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| **Operating Systems & Networking Fundamentals**  Diploma in CSF/FI/IT  Year 1 (2021/22) Semester 2 | Week 6 |
| **2 hours** |
| **Practical : Windows File Systems** | |

**Objectives**

The practical aims to familiarize students with Windows file system. At the end of the practical, students should be able to:

* understand defragmentation
* partition disk
* differentiate between FAT and NTFS file systems
* convert from one file system to another

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| **Lab Resources**  The equipment required for this lab:-   1. Windows Workstation 2. VMware Workstation 3. Windows 10 Virtual Machine   **Restoring Original Image**   * Open VMware Workstation and restore Windows 10 original image  1. Select and right click *Windows\_10\_Ent* from *My\_Computer* 2. Point to *Snapshot* 3. Click *Revert to Snapshot: Snapshot 1 Original* 4. Click *Yes* |

**Lab Overview**

The following activities will be performed in the lab.



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| Tip: Zoom in the word document for better view of the pictures |

**Topic 1: Data on disk (Defragmentation)**

Cluster is the smallest unit of allocation for data. In other words, every time a file needs storage space, it will be allocated in terms of number of cluster(s).

Q1) **Research:** what is the size of default cluster size for NTFS in Windows 10?

4 KB

Check hard disk (Windows)

Over a period of time, after countless reads and writes, the condition of a disk may deteriorate. To check on the condition of a disk, perform the “**chkdsk**” command.

Follow the instructions below to check on a disk condition for Windows OS.

1. If you have not login into Windows 10 VM, do so now.

User: *nstudent*

Password:

1. Right click on “*Command Prompt*” and Click on “*Run as administrator*”

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| Defrag-ChkDsk_2 | In the command prompt, type *chkdsk* |
| Defrag-ChkDsk2_2 | Observe the information returned by the *chkdsk* command. |

Q2) From the information returned by *chkdsk* command, how many bad sectors are there? Is the disk still in good condition? Explain.

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| 0 bad sectors. Yes the disk is still in good condition because there are no bad sectors. |

Q3) Does the statement “*4096 bytes in each allocation unit*” sound familiar? Explain using own words what that means.

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| It means that each cluster contains 4096 bytes which is 4KB. |

Fragmentation

Over a period of time, after multiple read and write to the disk, fragmentation starts to develop. Fragmentation is the result of files not able to be stored in a contiguous manner in a disk. Haphazard storage of files in hard disk (not applicable for SSD) results in slow read and longer write hence impacting computer performance. Fragmentation can be largely categorized as internal or external fragmentation.

Internal and external Fragmentation

Refer to Wikipedia webpage <http://en.wikipedia.org/wiki/Fragmentation_(computer)> for more information on internal and external fragmentation. Subsequently, answer the questions that follow.

Q4) What is the implication of having a large cluster size (e.g. 32KB) if the files are mainly small in size? (Hint: Imagine your files are mainly of small size, e.g. in the region of 10KB, then evaluate what is the consequence of such huge cluster size.)

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| You waste a lot of space as there will be a lot of internal fragmentation or slack space when saving the files. Especially the smaller files. If you were using a region of 10KD, 32- 10 = 22KB of space will be wasted. |

Q5) If a file occupies several clusters, each cluster number in the file allocation table points to the next, and so on until the end of file. Given that the chain of clusters allocated for the following files are as follows:

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| **File Name** | **Cluster numbers** |
| File1 | 18→19→20→21→22→23→24→EOF |
| File2 | 55→56→100→101→102→322→323→324→400→401→EOF |

Which file has external fragmentations? What is the key indicator that an external fragmentation has occurred?

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| File2. The key indicator is when the cluster numbers are non-contiguous. |

Q6) What is the consequence of external fragmentations and how do you overcome this problem?

* Internal fragmentation is when the cluster isn’t filled up.
* External fragmentation is when you skip clusters.

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| Defragmentation |

Defragmentation

Disk defragmentation can be performed on fragmented hard disk. This is occasionally done after a period of time. Follow the steps tabulated below to defragment files in Windows OS.

