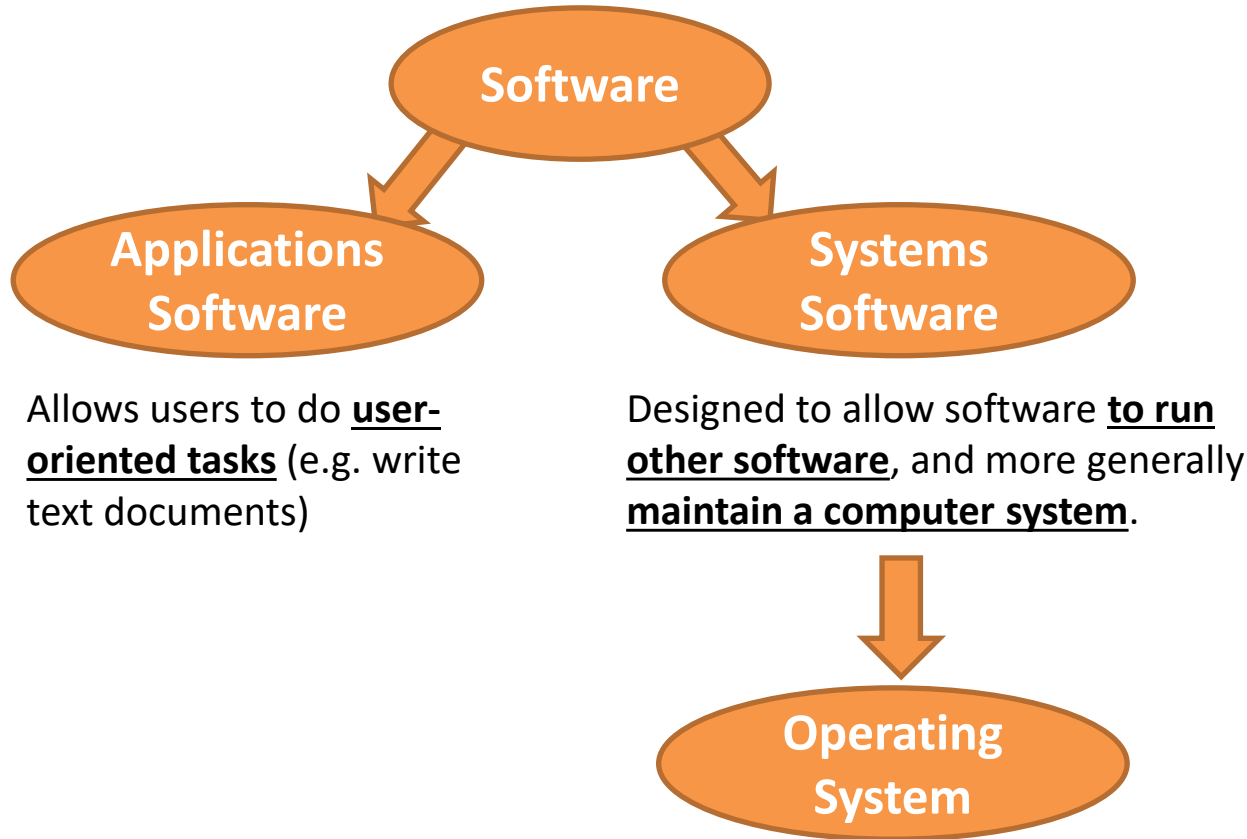# Computer Systems ::
Operating Systems

Learning objectives:

- **Describe the purpose and functions of operating systems**

- **Compare Single user and multiuser operating systems**

- **Compare one-task and multitasking operating systems**

Recall

- What is Software?

- What types of software do you know?

- Why is software important for computer systems?

- What is System Software?

- What is Application software?

- Give the 4 system software types

- Give me examples application software

What is systems software

```
                        ┌─────────────┐
                        │  Software   │
                        └─────────────┘
                         ↙           ↘
        ┌──────────────────┐    ┌──────────────┐
        │   Applications   │    │   Systems    │
        │     Software     │    │   Software   │
        └──────────────────┘    └──────────────┘
```

Software

Applications Software

Systems Software

Allows users to do **user-oriented tasks** (e.g. write text documents)

Designed to allow software **to run other software**, and more generally **maintain a computer system**.

⬇

Operating System

Software that **manages computer hardware** and **software resources** and **provides common services** for computer programs.

All computers have an operating system, they cannot function without one

What is operating system?

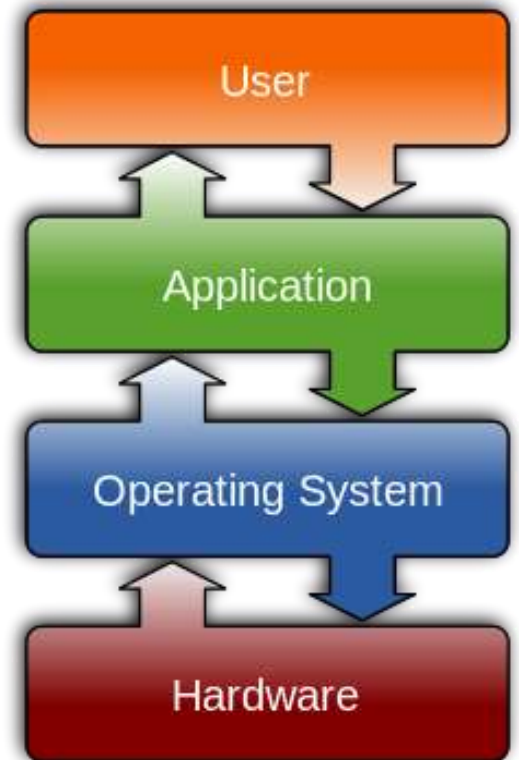Try to build your own definition

What is operating system?

a set of …

that manage…

and provide …

What is operating system?

