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## METHOD OF USING DUAL-BOOTING AND MULTI-BOOTING OF 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, run-time environment is attained.

Dual-booting is a technique which allows a single physical computer to run two operating systems.

Multi-booting allows to the common configuration of multiple operating systems on computer, and ability to choose which operating system to boot.

I have Implemented method of using dual-booting and multi-booting based on the external SSD system drive.

*Key words:* system drive, HDD, SSD, operating system, installation files, WIM-file, DISM, Diskpart, BCDboot, Microsoft Windows.

### **1. Introduction.**

An external drive is just a hard drive (HDD) or solid-state drive (SSD) 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.

A solid-state drive (SSD), or solid-state disk is a solid-state storage device that uses integrated circuit assemblies as memory to store data persistently. 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. However, while the price of SSDs has continued to decline over time (24 cents per gigabyte as of 2017), consumer-grade SSDs are (as of 2017) still roughly four times more expensive per unit of storage than consumer-grade HDDs.

As of 2017, most SSDs use 3D TLC NAND-based flash memory, which is a type of non-volatile memory that retains data when power is lost. For applications requiring fast access but not necessarily data persistence after power loss, SSDs may be constructed from random-access memory (RAM). Such devices may employ batteries as integrated power sources to retain data for a certain amount of time after external power is lost.

However, all SSDs still store data in electrical charges, which slowly leaks over time if left without power. This causes worn out drives (that passed their endurance rating) to start losing data typically after one (if stored at 30°C) to two (at 25°C) years in storage; for new drives it takes longer [1].

## **2. 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 [2].

### **3. Microsoft Windows operating systems. From Windows 8.1 to Windows Server 2016.**

Windows 8.1 (codenamed Blue) is a computer operating system released by Microsoft. First unveiled and released as a public beta in June 2013, it was released to manufacturing on August 27, 2013, and reached general availability on October 17, 2013, almost a year after the retail release of its predecessor. Windows 8.1 is available free of charge for retail copies of Windows 8 and Windows RT users via the Windows Store. Unlike service packs on previous versions of Windows, users who obtained Windows 8 outside of retail copies or pre-loaded installations (i.e., volume licensing) must obtain Windows 8.1 through new installation media from their respective subscription or enterprise channel. Microsoft's support lifecycle policy treats Windows 8.1 similar to previous service packs of Windows: It is part of Windows 8's support lifecycle, and installing Windows 8.1 is required to maintain access to support and Windows updates after January 12, 2016. However, unlike previous service packs, Windows 8.1 cannot be acquired via Windows Update.

Windows 8.1 received mixed reception, although more positive than Windows 8, with critics praising the expanded functionality available to apps in comparison to 8, its OneDrive integration, along with its user interface tweaks and the addition of expanded tutorials for operating the Windows 8 interface. Despite these improvements, Windows 8.1 was still criticized for not addressing all digressions of Windows 8 (such as a poor level of integration between Metro-style apps and the desktop interface), and the potential privacy implications of the expanded use of online services. As of February 2018, the market share of Windows 8.1 on desktops is 7% [3].

Windows Server 2012 R2 was released on October 18, 2013. It was unveiled on June 3, 2013 at TechEd North America. According to Windows Server 2012 R2 datasheet published on May 31, 2013, there are four editions of this operating system: Foundation, Essentials, Standard and Datacenter. As with Windows Server 2012, the Datacenter and Standard editions are feature-identical, varying only based on licensing (particularly licensing of virtual instances). The Essentials edition has the same features as the Datacenter and Standard products, with some restrictions.

A further update, formally designated Windows Server 2012 R2 Update, was released in April 2014, a cumulative set of security updates, critical updates and updates.

Windows Server 2012 R2 was succeeded by Windows Server 2016.

Microsoft has confirmed the following changes introduced by Windows Server 2012 R2:

- Automated Tiering: Storage Spaces stores most frequently accessed files on fastest physical media
- Deduplication for VHD: Reduces the storage space for VHD files with largely similar contents by storing the similar contents only once

- Windows PowerShell v4, which now includes a Desired State Configuration (DSC) feature
- Integrated Office 365 support (Essentials edition)
- User interface changes from Windows 8.1, including visible Start button.
- UEFI-based virtual machines
- Upgrades from driver emulators to synthetic hardware drivers to minimize legacy support
- Faster VM deployment (approximately half the time)
- Internet Information Services 8.5
- Server Message Block: Performance and event logging quality improvements, support for Hyper-V Live Migration over SMB, bandwidth prioritization management, and the ability to remove SMB 1.0 support
  - Windows Deployment Services: Support for managing WDS via PowerShell.
  - Windows Defender is available in a Server Core installation, and is installed and enabled by default.
  - IP Address Management (IPAM)
  - Group Policy has a new "Policy Cache"
  - TLS support is extended to support RFC 5077, "Transport Layer Security (TLS) Session Resumption without Server-Side State"
- Hyper-V role and Hyper-V management console are added to the Essentials edition.
- Windows Server Update Services was made available for Windows Server 2012 R2 Essentials edition.
  - ReFS gained support for alternate data streams and automatic error-correction on parity spaces [4].

