Week 1 – Assignments

1. A Case Study of Operating Systems: Dos, Windows, UNIX, Linux, Mac, Android, and iOS.

1. Windows Operating System :

Windows Operating System was introduced into the market in the year 1985, and as a robust and comprehensive kind of software, has almost 90% market share over and above other operating system [15]. With its great and dominance presence in commercial buildings, industrial facilities, as well as its obvious presence as home computers. Although this assertion is believed not to be so again as a result of overwhelming peoples interest in open source operating systems.
The Microsoft Operating System as a family of Microsoft windows was created as a graphical layer over that of old MS dos with its root from MS DOS Command line and this it retains till date with DOS Box command prompt that is cmd.exe. [16]. Original Windows NT core happens to be the first to take shape in OS/2 operating system upon which modern versions are dependent. 32 and 64-bit AMD and Intel systems accommodate Windows OS, DEC Alpha, PowerPC architectures Windows OS, and MIPS is also comfortable with recent versions, likewise low and mid-range servers. Database and web servers also allows Windows operating system to use them. In recent years, Microsoft has proofed significant with marketing and with its finance to establish that Windows interoperability is not in doubt and that it has all that it takes as a platform to run any enterprise application.

Merits of Windows OS :

i. Technical/Maintenance support: Support is made available either online or offline because of its general acceptability by so many users.
ii. Compatibility: Windows accommodates almost every applications, game works and different types of drivers.
iii. Enormous quantity of functions: Getting use to Windows, one would realize that there are many functions one can do almost anything quite easily with when call up.

Demerits of Windows OS :

i. Viruses: Need to purchase an antivirus programs that needs to be activated frequently, and this can be done on Auto or Manual mode, although free antivirus exist but with limitations.
ii. Slow: Windows operating system, particularly Vista and Windows 7 needs a lot of system resources like registers, cache, main memory, processor, disk space, and this makes the system runs slower.
iii. Price: The cost of purchasing Windows operating system is high and very few users can afford it and this necessitate cracking and makes pirated software version available.

2 UNIX Operating System :

UNIX happens to be one of the very few oldest of all operating system in recent time of ICT world that is still generally and widely used and available till date, as none conspicuous operating system but its somehow secret in its operation and interface design, it is primarily designed for the use by very large enterprise computing systems. It happens to be one of the common operating system that is run by servers and other computers that form the large bulk of the Internet. One might never use UNIX on local PC, but indirect use is obvious in one form or another, every time one log on to the internet. Very few users runs UNIX on their personal systems, and a lot of different versions of UNIX operating system are many users have installed on desktop machines. There are so any different types and features basic UNIX interface; Linux, with its different version turn out to be the most common and popular for personal computer platform.
Setting up a UNIX OS can be difficult and it requires some knowledge to operate, but it is stable and robust, and efficient with system resources. UNIX OS uses the "UNIX file system". However, most file systems used by UNIX OS are impartially similar, but different uniquely from of other operating systems file systems, such as DOS or Windows. The trademark UNIX® is been owned by the Open Group, Only PCs fully compliant with and certified to the Single UNIX Specification qualify as "UNIXR", others are referred to or known as "Unix system-like" or "Unix-like".
Between later and early part of 1970 and 1980 respectively, UNIXs way in academic circles led to large scale acceptance of UNIX by commercial businesses, the most prominent of which is Sun Microsystems. Additional to certified UNIX

computer systems, today Operating system like that of UNIX such example likes BSD products and Linux are regularly come across. UNIX with is pros and cons and besides being a free system, are found as to run on most machine.

Merits of UNIX :

UNIX provides more control by the user. Some OS like Windows and Mac are based on icon and mouse making them more user friendly, user can also activate what the operating system allows. On UNIX, user has no limitation as anything can be done in as much as the operating system offers it.
What it means is that user can work freely without the fear of thinking that the system can be messed up even when the user does not know what he/she is doing. UNIX also can offer both freedom and danger because the operating system can be changed and make more compatible with what one want to do. If one knows what it takes to work perfectly well with UNIX, the operating system can be so powerful that it can be customized, and because it has been in used for a long time, most bugs have been cleared and this fact makes it very reliable.