a set of programs that manage computer hardware resources and provide common services for application software.
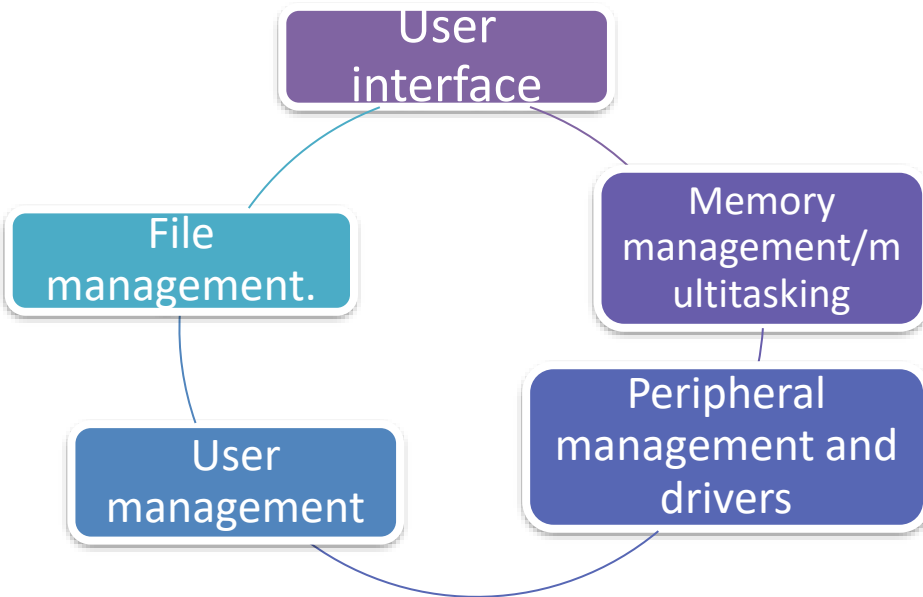
Activity 1. Research work

Work in pairs
**Make research on main components of an operating system.
Present your findings to the class**

https://www.canva.com/ru_ru/infografika/shablony/

User
interface

File
management.

Memory
management/multitasking

User
management

Peripheral
management and
drivers

Use presentation: Operating system for students

Task: *create an INFOGRAPHIC* on the topic *"*Main functions of an Operating System"

Successful criteria :
•describes the purpose main components of OS
•describes the functions main components of the OS

20 Minutes

Activity 2. Individually work

CARD GAME
What is the role of the OS?

Match relevant cards

Learning objectives:
Describe the purpose and main role of operating system

https://learningapps.org/display?v=pvjk0zzh520

Answer

What is the role of the OS?

Managing memory

Manage peripherals

Manage hardware interfaces

Swapping between programs on time-slicing

Allocating storage

The memory management function keeps track of the status of each memory location, either allocated or free. It determines how memory is allocated among competing processes, deciding which gets memory, when they receive it, and how much they are allowed. An operating system must also keep track of programs in memory.

Usually OS ma[...] peripherals via a d[...] handles the tran[...] requests betwee[...] and the comput[...] where a process[...] outgoing data bef[...] sent, and where[...] messages will be s[...] they are received wakes up the device when it is needed and put it back to sleep when it is not

Well done!

OK

use to communicate with each other.

[...]ser system, [...] is the set [...]cessing time ets. With a [...] system, a [...]s the set [...]cessing time each program gets. Slices (also called threads) are alternately processed to give the illusion of many tasks happening at once

This is not only reading, storing and writing data to a disk, but also attaching ownership and permissions to storage AND how and where on the disk the data is stored.

"Missing words"

Activity 3. Individually work

Listen to the video and **fill** in the **missing words**

https://www.youtube.com/watch?v=5AjReRMoG3Y

I'm going to explain the basics an _____

It is the chief program that manages all of the _____ and _____

There are _____of every OS and they all work together like a team to get completed

The _____is charge of the main memory, it scans every request for memory space and checks if it is valid

The _____decides how to allocate the brain of the computer, known as the central processing unit.

The _____monitors every device channel and control unit.

The _____checks every file that is on the system

The _____, this provides a way for users to share hardware and software resources

How do we the user _____ with the OS, we rely on the use of a user interface. This gives us a _____.

https://learningapps.org/display?v=pnyuo443n20

I'm going to explain the basics an OS

It is the chief program that manages all of the hardware and software

There are four essential managers of every OS and they all work together like a team to get completed