Windows 10 is a personal computer operating system developed and released by Microsoft as part of the Windows NT family of operating systems. It was released on July 29, 2015. It is the first version of Windows that receives ongoing feature updates. Devices in enterprise environments can receive these updates at a slower pace, or use long-term support milestones that only receive critical updates, such as security patches, over their ten-year lifespan of extended support.

Windows 10 introduces what Microsoft described as "universal apps"; expanding on Metro-style apps, these apps can be designed to run across multiple Microsoft product families with nearly identical code—including PCs, tablets, smartphones, embedded systems, Xbox One, Surface Hub and Mixed Reality. The Windows user interface was revised to handle transitions between a mouse-oriented interface and a touchscreen-optimized interface based on available input devices—particularly on 2-in-1 PCs; both interfaces include an updated Start menu which incorporates elements of Windows 7's traditional Start menu with the tiles of Windows 8. The first release of Windows 10 also introduces a virtual desktop system, a window and desktop management feature called Task View, the Microsoft Edge web browser, support for fingerprint and face recognition login, new security features for enterprise environments, and DirectX 12 and WDDM 2.0 to improve the operating system's graphics capabilities for games.

Microsoft aimed to have Windows 10 installed on at least one billion devices in the two to three years following its release. Up to August 2016, Windows 10 usage was increasing, with it then plateauing, while eventually in 2018, it became more widely used than Windows 7, and thus the single most used Windows version overall (at 42.78%, thus the other more used

overall), though not on some continents as measured by web traffic. As of November 2017, the operating system is running on more than 600 million devices and has an estimated usage share of 32% on traditional PCs and 15% across all platforms (PC, mobile, tablet, and console). Windows 10 was first the most used version in Iceland and later in other developed countries, such as Australia that also has very high adoption (among the highest).

Windows 10 harmonizes the user experience and functionality between different classes of device, and addresses shortcomings in the user interface that were introduced in Windows 8. Windows 10 Mobile, the successor to Windows Phone 8.1, shares some user interface elements and apps with its PC counterpart.

The Windows Runtime app ecosystem was revised into the Universal Windows Platform (UWP). These universal apps are made to run across multiple platforms and device classes, including smartphones, tablets, Xbox One consoles, and other compatible Windows 10 devices.

Windows 10 introduces a new default web browser, Microsoft Edge. It features a new standards-compliant rendering engine forked from Trident, annotation tools, and offers integration with other Microsoft platforms present within Windows 10. Internet Explorer 11 is maintained on Windows 10 for compatibility purposes, but is deprecated in favor of Edge and will no longer be actively developed.

Windows 10 incorporates Microsoft's intelligent personal assistant, Cortana, which was first introduced with Windows Phone 8.1 in 2014. Cortana replaced Windows' embedded search feature, supporting both text and voice input. Many of its features are a direct carryover from Windows Phone, including integration with Bing, setting reminders, a Notebook feature for managing personal information, as well as searching for files, playing music, launching applications and setting reminders or sending emails. Cortana is implemented as a universal search box located alongside the Start and Task View buttons, which can be hidden or condensed to a single button [5].

Windows Server 2016 is a server operating system developed by Microsoft as part of the Windows NT family of operating systems, developed concurrently with Windows 10. The first early preview version (Technical Preview) became available on 1 October 2014 together with the first technical preview of System Center. Windows Server 2016 was released on 26 September 2016 at Microsoft's Ignite conference and became generally available on 12 October 2016.

Windows Server 2016 has a variety of new features, including:

- Active Directory Federation Services: It is possible to configure AD FS to authenticate users stored in non-AD directories, such as X.500 compliant Lightweight Directory Access Protocol (LDAP) directories and SQL databases.
- Windows Defender: Windows Server Antimalware is installed and enabled by default without the GUI, which is an installable Windows feature.
- Remote Desktop Services: Support for OpenGL 4.4 and OpenCL 1.1, performance and stability improvements; MultiPoint Services role.
- Storage Services: Central Storage QoS Policies; Storage Replicas (storage-agnostic, block-level, volume-based, synchronous and asynchronous replication using SMB3 between servers for disaster recovery). Storage Replica replicates blocks instead of files; files can be in use. It's not multi-master, not one-to-many and not transitive. It periodically replicates snapshots, and the replication direction can be changed.
- Failover Clustering: Cluster operating system rolling upgrade, Storage Replicas

- Web Application Proxy: Preauthentication for HTTP Basic application publishing, wildcard domain publishing of applications, HTTP to HTTPS redirection, Propagation of client IP address to backend applications

- IIS 10: Support for HTTP/2
- Windows PowerShell 5.1
- Windows Server Containers

Windows Server version 1709 was released on 17 October 2017. It is offered to the Microsoft Software Assurance customers who have an active Windows Server 2016 license and has the same system requirements. This is the first Windows Server product to fall under the "Semi-Annual Channel" (SAC) release cadence. This product only features the Server Core and the Nano Server modes. Of the two, only the Server Core mode of the OS can be installed on a bare system. The Nano Server mode is only available as an operating system container [6].

