of files from the Windows image to the system partition.
- If a BCD store already exists on the system partition, BCDboot creates a new boot entry in the existing BCD store based on settings in the BCD-Template file.
- If there is already a boot entry for this Windows partition, by default, BCDboot erases the old boot entry and its values. To retain the values from an existing boot entry when you update the system files, you can use the /m option together with the BCDBoot.exe command.

The following command-line options are available for BCDboot.exe.

```
BCDBOOT <source> [/l <locale>] [/s <volume-letter> [/v] [/m [{OS Loader GUID}]]
```

[5].

### Dual-booting and multi-booting

The term dual-booting refers to the common configuration of specifically two operating systems. Multi-booting is the act of installing multiple operating systems on a computer, and being able to choose which one to boot. Multi-booting may require a custom boot loader.

Multi-booting allows more than one operating system to reside on one computer, for example if you have a primary operating system and an alternate system that you use less frequently. Another reason for multi-booting can be to investigate or test a new operating system without switching completely. Multi-booting allows a new operating system to configure all applications needed, and migrate data before removing the old operating system, if desired. A possible alternative to multi-booting is virtualization, where a hypervisor is used to host one or more virtual machines running guest operating systems. Multi-booting is also useful in situations where different software applications require different operating systems. A multi-boot configuration allows a user to use all of this software on one computer. This is often accomplished by using a boot loader such as NTLDR, LILO, or GRUB which can boot more than one operating system. Multi-booting is also used by software developers when multiple operating systems are required for development or testing purposes. Having these systems on one machine is a way to reduce hardware costs.

In a multi-boot computer each of the multiple operating systems can reside on its own storage device, or some storage devices might contain more than one operating system in different partitions.

An example of a computer with one operating system per storage device is a dual-booting computer that stores Windows on one disk drive and Linux on another disk drive. In this case a multi-booting boot loader is not strictly necessary because the user can choose to enter BIOS configuration immediately after power-up and make the desired drive first in the boot-order list. However, it is more convenient to have a multi-booting boot loader on one of the drives, set BIOS once to always start booting from (i.e., load the boot loader from) that drive, and then allow the user to choose an operating system from that boot loader's menu. No special disk partitioning is necessary when each operating system has its own dedicated disk drive.

An example of a computer with multiple operating systems per storage device is a dual-booting computer that stores both Windows and Linux on the same disk drive. In this case a multi-booting boot loader is necessary. Also, the disk must be partitioned to give each operating system its own partition on the disk drive.

The basic concept involves partitioning a disk to accommodate each planned installation, usually including separate partitions for boot, root, data storage and backups [6].

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**The new methods of using Windows family operating systems on external system drive.**

A number of methods have been developed for using Microsoft Windows family operating systems on external system drive and the following results have been obtained:

1. Method of using microSD card as a system drive via installation files and software of the operating system Microsoft Windows.

For configuration of microSD card as a system drive were applied unpacked files of WIM-file and tools such as DISM, Diskpart, BCDboot. Accordingly, microSD card can be a drive system for both physical computers and virtual machines. Operating-system-level virtualization was carried out based on the VMware Workstation Pro software. It has been found that the use of microSD cards by this method, improves the energy efficiency of the system.

2. Method of using dual-booting and multi-booting based on the virtual machine using Microsoft Windows family operating systems, such as Windows 8.1, Windows 10, Windows Server 2016.

For configuration of virtual machine with appropriate functionality were applied unpacked files of WIM-file and tools such as DISM, BCDboot. As a result, the virtual machine was able to load different operating systems in turn without changing its own configuration options. Operating-system-level virtualization was carried out based on the VMware Workstation Pro software. It has been found that the developed technique provides the possibility to create virtual machines, the architecture of which is more similar to the architecture of physical machines.

3. Method of using dual-booting and multi-booting based on the external SSD system drive.

For configuration of external SSD as a system drive were applied unpacked files of Windows 10 WIM-file and tools such as DISM, Diskpart, BCDboot. And for configuration dual-booting and multi-booting were applied VHD technology and operating systems, such as Windows 8.1, Windows Server 2012 R2, Windows Server 2016 on single partition of external SSD system drive. It has been found that the use of external SSD by this method, improves modernization of traditional computer architecture and new system functionality for external SSD.

4. Method of using of external microSD as a system drive card using multi-booting of Windows family operating systems on VHDX files only via attaching vhd files as virtual disks to windows OS setup menu.

For configuration of external SSD as a system drive were applied ISO image files of Windows OSs, traditional installation process and tools such as DISM, Diskpart.

The results of the work can be used in design and optimization of computer systems.

Possible directions for further research is continuing work on adaptation of Windows family operating systems for using on any external storage units of computer systems.

Microsoft Windows has been with us, in one form or another, for more than thirty years. Its success as a commercially viable operating system helped to make Microsoft the software giant that it is today, and while there will always be challengers to the throne Windows remains the most popular operating system on the market. At last estimate, approximately 90% of all of the world's computing was done on machines running some form of MS-Windows. Undoubtedly, Microsoft will continue to develop their operating system, introducing new features and refinements, with the intention of keeping Windows at the forefront of home and business computing.

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#### МЕТОДИ ВИКОРИСТАННЯ ОПЕРАЦІЙНИХ СИСТЕМ РОДИНИ WINDOWS НА ЗОВНІШНЬОМУ СИСТЕМНОМУ ДИСКУ

**Василь Костоґриз**

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Операційна система комп'ютера, як правило, встановлена на його внутрішньому SSD (HDD). Коли користувач завантажує комп'ютер, BIOS завантажує завантажувач із внутрішнього SSD, а завантажувач завантажує встановлену операційну систему. Завантажувач завантажується в основну пам'ять з постійної пам'яті. На сучасних комп'ютерах загального призначення процес завантаження може зайняти десятки секунд або навіть хвилин і, як правило, включає проведення самотестування при включенні, локалізацію та ініціалізацію периферійних пристроїв, а потім пошук, завантаження та запуск операційної системи. Завантаження завершується, коли досягається виконання нормального оперативного робочого середовища.

Було реалізовано декілька методів використання операційних систем родини Microsoft Windows на зовнішньому системному диску.

Дані методи забезпечують використання ОС Windows на зовнішніх носіях, які можуть бути застосовані при оптимізації комп'ютерних систем.

Говорячи про ступінь вивчення проблеми, можна констатувати, що відповідні методи представлені в теоретичній і практичній літературі не досить широко.

Таким чином, актуальним є дослідження нових методів використання операційних систем родини Microsoft Windows на зовнішніх носіях пам'яті.



Було розроблено метод, що дозволяє встановлювати операційні системи Microsoft Windows на microSD карту за допомогою інсталяційних файлів та програмних засобів ОС (операційної системи) Microsoft Windows.

Застосування microSD карт як системного диску дозволить суттєво знизити енергоспоживання системи та відповідно підвищити енергоефективність.

Розроблено метод, що надає можливість застосування подвійного завантаження та мультизавантаження на основі віртуальної машини використовуючи операційні системи родини Microsoft Windows на прикладі Windows 10, Windows Server 2016.

Також розроблено метод використання подвійного завантаження та мультизавантаження на основі зовнішнього системного диску, зокрема реалізовано спосіб застосування подвійного завантаження та мультизавантаження на основі зовнішнього SSD-системного диску.

*Ключові слова:* системний диск, HDD, SSD, microSD карта, операційна система, інсталяційні файли, WIM-файл, DISM, Diskpart, BCDboot, Microsoft Windows

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