The memory manager is charge of the main memory, it scans every request for memory space and checks if it is valid
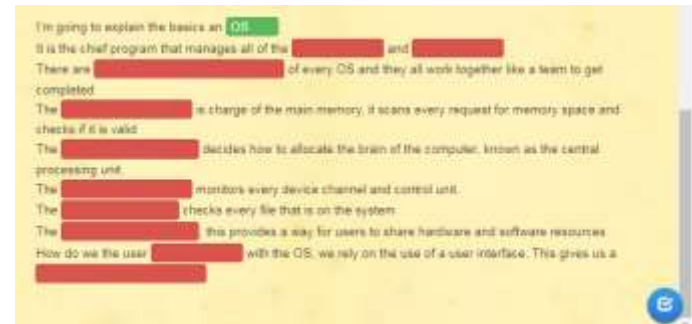
The process manager decides how to allocate the brain of the computer, known as the central processing unit.
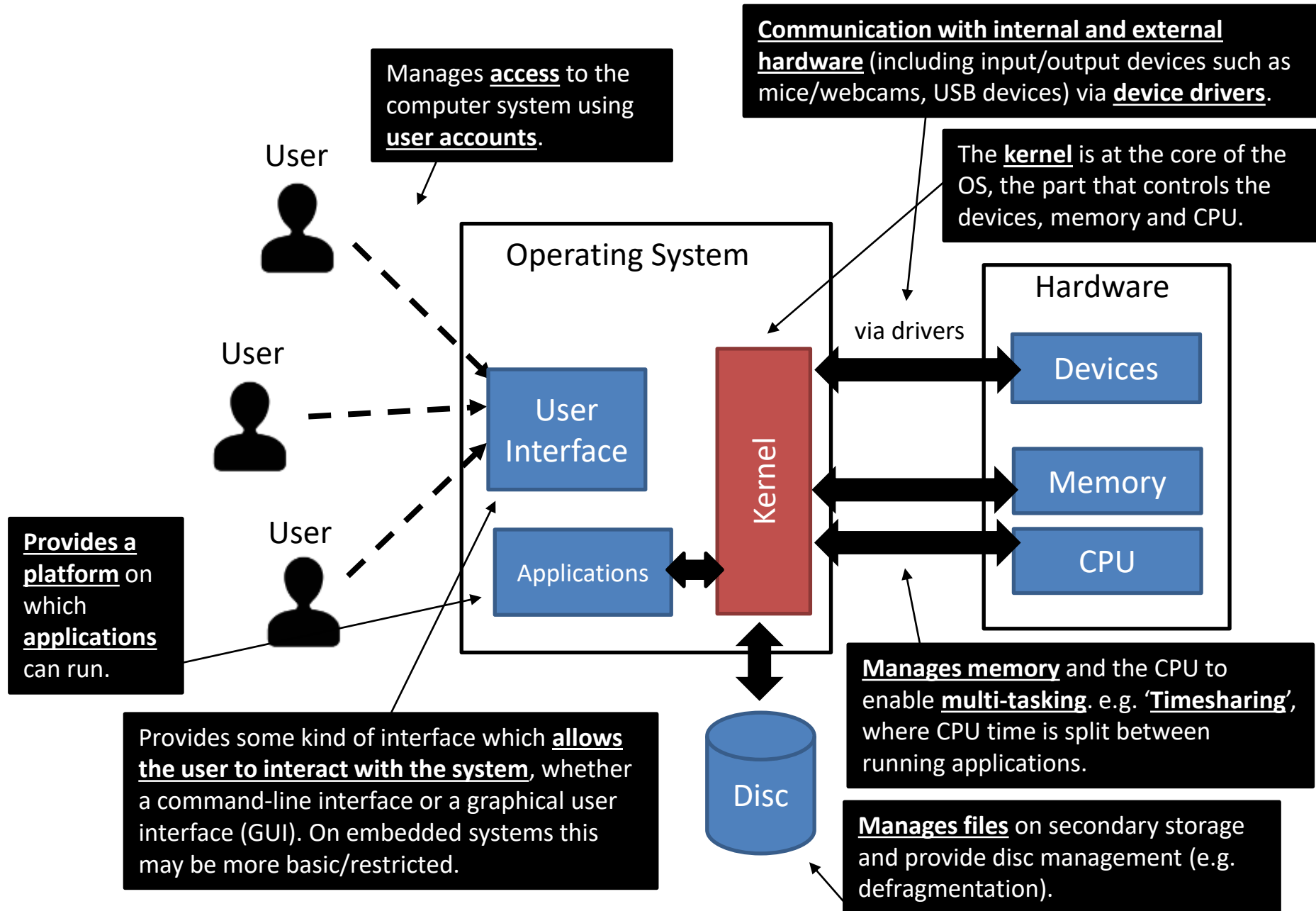
The device manager monitors every device channel and control unit.

The file manager checks every file that is on the system

The network manager, this provides a way for users to share hardware and software resources

How do we the user interact with the OS, we rely on the use of a user interface. This gives us a visual understanding.

What is the role of the Operating System?

Manages **access** to the computer system using **user accounts**.

Communication with internal and external hardware (including input/output devices such as mice/webcams, USB devices) via **device drivers**.

The **kernel** is at the core of the OS, the part that controls the devices, memory and CPU.

User

User

User

Operating System

User Interface

Applications

Kernel

Hardware

via drivers

Devices

Memory

CPU

Provides a platform on which **applications** can run.

Provides some kind of interface which **allows the user to interact with the system**, whether a command-line interface or a graphical user interface (GUI). On embedded systems this may be more basic/restricted.

Disc

Manages memory and the CPU to enable **multi-tasking**. e.g. '**Timesharing**', where CPU time is split between running applications.

Manages files on secondary storage and provide disc management (e.g. defragmentation).

What the OS does

We'll look in more detail at the main components of an Operating System…

1. User interface
2. Memory management/multitasking
3. Peripheral management and drivers
4. User management
5. File management.

#1 :: User Interface

We have already seen that user interfaces provide a means by which the user can interact with the system.

Graphical User Interface (GUI)

A visual display and interaction via a variety of inputs, including keyboard, mouse and touch.

Advantages:

- More **user friendly**/intuitive.
- On touch-enabled devices, allows interaction by touch, including finger gestures (e.g. swiping, zooming).
- Multitasking

Command Line

Instructions issued by text-based interface.

Advantages:

- Less memory intensive.
- Requires only keyboard input.
- More **powerful**: commands are customisable.
- can be much faster than any other type of interface
- does not use as much CPU processing time as others

#1 :: User Interface

We have already seen that user interfaces provide a means by which the user can interact with the system.

Graphical User Interface (GUI)

A visual display and interaction via a variety of inputs, including keyboard, mouse and touch.

Disadvantages:
- GUIs require system resources and more complex hardware than CLIs
- GUI needs significantly more memory (RAM) to run than other interface types
- GUI uses more processing power than other types of interface

Command Line

Instructions issued by text-based interface.

Disadvantages:
- Learning the commands may make it not suitable for a new user.
- Some commands may be harder to perform in a CLI than in a GUI.
- Single tasking

A few command line commands…

These are some of the common commands in UNIX and Linux:

ls: Lists all the file in the current directory.

```
[jamie@web-drfrost ~]$ ls
composer2.phar   composer.phar   php-fpm.log            server-manageloggedin.php
composer.json    error.log       public_html           src
composer.lock    grep            server-liveserver.php  vendor
[jamie@web-drfrost ~]$ █
```

cd *directory*: Changes the current directory to that named.

```
[jamie@web-drfrost ~]$ cd public_html
[jamie@web-drfrost public_html]$ █
```

".." indicates the parent directory, so cd .. goes up a level.