Demerits of UNIX :

Successfully usage of UNIX requires that an expert will be needed on site. Simple installation of new products and updates may be difficult if one is not a UNIX expert.
Interacting with UNIX system using its command process is difficult, more difficult for a novice, this is why UNIX is most used by sophisticated users. UNIX operating system is a customizable OS, different dialects and languages of UNIX are available in versions.
For example, there was a time Berkley UNIX group were not comfortable with how UNIX classifies users, they had to change the operating system code. Therefore, an expert UNIX user at a domain might face a serious learning curve challenge at another domain or location.

3 Linux Operating System:

what this means is that Linux is a FREE OS, one can perform International Journal of Computer Applications (0975 – 8887) downloads, modification and also redistribution without any cost. Linux is relatively new in the operating system realm. It was written in the year 1991, and also enhanced for current

usage.

Linux and Windows can be compared to an entity that its floor and roof are either replaceable or not. However, with Linux, as an entity, both floor and roof can be moved in any manner as one want, but Windows floor and roof are very rigid that it remains immovable. One cannot go beyond what Microsoft has designed [16, 18].

Linux, designed by Linus Torvalds in the year 1991, heads a group of fresh school open source Unix's that came to be in the year 1990, it also include FreeBSD, NetBSD, OpenBSD, and Darvin. All these is a representation of a design direction that the whole group agreed upon. Linux code is totally different compared to the original UNIX source tree code, however, it uses UNIX standards to behave like a UNIX.

Developers in Linux open source community have desires to acquire a substantial share of end-user desktops making Linux's intended users to increase in number than the users of the old-school Unix's, who have fear share desire in the server and workstation market. The aspiration to reach end users made Linux developers much more concerned with ease of installation and in resolving software distribution issues as it was more difficult with UNIX as proprietary systems, applications in Linux are forced to display high degree of ruggedness than their colleagues with proprietary UNIX status.

Merits of Linux OS :

i. Price: Linux is F-R-E-E. It can be downloaded, installed, used, modified without incurring any cost.

ii. Variety: Linux is nowhere a complete OS but a kernel. The fact that it is a kernel, it requires additional ad-ins in form of software. Many of these kinds of distributions or distros exist.

iii. Virus: The fact that it is open sourced, it is less vulnerable compared with Mac, it does not mean that it's free from virus attack.

Demerits of Linux OS :

i. Complicated: A good deal of Computer skills are required to use Linux distros even when some of them are quite easy to use.

i. Compatibility: Although Linux has a few percent of the market share like Mac, however, it does not have many programs and games like that of Windows.

ii. Vendors: Linux has very few vendors selling Linux computers, if one needs Linux computer, then it

might be that one will need to purchase Windows computer, reformat the hard drive, and then install Linux on it.

4 Macintosh Operating System (MAC OS) :

Mac OS is much older than Windows OS. It was released one year earlier its Microsoft counterpart, and it happens to be the first among other OS, ever successful graphical-inclined OS. Mac OS has undergone basically, two important design transitions, and is on its third stage. The first transition was from supporting only a single application at one time to the ability to cooperatively multitask multiple applications (MultiFinder); the second was the transition from 68000 to PowerPC processors, the third was the coming together of Mac OS design ideas with a Unix-derived infrastructure in Mac OS X.
Mac OS has very high unifying idea significantly different These explain a great detail of what an Apps Graphical User Interface is supposed to depict with its expected behavior. One major idea the Mac Interface Guidelines is that everything should stay where they are kept.
Mac operating system apps is termed not huge monoliths. The system's graphic user interface (GUI) support program instructions or codes, which is partly implemented in a ROM conveyed with the hardware and partly implemented in shared libraries, communicates easily with Mac OS software programs through a quite stable event interface. Hence, the operating system design encourages a distinct and clean separation between GUI interface and application engine. Leading-edge Unix's like Linux OS are beginning to borrow ideas like file attributes from Mac OS.

Merits of Mac OS

i. Viruses: Apple Macs get almost no viruses. This is because Windows has a very large and superior market share over other OS.
ii. Reliability: Apple computers offers itself for Macs to run only on it, and hence less prone to crashing of hardware and software.
iii. Looks: often time, Mac seems to look better than its counterpart, windows OS.

Demerits of Mac OS

i. Expensive: The cost of purchase of Mac is more than that of Windows.

ii. Only available on Apple computers: Already having a computer system that is not an Apple, one will not be able to install MAC in such system. Otherwise, one will need to purchase a new computer system.
iii. Compatibility: Very few programs can only run on MAC OS, likewise computer games.