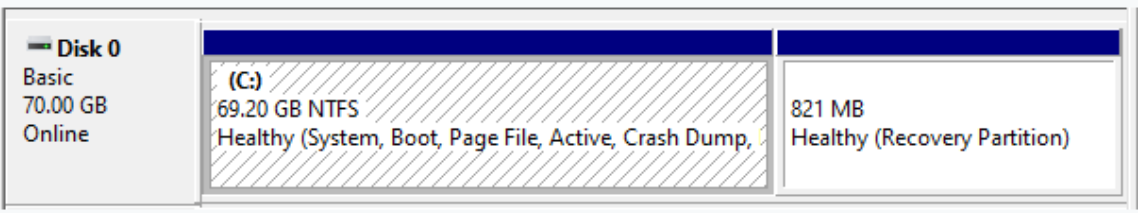
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| Defrag-Defrag_1 | 1. Open up the Run dialog box by pressing ⊞Win+ r keyboard key. 2. Type “*dfrgui”* and press *OK*. |
| Defrag-Defrag4_2 | Note: Optimize process may take some time depending on disk status.   1. Select the C: drive 2. Click on “*Analyze*” button to analyze the drive first 3. Do not Click “*Optimize*” (defragmenting the drive takes a long time) 4. Click “*Close”* once end. |

Q7) What happens in the defragmentation process? What are the benefits of defragmentation?

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| Rearranges the clusters to make them contiguous so the computer can run faster. It also increase the hard disk’s life. |

**Topic 2: Windows Partition (FAT & NTFS)**

In a computer system, a hard disk is often partitioned before being formatted with a file system type. So, what is actually a partition? And more importantly, why a partition is needed. Are there any benefits to having a partition in a computer system?  
  
Partitioning a hard disk basically means allocating storage spaces in a hard disk with a file system so that files (data) can be read from and written to. More often than not, in a computer system, multiple partitions are created serving different purposes.

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**Figure 1 Hard Disk Partitions**

For instance, in Figure 1, a hard disk had been partition into two separate storage spaces. Approximately,

1. 69GB storage space allocated for storing Windows 10 system files.
2. 821MB allocated as a Recovery Partition.

Each of the partition has its own drive letter assigned. By partitioning the hard disk as such, incidental corruption of data files will not necessarily render the whole computer useless. Only the data partition needs to be fixed. The computer does not need to be reformatted at all depending on the severity of the corruption.

Q1) Apart from separating disk storage into different purposes, highlight **two** other uses of disk partitioning.

Most PCs come from the factory with a single partition on your disk drive, meaning that it shows up as one drive in the Computer window (as C:), explain the reason for creating a separate partition (as D:) to store your data files.

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| If one partitions gets corrupted. You will not lose all your data as you can use an external hard disk to transfer the data of the non-corrupted partitions to it. If all your data is on one partition and it get corrupted, all data might be lost if recovery fails. Will be saved however, if recovery works (luck). |

Creating a partition

More often than not, a partition is created together with the file system. A file system allocates locations on disk for storage. It also keeps a record of where specific information is kept. In Windows OS, partition can be created with NTFS or FAT32 file system.

Follow the tabulated steps below to create partition in NTFS.

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| diskmgmt_2 | 1. Press ⊞Win+r to open Windows run dialog 2. In the Run dialog box, type “*diskmgmt.msc*” |
|  | 1. In Disk Management, right click on *Disk 0 (C:)* and select *Shrink Volume*. 2. Enter the amount of space to shrink in MB: *10000*. |
|  | 1. In Disk Management, right click on *Disk 0 9.77GB unallocated*. 2. In the pop-up that appears, click on “*New Simple Volume...*” |
| NewSimpleVolumeWizard_2 | 1. In the New Simple Volume Wizard, click “*Next >*” |
| NewSimpleVolumeWizard2-SpecifyVolume_2 | 1. Specify the volume size as 5000MB 2. Click “*Next >*” |
| NewSimpleVolumeWizard3-AssignDriveLetter_2 | 1. Assign a drive letter for the partition. Select E or any other drive letter not in conflict 2. Click “*Next >*” |
| NewSimpleVolumeWizard4-FormatPartition_2 | 1. Select “*NTFS*” as the file system type 2. In Volume label, type “System” 3. Click “*Next >*” 4. Complete the New Simple Volume wizard by clicking “*Finish”* |
|  | A partition named *System (E:)* on Disk 0 is created, of approximately 5GB (4.88GB) with NTFS file system type. |

To create a FAT32 file system type in Windows OS, perform the same steps as above except choose FAT32 file system type.