grep *text files*: Searches for a string/regular expression within the indicated file(s).

```
[jamie@web-drfrost homework]$ grep 'INSERT INTO drfrostmaths_schoolsow' *.php
process-add-schoolsow.php:      $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsow VALUES ('',?,?,?,?,'',?,CURRENT_TIMESTAMP,CURRENT_TIMESTAMP)");
process-add-schoolsow.php:      $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowterm VALUES ('',?,?,?)");
process-add-schoolsow.php:        $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowskills VALUES (?,?,?)");
process-add-term.php:$stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowterm VALUES ('',?,?,?)");
process-startassessment.php:          $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowskills VALUES (?,?,'s')");
process-update-term-skills.php:    $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowskills VALUES (?,?,?)");
util-addsow.php:    $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsow VALUES ('',NULL,?,?,?,'',?,CURRENT_TIMESTAMP,CURRENT_TIMESTAMP)");
util-addsow.php:    $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsow VALUES ('',?,NULL,?,?,'',?,CURRENT_TIMESTAMP,CURRENT_TIMESTAMP)");
util-edexcelskills.php:   $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowskills VALUES (?,?,'s')");
util-updatesow.php:    $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowterm VALUES ('',?,?,?)");
util-updatesow.php:          $stmt = $db->prepare("INSERT INTO drfrostmaths_schoolsowskills VALUES (?,?,?)");
[jamie@web-drfrost homework]$ █
```

A few command line commands...

These are some of the common commands in UNIX and Linux:

cat *file*: Displays the contents of a file.

```
[jamie@web-drfrost homework]$ cat util-updatesow.php
<?php

include '../███████████.php';
$forceLogin = 2;
include '../████████.php';

$swid = isset($_POST['swid']) ? $_POST['swid'] : "";
$yeargroup = isset($_POST['yeargroup']) ? $_POST['yeargroup'] : "";
$label = isset($_POST['label']) ? $_POST['label'] : "";
$terms = isset($_POST['terms']) ? json_decode($_POST['terms'], true) : array();

if(!$swid) {
    header("HTTP/1.0 500 The SoW id was not supplied.");
    exit;
}
if(!isTeacher($luser)) {
```

man *command*: Displays the manual/help for a particular command.

```
[jamie@web-drfrost homework]$ man cat
```

```
CAT(1)                          User Commands                          CAT(1)

NAME
       cat - concatenate files and print on the standard output

SYNOPSIS
       cat [OPTION]... [FILE]...

DESCRIPTION
       Concatenate FILE(s), or standard input, to standard output.
```
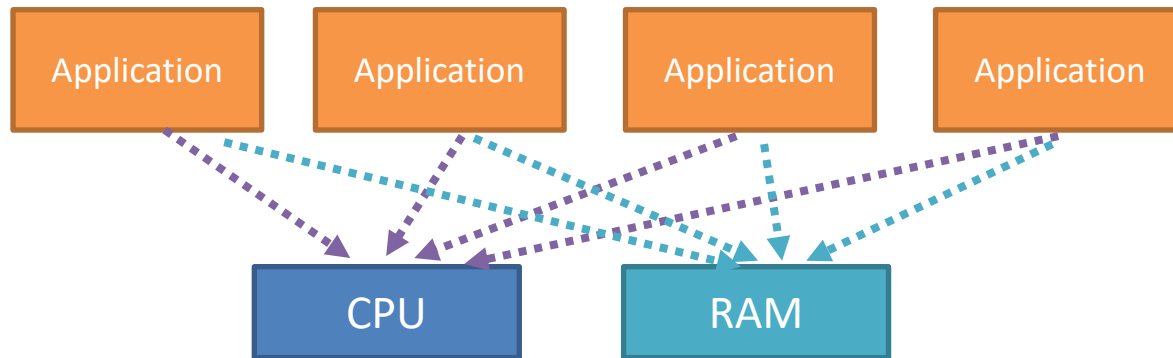
Many applications might be open simultaneously, each needing use of the CPU to execute its commands. They also need to share memory (RAM) without risk of one program's data getting mixed up with another.
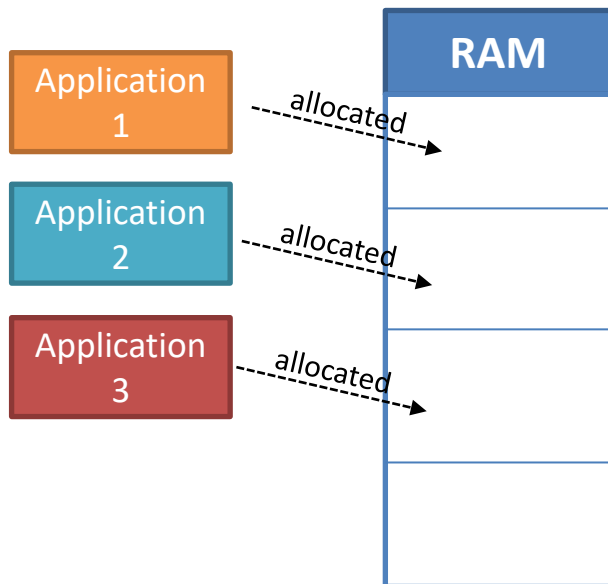
| Application | Application | Application | Application |

CPU   RAM

For each individual CPU core, the OS will need a strategy for **sharing up time on the processor**, as each core can only run one command at a time…

Memory Management Unit (MMU):

The **memory manager** allocates certain regions of memory to each application, ensuring **no interference between applications**.
If an application attempts to access memory outside what has been allocated to it, a **segmentation fault** error message is generated.

RAM

Application 1 - - - *allocated* - - ->
Application 2 - - - *allocated* - - ->
Application 3 - - - *allocated* - - ->

CPU Scheduler:

There are many strategies that the OS might use for sharing up the CPU time between running processes:

- **Round-robin**: A fixed amount of time is allocated to each application.

time →

| 1 | 2 | 3 | 1 | 2 |

Although the OS may give the appearance that the applications are running simultaneously, the CPU is **rapidly switching between them** . Each process will have to wait its turn once the time allocated to it is up.

- **Shortest remaining-time first**: Do task first with least processor time remaining. Obviously requires knowledge of predicted time lengths.

| 2 | 3 | 1 |

See https://en.wikipedia.org/wiki/Scheduling_(computing) if you want to read more on scheduling strategies and what various OSs actually use.