#### **4. 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. For example, if the focus is set on disk 0, and you select volume 8 as on disk 2, the focus shifts from disk 0 to disk 2, volume 8. Some commands automatically change the focus. For example, when you create a new partition, the focus automatically changes to the new partition.

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 [7].

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 [8].

You can also use the DISM image management command to list the image index numbers, to verify the architecture for the image that you are mounting, append an image, apply an image, capture an image and delete an image.

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: [9]
```

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.

For example, if you have set up an additional hard drive or partitions by using Windows, and your Windows no longer appears in your boot menu, you can use the bcdboot D:\Windows command to restore the Windows boot entry, where D is the drive letter of your 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. The new method of using dual-booting and multi-booting on external system drive.

The method of using dual-booting and multi-booting based on external system drive consist of a few steps:

- a) Prepare USB external SSD based on NTFS file system using diskpart tool:
  - Insert a USB external SSD into a running computer.
  - Open a Command Prompt window as an administrator.
  - Type diskpart.
  - In the new command line window that opens, to determine the USB external SSD number or drive letter, at the command prompt, type list disk, and then click ENTER. The list disk command displays all the disks on the computer. Note the drive number or drive letter of the USB external SSD.
    - At the command prompt, type select disk <X>, where X is the drive number or drive letter of the USB flash drive, and then click ENTER.
    - Type clean, and the click ENTER. This command deletes all data from the USB flash drive.
    - To create a new primary partition on the USB external SSD, type create partition primary, and then click ENTER.
    - To select the partition that you just created, type select partition 1, and then click ENTER.
      - Type active, and then click ENTER.
      - To format the partition, type format fs=ntfs quick, and then click ENTER.
      - To assign a drive letter, type assign, and then click ENTER.
      - Type exit, and then click ENTER.
- b) Install Microsoft Windows 10 Enterprise 2016 LTSB on the USB external SSD (consist of external enclosure AGESTAR 31UB2A18 and SSD INTEL SS DSC2BB240G7):
  1. Use the DISM tool to apply images to your Windows partition, run the DISM /apply-image /imageFile: <image\_file> /index:<index\_number> /ApplyDir:<image\_path> command.

Example:

```
dism /apply-image /imagefile:d:\sources\install.wim /index:1 /applydir:e:\
```

2. Set up a basic system partition using the BCDboot tool to initialize boot configuration data that is used to start Windows.

USB external SSD system drive boot configuration based on next example:

```
bcdboot C:\Windows /s S: /f ALL
```

This example is taken from Microsoft site, it copies BCD files that support booting on either a UEFI-based or a BIOS-based computer from the C:\Windows folder to a USB flash drive that was assigned the volume letter S [11].

c) Create 3 VHDXs (intel.vhdx, intel2.vhdx, intel3.vhdx) on external SSD system drive from diskpart using next example (taken from Microsoft site) [12]:

1. From the Command Prompt, open Diskpart.
  - Type diskpart, and then click ENTER.
2. Create and prepare a new VHDX.
  - Type create vdisk file=C:\windows.vhdx maximum=25600 type=fixed, and then click ENTER.
3. Attach the VHDX. This adds the VHDX as a disk to the storage controller on the host.
  - Type attach vdisk, and then click ENTER.
4. Create a partition for the Windows files, format it, and assign it a drive letter. This drive letter will appear in File Explorer.
  - Type create partition primary  
format quick label=vhdx  
assign letter=v, and then click ENTER.
5. Exit Diskpart
  - Type exit, and then click ENTER.

d) Create 3 bootable USB flash drives with Microsoft Windows 8.1 Enterprise, Microsoft Windows Server 2012 R2, Microsoft Windows Server 2016.

e) Install operating systems from bootable USB flash drives to 3 VHDXs (intel.vhdx, intel2.vhdx, intel3.vhdx) using MS Windows OS traditional installation process via attaching vhdx files as virtual disks to windows OS setup menu.

For attaching vhdx files need to use DiskPart tool via running cmd.exe from Windows OS setup menu.

After successfully complete of MS Windows OS installation process on the first VHDX file will be possible OS dual-booting, after complete of OS installation process on the second and third VHDX files – multi-booting will be present in OS boot menu for USB external SSD system drive.

## 6. Experimental results.

The new method of using dual-booting and multi-booting on external system drive was successfully used. The installation of Microsoft Windows 10 Enterprise LTSB was successfully applied to SSD INTEL SS D5C2BB240G7 based on external enclosure AGESTAR 31UB2A18. That gives a possibility to create an external system drive as a part of system architecture. An important possibility is applying of MS Windows OS traditional installation process to VHDX files that are located on the external system drive via attaching

them to windows OS setup menu. Dual-booting and multi-booting on external system drive are results of the alternate applying of Microsoft Windows operating systems to external SSD as system drive and to VHDX files as virtual system drives.

### 7. Conclusions.

In this work I have Implemented 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.

### REFERENCES

1. Solid-state drive, 2018 , Available at: [https://en.wikipedia.org/wiki/Solid-state\\_drive](https://en.wikipedia.org/wiki/Solid-state_drive).
2. Multi-booting, 2018, Available at: <https://en.wikipedia.org/wiki/Multi-booting>.
3. Windows 8.1, 2018, Available at: [https://en.wikipedia.org/wiki/Windows\\_8.1](https://en.wikipedia.org/wiki/Windows_8.1).
4. Windows Server 2012, 2018, Available at: [https://en.wikipedia.org/wiki/Windows\\_Server\\_2012](https://en.wikipedia.org/wiki/Windows_Server_2012).
5. Windows 10, 2018, Available at: [https://en.wikipedia.org/wiki/Windows\\_10](https://en.wikipedia.org/wiki/Windows_10).
6. Windows Server 2016, 2018, Available at: [https://en.wikipedia.org/wiki/Windows\\_Server\\_2016](https://en.wikipedia.org/wiki/Windows_Server_2016).
7. DiskPart Command-Line Options (Standard 7 SP1), 2014, Available at: [https://msdn.microsoft.com/en-us/library/ff794606\(v=winembedded.60\).aspx](https://msdn.microsoft.com/en-us/library/ff794606(v=winembedded.60).aspx).
8. DISM, 2018, Available at: <https://docs.microsoft.com/en-us/powershell/module/dism/?view=win10-ps>.
9. DISM Image Management Command-Line Options, 2017, Available at: <https://docs.microsoft.com/en-us/windows-hardware/manufacture/desktop/dism-image-management-command-line-options-s14#apply-image>.
10. BCDboot Command-Line Options, 2012, Available at: [https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-7/dd744347\(v=ws.10\)](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-7/dd744347(v=ws.10)).
11. BCDBoot Command-Line Options, 2017, Available at: <https://docs.microsoft.com/en-us/windows-hardware/manufacture/desktop/bcdboot-command-line-options-techref-di>.
12. Boot to a virtual hard disk: Add a VHDX or VHD to the boot menu, 2018, Available at: <https://docs.microsoft.com/en-us/windows-hardware/manufacture/desktop/boot-to-vhd--native-boot--add-a-virtual-hard-disk-to-the-boot-menu>.

**МЕТОД ВИКОРИСТАННЯ ПОДВІЙНОГО ЗАВАНТАЖЕННЯ ТА  
МУЛЬТИЗАВАНТАЖЕННЯ ОПЕРАЦІЙНИХ СИСТЕМ СІМЕЙСТВА  
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Операційна система комп'ютера, як правило, встановлена на його внутрішньому SSD (HDD). Коли користувач загрузає комп'ютер, BIOS завантажує завантажувач із внутрішнього SSD, а завантажувач завантажує встановлену операційну систему. Завантажувач - це комп'ютерна програма, яка завантажує операційну систему або інше системне програмне забезпечення комп'ютера після самоперевірки живлення. Завантажувач завантажується в основну пам'ять з постійної пам'яті. На сучасних комп'ютерах, процес завантаження може займати десятки секунд або навіть хвилини, і зазвичай передбачає автоматичне тестування живлення, виявлення та ініціалізацію периферійних пристроїв, а потім пошук, завантаження та запуск операційної системи. Завантаження завершено, коли досягнуто нормальне, оперативне середовище виконання.

Подвійне завантаження - це техніка, яка дозволяє на одному фізичному комп'ютері запускати дві операційні системи.

Мультизавантаження дозволяє встановлювати загальну конфігурацію кількох операційних систем на комп'ютері та можливість вибору операційної системи для завантаження.

У статті показано, як реалізувати спосіб використання подвійного завантаження та мультизавантаження на основі зовнішнього SSD накопичувача.

*Ключові слова:* системний диск, HDD, SSD, операційна система, файли встановлення, WIM-файл, DISM, розділ диску, BCDboot, Microsoft Windows.

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