5 Android Operating System :

The original creator of the platform is Android Inc., Google later bought it over and released the OS as AOSP (Android Open Source Project) in 2007. This new development was complemented by the founding of the OHA (Open Handset Alliance), a consortium saddled with the responsibility to develop and distribute Android. The software, which is now been released under the Apache license is tagged among others, a free open source license. Android releases a new version every few months as a result of the available huge developer communities who regularly updates and create applications using custom-built version of Java.
The OHA group is a consortium of several software, hardware and telecom companies, T-Mobile, Intel, Qualcomm, NVIDIA, HTC, Motorola and Google Inc., for which Android provides their software platform. Their main objective of OHA is to develop available technologies that will considerably lower the cost and time of developing and distributing mobile devices and services.

Merits of Android OS

i. Open Source Platform supported by a wide-range of mobile device manufacturer and communities
ii. Easy access to many free and premium app from communities of Apps developers that support Android OS
iii. Multitasking: Android Operating system has the capability of running many applications and processes within the same available time
iv. Fast and easy notification of SMS, email or RSS reader alert
v. Widget zed home screen allows easy access to settings of phones without wasting time and with ease
vi. The continuous upgrades in appearance and features might shortly leave other iOS far behind soon.
vii. Good for programmers who likes to jumble with Linux Kernel for making alterations in OS.

Demerits of Android OS :

i. Unstable and disposed to crashes compared to other OS.
ii. Being open source, so many apps are created. Very few of these applications might have bugs which can be abused by hackers or viral infections.
iii. To sign in as administrator for advanced settings, one need to get acquainted with Linux commands.
iv. Frequent updates on the OS could make one upgrade to the latest, and this is called rooting. Rooting should be done carefully, otherwise, one could end up in trouble.
v. Majority of Applications require internet connections for operation which sometimes is a disadvantage.
vi. Poor battery backup management.

6 iPhone Operating System (iOS):

iOS, which is a mobile OS, is designed and owned by Apple Inc. It was designed and developed for iPhone, but later extended support for iPad and Apple TV. iOS root comes from Mac OS X, hence it is UNIX based OS. Like other OS, iOS is frequently updated starting from iOS version 4.0 and the latest is iOS version 5.1.The Core OS layer resides in the bottom of iPhone OS architecture[19].
Core services layer of iOS architecture encompasses an additional abstraction layer, cocoa touch layer and media. The Core OS layer contain the scheduler inclusively, Mach kernel, file system, hardware drivers and control the memory system, network and inter process communication and security framework to secure the system and program data. As confirmed that the core services layer of the OS has an abstraction setup. It also contain nonstop accessibility to the network availability, basic framework for objective-C programming, state of mobile device, access to location information and address book. As of March 2012, 550,000 iOS apps are available in Apple store (Anup, Raman et al 2015). iOS has many benefits and non-benefits as stated below.

Merits of iOS :

i. Stable and safe Operating System for mobile phones
ii. Probably the most loved interface for any mobile OS in the market. Good looking designed desktop and app icons which go hand to hand with the

stunning looks of Apple devices.
iii. Minimal viruses and safe OS with the consideration of very high standard when applications were developed and when updates were also made.
iv. High adherence to current web standard and procedures.
v. High consideration for cloud storage technology.
vi. Easy access to free and premium apps from Apple store.

Demerits of iOS :

i. iOS only support Apple Hardware, and less operability
ii. Very costly

2. A Comparative Study of Operating Systems Commands in Case of Dos and UNIX

What is DOS?

DOS stands for a **Disk Operating System**. It is a computer operating system that was used in **Microsoft's x86-based PCs**. The Disk Operating System (DOS) was released in **1981**, and it was a single-processing operating system. X86-based PCs are Microsoft Corporation-expanded personal computers. The hard drive device will be used to run DOS. MS-DOS was renamed **IBM PC DOS**, and several operating systems were suited with MS-DOS and referred to as DOS.

The Disk Operating System (DOS) contains **C Programming Language**, Assembly Language, and x86-based language. The **Microsoft Corporation** and **Tim Paterson** develop the Disk Operating System. Microsoft created the x86-based computers, which run on the DOS. The source models were available in DOS format. DOS was first introduced in **1981**, while Windows 8.0 was released in **2000**. Since **2018**, the DOS has close source and open-source versions for selected versions.

DOS is a mono-spaced raster typeface with a font size that is comparable to Courier. This type of font size was intended as an MS-DOS typeface and utilized cross zeros. **Deltree** is the command used for external code, whereas Dir was used for internal code. Disk Operating System (DOS) was used for personal computers before Windows had arrived. It is a single-

command operating system that cannot handle multiple commands. DOS can be used to access disk storage devices, including **optical disks, floppy disks**, and **hard disk drives**. Operating disk drives help in the organization of file systems for reading and writing to disk storage.