The OS manages communication between software and internal hardware/peripherals (i.e. external hardware).

Operating System
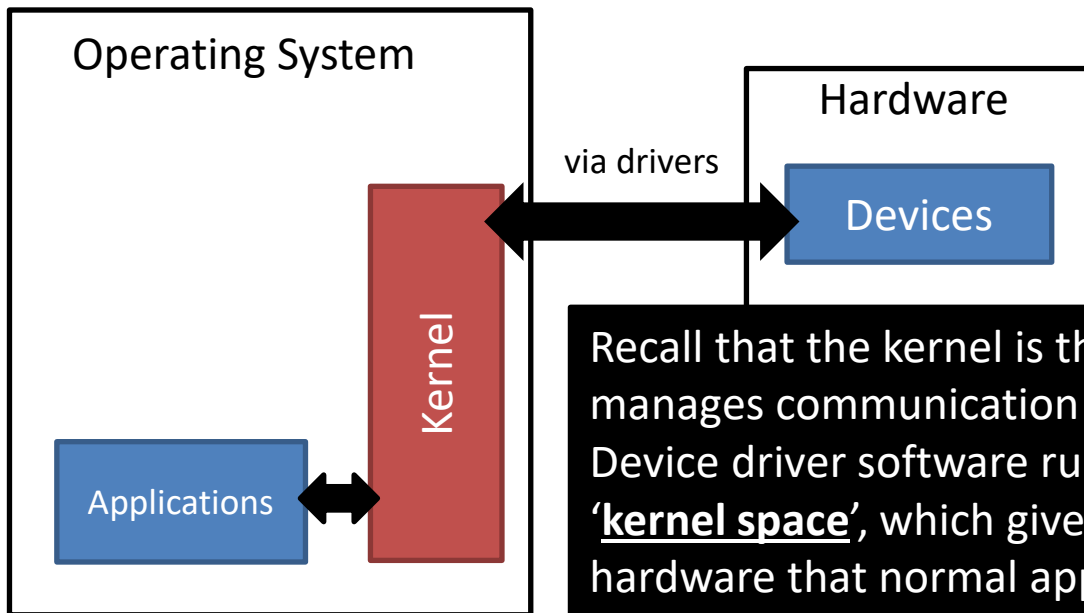
Kernel

Applications

via drivers
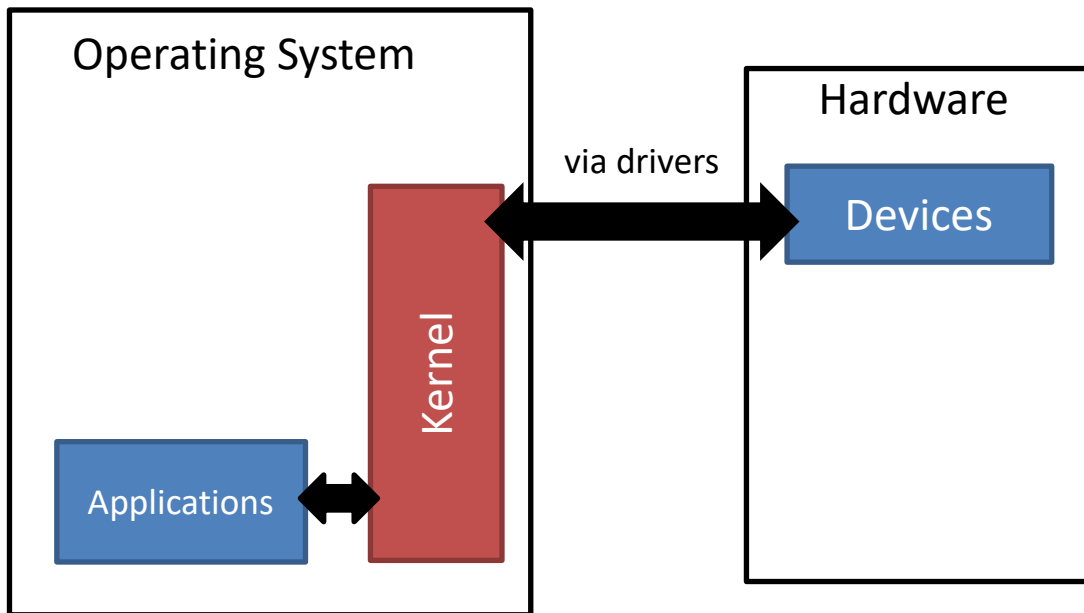
Hardware

Devices

Each hardware device has to have a **device driver**: this is special **software** that **translates** standardised programming calls from the application, e.g. a request to get the mouse position, to device-specific operations of the hardware.

For example, we can **access the mouse position and clicks in JavaScript**. We are unconcerned in our code what specific make of mouse is plugged in or how exactly to 'talk' to the specific hardware.

The device driver therefore takes standardised non-manufacturer-specific calls like 'get (x, y) position' and turns it into more technical low-level commands that directly communicates with the specific mouse the driver is for.

The OS manages communication between software and internal hardware/peripherals (i.e. external hardware).

Operating System

Hardware

via drivers

Devices

Kernel

Applications

Recall that the kernel is the 'inner sanctum' of the OS that manages communication with devices/memory/the CPU. Device driver software runs within something called the '**kernel space**', which gives it permissions to access hardware that normal application code would not.

When hardware is plugged into a Windows computer, it searches an online 'Device Store' for the latest driver published by the manufacturer, and installs this automatically.

Installing device driver software
Click here for status.

12:19 AM
11/16/2011

Single-user vs Multi-user

A **single-user** OS allows only one user to be logged in at any given time (even if multiple users are set up). A multi-user OS allows multiple users to be logged in **at the same time**.

Windows NT and Unix for example allows multi-user access. For example, a bank's mainframe would need to be multi-user, with cashiers and ATMs the 'users' all accessing a central store of bank accounts.