Q2) Format the balance unallocated storage in Disk with FAT32. Specify the *Volume label:* Data. List the steps taken in textbox provided.

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| Right click on the unallocated storage. Click new simple volume. Let the size be all the unallocated space. Assign the space a drive letter. Change the file system from NTFS to FAT32. Change volume label from new volume to Data. |

**Topic 3: Windows File Systems**

In Windows OS, generally, there are two main types of file system that are often used. They are FAT and NTFS. FAT is the older file system of the two. It has now evolved into FAT32 and exFat.

Q1) **Research** by reading up FAT32 and NTFS file systems. Make comparisons between these two file systems as factored in the table below. An example each has been given for “Max file name length” and “Max File size” factors. Complete the table for the remaining factors.

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| **Factors** | **NTFS** | **FAT32** |
| Max file name length | Up to 255 | Up to 255 |
| Max File size | Limited only by volume size which is 16TB | 4GB |
| Max volume size | 256 TB | 4 GB |
| Compression | Yes | No |
| Encryption | Local and Network | Only Network |
| File Access Permission | NTFS permissions are used to manage access to the files and folders that are stored in NTFS file systems. | Does not support file permissions. Permissions for everything are determined by how the drive is mounted. |
| Storage Reliability | Allows you to set specific permissions to local filse/folders. | Only offers shared permissions |

Q2) Even though FAT32 is the older file system, many devices (e.g. flash drives) still use it? Explain why.

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| * NTFS: Support for transferring big files with no limit. The most ideal file system for hard drives and external hard drives. * FAT32: Support for transferring a single file within 4GB. Used as the file system for SD card, USB flash drive.   As most files are smaller files which are below 4GB, FAT32 is better as less space will be wasted.  Also, FAT32 is compatible with every device but NTFS is only compatible with limited types of devices. |

**WARNING: THE TEACHING TEAM IS NOT RESPONSIBLE IF YOU FORMAT YOUR OWN MACHINE. YOU SHOULD DO THIS IN THE VIRTUAL MACHINE (NOT THE HOST MACHINE!).**

Is there a way to convert FAT32 into NTFS file system?

The short answer is yes. Follow the tabulated steps below to convert file system. Take note that any data has to be backup first. This is because disk drive needs to be reformatted in order to convert the file system.

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| FileSystemConversion_2 | Open File Explorer   1. Right click on FAT32 files system. This is the F: drive 2. Click on “*Format…*”   (**ENSURE THAT YOU ARE INSIDE THE VIRTUAL MACHINE WHEN FORMATTING**) |
| FileSystemConversion2_2 | 1. Before formatting, choose the file system as NTFS 2. Click “*Start*” once ready |
| FileSystemConversion3_2 | Once formatting is done, open File Explorer   1. Right click on F: drive 2. Check that you are looking at the Data (F:) drive. 3. Observe that the file system for the F drive is now NTFS and no longer FAT32 |

Q3) Reformatting of disk to convert file system is rather destructive. **Research** on how to convert from FAT to NTFS file system without causing loss of data.

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| You can download a 3rd party software AOMEI which allow you to convert from FAT32 to NTFS without data loss. |

Q4) Is file system conversion from NTFS to FAT permissible? Why or why not? Give reasons for the answer.

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| You can change from NTFS to FAT32 in disk management but it will cause data loss making it unideal. But if you use a 3rd party software like AOMEI, you can do so without datal lost as there is no need to format selected drives. |

-- The End --