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Features of DOS

There are various features of the disk operating system. Some features of the operating system are as follows:

1. It is a free OS.
2. It is a 16-bit OS.
3. It aids make file management, e.g., creating, editing, deleting files, etc.
4. It doesn't support GUI.
5. It is a single-user OS.
6. It has a text-based interface and operates completely on text and codes.

What is UNIX?

UNIX is a computer OS that supports multiple processors. UNIX was derived from the original **AT&T UNIX system**, which was designed and developed in the **19th century**. The UNIX operating system was created by **FreeBSD**, **Brian Kernighan, Nokia Bell Labs, Douglas Mcllroy, Ken Thomson, Dennis Ritchie**, and **Joe Ossanna**. Plan 9 and Linux are two OS versions of the UNIX OS.

The **C** and **Assembly languages** were used to develop the UNIX OS. UNIX was first introduced on **November 3, 1971**, and the Turning Award was later given to this operating system. UNIX OS uses servers to run medium-to-large-scale computer systems. The servers used for the UNIX operating system are Application Servers and Database Servers. The servers include SUN, IBM, HP, and some others.

UNIX is a multi-purpose operating system that may be used on desktops, laptops, and servers. The UNIX end-of-line system is known as **("/n")**. UNIX is made up of environment variables, some of which are set by the system. The user controls some variables, while the shell and program control others. The UNIX operating system contained a regular expression with characters in the sequence that matched the text. The UNIX operating system contains multitasker and multiuser features.

UNIX offers a graphical user interface that is comparable to that of Windows. The abbreviation for UNIX is UNICS, which stands for UNiplexed Information Computing System. It began working on programming in the **1960s** and became operational in **1971**. The UNIX operating system has been widely utilized in complicated, critical applications for some companies. Data Enterprise Centre prefers the UNIX OS.

3. A Case Study of Flavors of Different Unix based Operating Systems Oracle Solaris, FreeBSD, Microsoft Xenix, IBM AIX, HP UX (A/P)

Flavors of UNIX Definition

The widely used term *flavors of UNIX* refers to the many that have been developed based on the original that was written in 1969 by Ken Thompson

Fragmentation of UNIX occurred almost from the beginning. It was the result of both commercial pressures and differences in opinion among developers as to the way in which operating systems should behave.

Among the ways in which the various *flavors* of UNIX differ are fundamental design, commands and features, (3) the hardware (i.e., processors) for which they are intended and (4) whether they are *proprietary software* (i.e., commercial software) or *free software* (i.e., software that anyone can obtain at no cost and use for any desired purpose).

Many of the proprietary flavors have been designed to run only (or mainly) on proprietary hardware sold by the same company that has developed them. Examples include:

- AIX - developed by IBM for use on its mainframe computers
- BSD/OS - a commercial version of BSD developed by Wind River for Intel processors
- HP-UX - developed by Hewlett-Packard for its HP 9000 series of business servers
- IRIX - developed by SGI for applications that use 3-D visualization and virtual reality
- QNX - a real time operating system developed by QNX Software Systems primarily for use in embedded systems
- Solaris - developed by Sun Microsystems for the SPARC platform and the most widely used proprietary flavor for web servers
- Tru64 - developed by Compaq for the Alpha processor

Others are developed by groups of volunteers who make them available for free. Among them are:

- Linux - the most popular and fastest growing of all the Unix-like operating systems
- FreeBSD - the most popular of the BSD systems (all of which are direct descendants of BSD UNIX, which was developed at the University of California at Berkeley)
- NetBSD - features the ability to run on more than 50 platforms, ranging

from acorn26 to x68k

- OpenBSD - may have already attained its goal of becoming the most secure of all computer operating systems
- Darwin - the new version of BSD that serves as the core for the Mac OS X

4. A Case Study of Different Flavors of Linux based Operating Systems: Centos, Debian, Fedora, Kali Linux, Ubuntu, openSUSE. (A/P)

Ubuntu

Ubuntu is a Linux distribution based on Debian. It is developed by Canonical and a community of developers. It has 3 official editions: *Desktop*, *Server* and *Core*, which can either run on a computer or on a VM. More than 34% of the websites using Linux use Ubuntu, according to W3Techs data. Its growth since 2010 has been amazing. It is also a popular distribution among cloud computing projects.