User account control

Different users have different levels access to the computer system (known as '**privileges**'), whether it be access to particular files/directories or to system utilities/device settings.
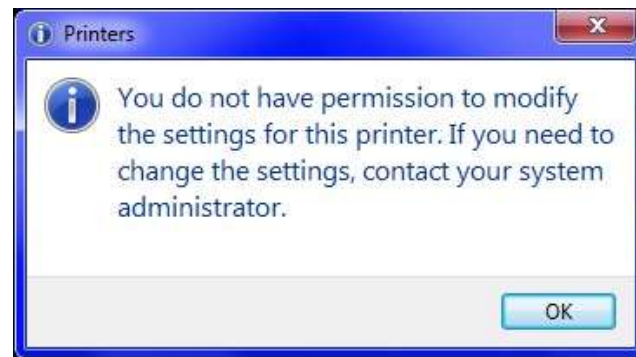
Typically each user on a desktop will have access to their own user folder (e.g. `C:/Users/DrFrost`) but not others' files.

#5 :: File Management

- The OS is responsible for **maintaining files** in a directory structure, as well as allowing files to be deleted, created and moved.
- It also directly **interacts with the hard-disk** via the kernel, deciding how to split the disk into sectors/tracks and keeping track of free space.
- There are various **file-related utilities** we will look at, for defragmenting the hard disk, encrypting and compressing files.
- The OS maintains the **default program to use for opening each type of file** based on its file extension. e.g. Should PNG files be opened with MS Paint or Photoshop?
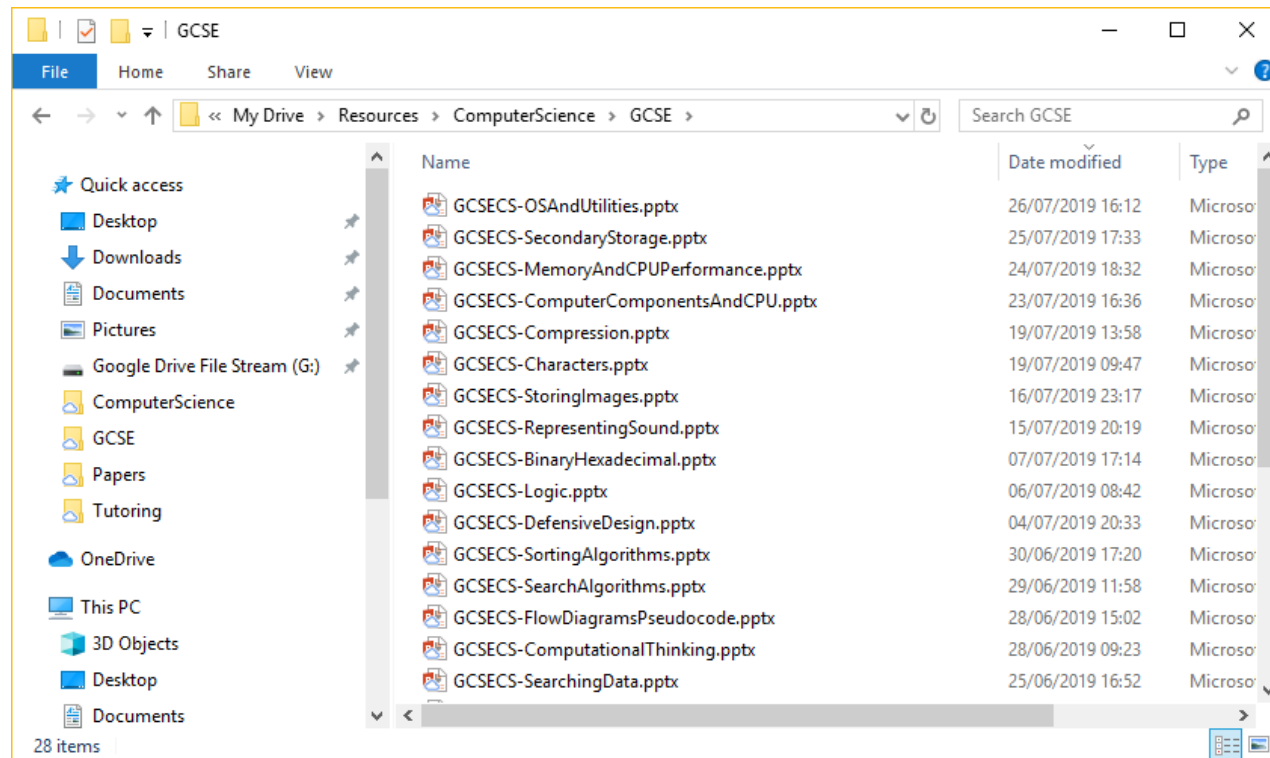
a. Defragmentation

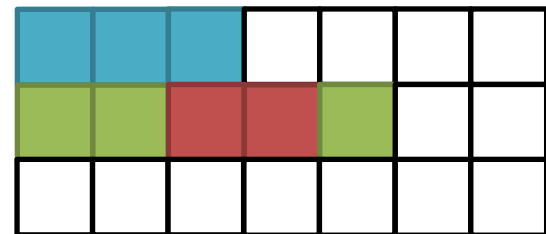If all the data for a particular file is stored **consecutively** on a hard disk, then the **file is quick to read** as the **mechanical arm has to move less**.
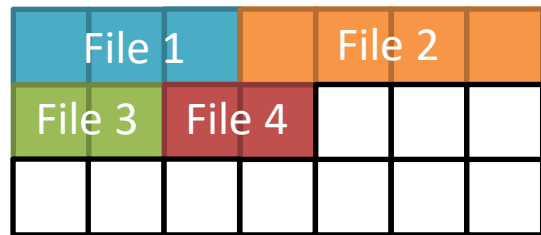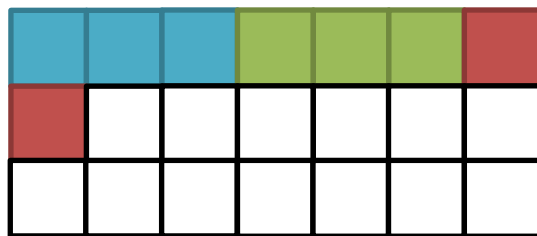
When files are added the OS naturally tries to fill up blocks of space without gaps.
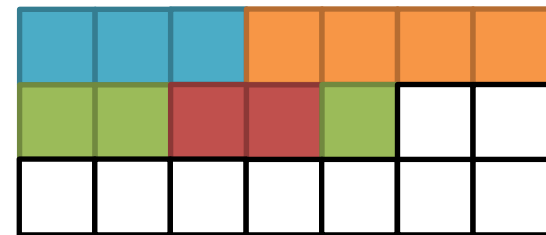
But suppose file 3 was edited and increased in size. We have to use space later in memory as there's not space just after file 3. This makes file 3 **slower to read from disk in future**.
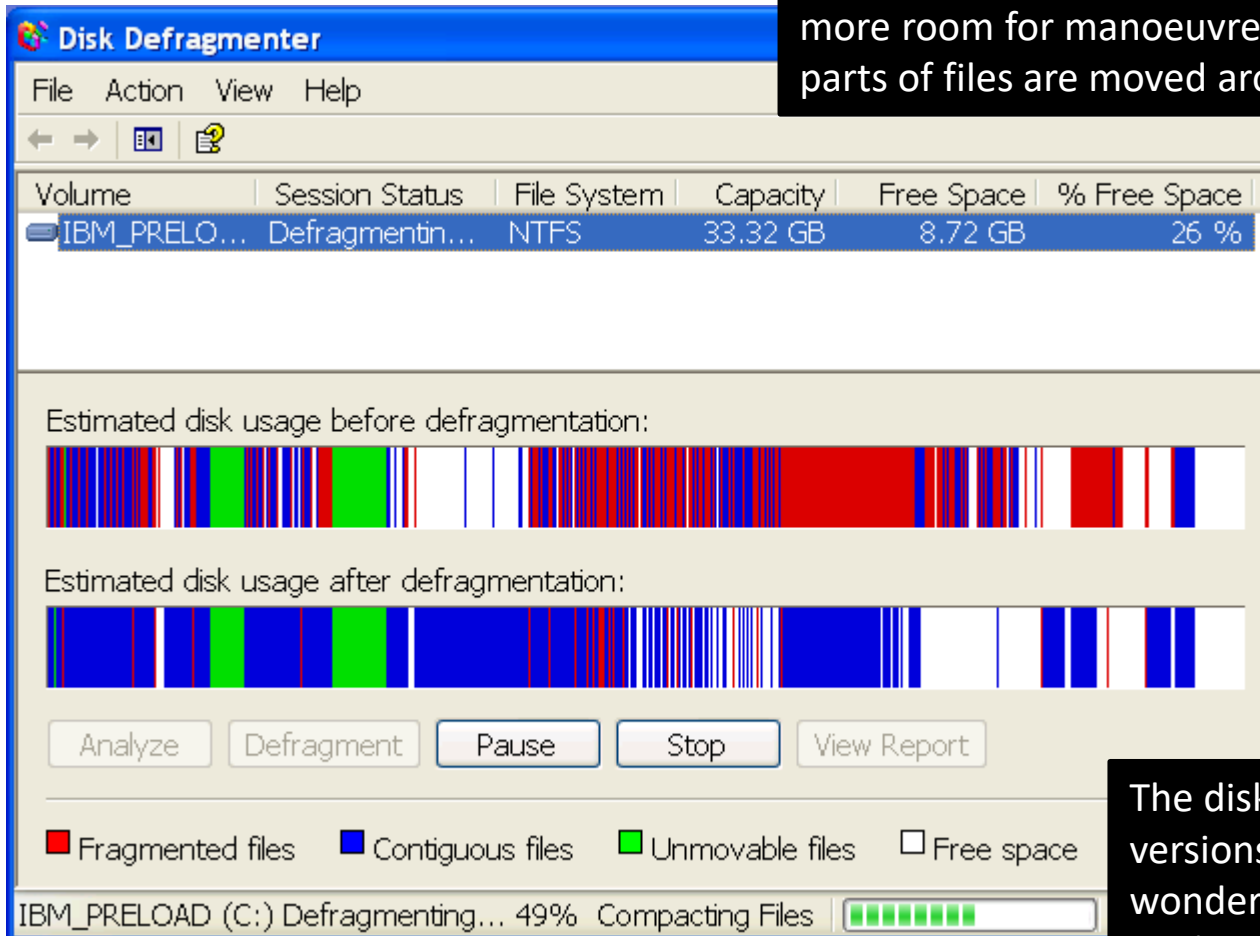
Defragment

The gaps are now gone and all the data for each file is together on the disk.

And suppose file 2 was deleted. The disk space is no longer being used in an efficient way.

Utility Software

Defragmenter tools require free space on the hard drive, as a temporary storage area to give more room for manoeuvre for the fragmented parts of files are moved around..

The disk defragmenter tool on older versions of Windows was a visual wonder to behold. As the utility ran, you'd gradually see more less red and more blue.
(Note: *contiguous = consecutive*)