Ubuntu License: GPL and other licenses.

Ubuntu Latest major release with long-term support (LTS): Ubuntu 22.04 LTS (Jammy Jellyfish).

Debian

Debian is an open source operating system. This distribution was first announced by Ian Murdock in 1993 as the "Debian Linux Release". The Debian Project is a community of developers and users that maintain the GNU OS based on open source software. Currently, Debian systems use the Linux kernel or the FreeBSD kernel. However, they are also working on providing Debian for other kernels. Primarily, GNU Hurd.

Debian License: BSD, GPL and other open licenses.

Debian Latest major release: Debian 11 (Bullseye).

CentOS Linux

CentOS Linux is a distribution based on the source code of the commercial distribution Red Hat Enterprise Linux (RHEL). It was launched in 2004 and is backed up by a growing community. It is a safe bet for those looking for high-quality code. But CentOS 8 will be its last version. In 2019, Red Hat announced that CentOS Linux would be replaced by CentOS Stream — an upstream development platform for RHEL. New open source alternatives have appeared due to this change of strategy. For instance, Rocky Linux, founded by Gregory Kurtzer, founder of the CentOS project.

CentOS Linux License: GNU GPL.

CentOS Linux Latest major release: CentOS Linux 8.

CentOS Stream

CentOS Stream is an upstream development platform for Red Hat Enterprise Linux (RHEL). It is a midstream between Fedora Linux and RHEL. This platform aims to take advantage of open-source innovation for shaping upcoming stable RHEL releases.

CentOS Stream License: GNU GPL.

CentOS Stream Latest release: CentOS Stream 9.

Red Hat Enterprise Linux (RHEL)

Red Hat Enterprise Linux (RHEL) is a commercial Linux distribution developed by Red Hat. It has a server version and a desktop version. As it uses open source software, published under a General Public License, they make their code available to the public via CentOS. Red Hat has sponsored the CentOS project since 2014.

RHEL License: GPL.

RHEL Latest major release: RHEL 9.

Gentoo

Gentoo is a Linux distribution that features a rolling release model. Gentoo Linux was originally created by Daniel Robbins. It was named after the fast-swimming "gentoo penguin", to reflect its potential. It is an attractive choice for Linux users looking for full control of the software. Gentoo users have great control over the services installed and running on their computer. They can immensely customize and optimize their system.

Gentoo License: Free software.

Gentoo Releases: rolling release.

Fedora

Fedora is a Linux distribution developed by the Fedora Project — sponsored mainly by Red Hat, with support from other companies. It is developed and maintained by the community and it is an upstream source of the commercial RHEL distribution. Fedora usually has more modern software versions, considered as "non stable", that are later included in RHEL. There are different Fedora editions available: *Workstation, Server, CoreOS, Silverblue* and *IoT*. Fedora Linux was launched in 2003.

Fedora License: GPL and other licenses.

Fedora Latest major release: Fedora 36.

OpenSUSE

OpenSUSE is a Linux distribution sponsored by SUSE Software Solutions Germany GmbH and other companies. It was formerly known as SUSE Linux. OpenSUSE has a rolling release version, Tumbleweed, and a regular release version, Leap.

OpenSUSE License: GNU GPL and other licenses.

OpenSUSE Latest release: OpenSUSE Leap 15.4.

Scientific Linux

Scientific Linux is another Linux distribution based on RHEL's free and open source software. It is produced by Fermilab, CERN, DESY and ETH Zurich. In April 2019, they announced its discontinuation. Nevertheless, its last version, Scientific Linux 7, will have maintenance updates until June 2024.

Scientific Linux License: GNU GPL and other licenses.

Scientific Linux Latest release: Scientific Linux 7.

CloudLinux

CloudLinux is a Linux distribution developed by CloudLinux, Inc. It is based on CentOS and uses the OpenVZ kernel and the RPM Package Manager. It is targeted to shared hosting providers and data centers. It stands out for improving server stability, density and security. The first version of CloudLinux OS was released in 2010.

CloudLinux Latest release: CloudLinux 8.6.

Elementary OS

Elementary OS is a Linux distribution based on Ubuntu. The OS is developed and maintained by Elementary, Inc. It aims to be a fast, open and privacy-respecting alternative to Windows and MacOS. It features a pay-what-you-want (PWYW) model.

Elementary OS License: GNU GPL and other licenses.