b. Compression software

We can compress one or more files, and even directories, into a single compressed file, so that **it takes up less space**.
The most common is **zip files**, which Windows has direct support for (see below).
Other common compressed file types are GZ (any 'dumps' of database data from the DFM database use this file format) and RAR and TAR.
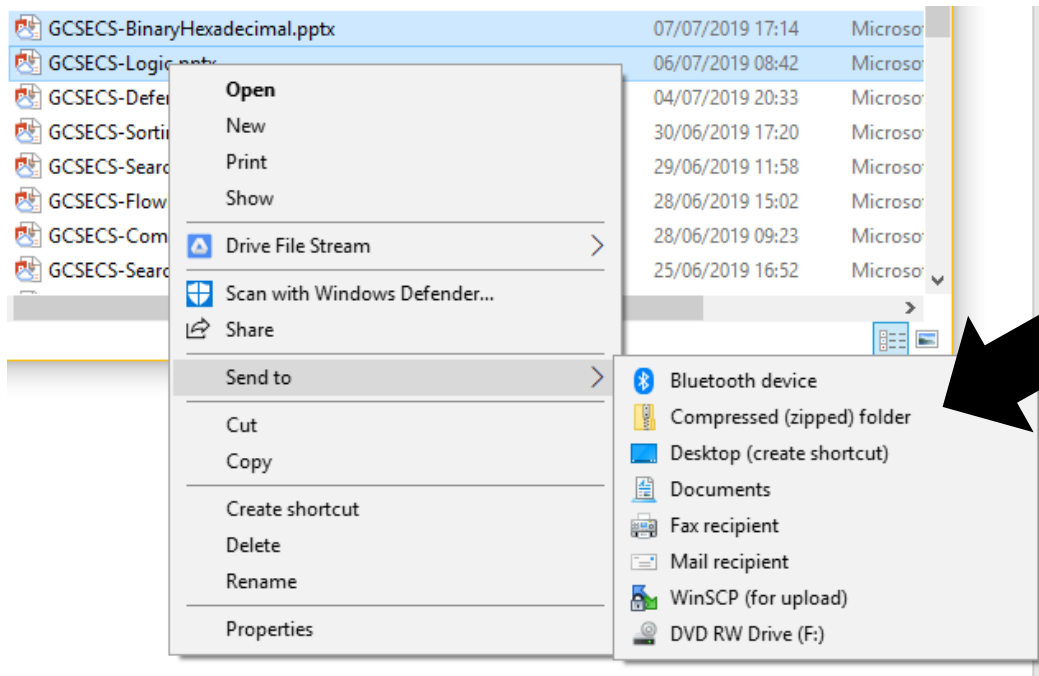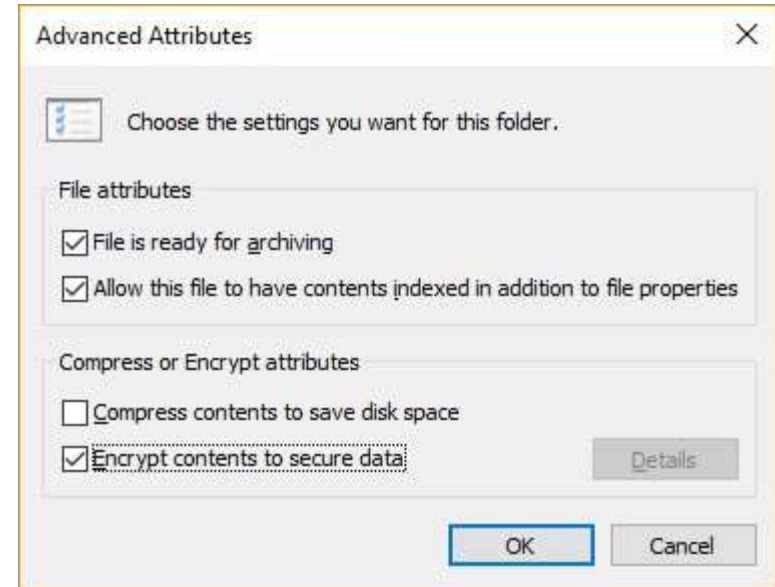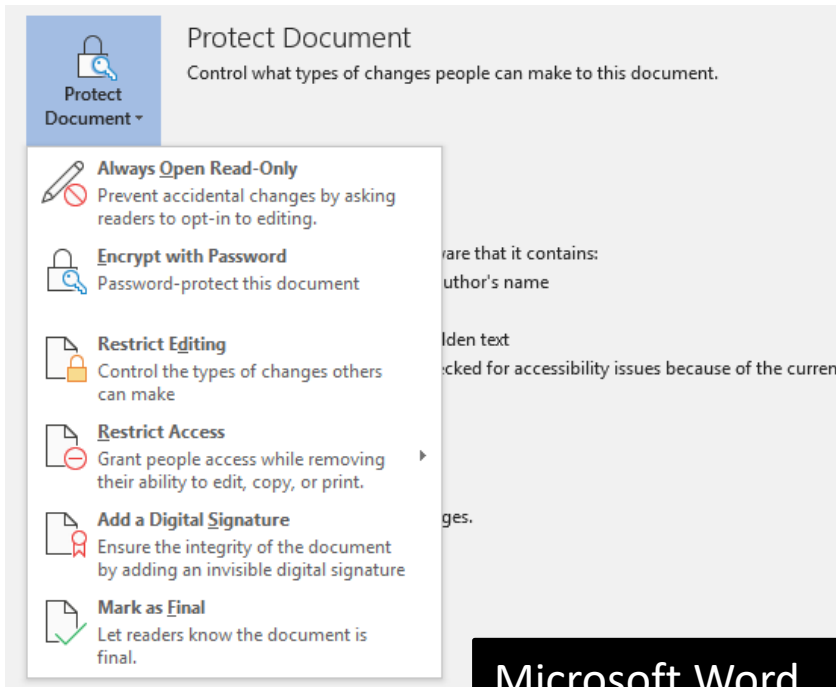
c. Encryption software

Encrypted data is **scrambled/encrypted** in such a way that it can only be decrypted with an **appropriate 'key'/password**.
Microsoft Word for example has and inbuilt encryption feature. Some more advanced versions of Windows allow arbitrary files and folders by encrypted.

Microsoft Word

Microsoft Windows

d. Data Backups

Data backups are producing a **copy of data** in case the original is destroyed, corrupted or deleted (whether intentionally or accidentally).

Back up utilities often do this process automatically. The DrFrostMaths server for example produces a back up of the entire (20GB+) database every day in case anything went catastrophically wrong.

Full Backup
When a complete copy of all data on a particular storage medium is taken.

Incremental Backup
Only files edited or created since the last full backup are stored. This requires much **less space** than a full backup.

If a back up is restored, we would use the last full backup combined with all subsequent incremental backups.

Types of OS:

Network OS

Handles all of the clients and traffic on a network. Usually built into all modern OSs

Server OS

Handles the network server. Usually has no GUI.

Multitasking OS

Allows for more than one program to run at the same time

Multi User OS

Allows for more than one person to use the OS at the same time

Realtime OS

An OS that updates in real-time....like when you buy tickets online.