Elementary OS Latest release: Elementary OS 6.1 (Jólnir).

Linux Mint

Linux Mint is a community-driven Linux distribution based on Ubuntu. This distribution started in 2006. The Linux Mint project was initially created by Clément Lefèbvre. Linux Mint OS' source code is available on GitHub. Most of the OS development is done in Python.

Linux Mint License: GPL.

Linux Mint Latest release: Linux Mint 20.3 (Una).

Arch Linux
Arch Linux is a Linux distribution based on 5 principles: simplicity, modernity, pragmatism, user centrality and versatility. It features a rolling release model.
Arch Linux License: GNU GPL and other licenses.
Arch Linux Release: rolling release.
Manjaro
Manjaro is a free Linux distribution based on Arch Linux. It is specially focused on accessibility and user-friendliness. It features a rolling release model. Its simplicity, stability and performance makes it a suitable alternative OS to MacOS and Windows. It offers multiple desktop environments.
Manjaro License: GPL and other open licenses.
Manjaro Latest release: Manjaro 21.3 (Ruah).
Oracle Linux
Oracle Linux (OL) is a Linux distribution packaged and distributed by Oracle; under GNU GPL since late 2006. It was formerly known as Oracle Enterprise Linux (OEL). It is based on RHEL's source code. Oracle Linux is available with two Linux kernels: the Red Hat Compatible Kernel (RHCK) and the Unbreakable Enterprise Kernel (UEK).

5. A Comparative Study of Windows based Operating Systems: Windows 95, Windows 98, Windows CE, Windows 2000, Windows ME, Windows XP, Windows NT.

Microsoft Windows version history

Microsoft Windows was announced by Bill Gates on November 10, 1983.[1] Microsoft introduced Windows as a graphical user interface for MS-DOS, which had been introduced two years earlier.[2] The product line evolved in the 1990s from an operating environment into a fully complete, modern operating system over two lines of development, each with their own separate codebase.

The first versions of Windows (1.0 through to 3.11) were graphical shells that ran from MS-DOS. Windows 95, though still being based on MS-DOS, was its own operating system, using a 16-bit DOS-based kernel and a 32-bit user space. Windows 95 also had a significant amount of 16-bit code ported from Windows 3.1.[3][4][5] Windows 95 introduced many features that have been part of the product ever since, including the Start menu, the taskbar, and Windows Explorer (renamed File Explorer in Windows 8). In 1997, Microsoft released Internet Explorer 4 which included the (at the time controversial) Windows Desktop Update. It aimed to integrate Internet Explorer and the web into the user interface and also brought many new features into Windows, such as the ability to display JPEG images as the desktop wallpaper and single window navigation in Windows Explorer. In 1998, Microsoft released Windows 98, which also included the Windows Desktop Update and Internet Explorer 4 by default. The inclusion of Internet Explorer 4 and the Desktop Update led to an antitrust case in the United States. Windows 98 included USB support out of the box, and also plug and play, which allows devices to work when plugged in without requiring a system reboot or manual configuration. Windows Me, the last DOS-based version of Windows, was

aimed at consumers and released in 2000. It introduced System Restore, Help and Support Center, updated versions of the Disk Defragmenter and other system tools.

In 1993, Microsoft released Windows NT 3.1, the first version of the newly developed Windows NT operating system. "NT" is an acronym for "New Technology".[4] Unlike the Windows 9x series of operating systems, it is a fully 32-bit operating system. NT 3.1 introduced NTFS, a file system designed to replace the older File Allocation Table (FAT) which was used by DOS and the DOS-based Windows operating systems. In 1996, Windows NT 4.0 was released, which includes a fully 32-bit version of Windows Explorer written specifically for it, making the operating system work like Windows 95. Windows NT was originally designed to be used on high-end systems and servers, but with the release of Windows 2000, many consumer-oriented features from Windows 95 and Windows 98 were included, such as the Windows Desktop Update, Internet Explorer 5, USB support and Windows Media Player. These consumer-oriented features were further extended in Windows XP in 2001, which included a new visual style called Luna, a more user-friendly interface, updated versions of Windows Media Player and Internet Explorer 6 by default, and extended features from Windows Me, such as the Help and Support Center and System Restore. Windows Vista, which was released in 2007, focused on securing the Windows operating system against computer viruses and other malicious software by introducing features such as User Account Control. New features include Windows Aero, updated versions of the standard games (e.g. Solitaire), Windows Movie Maker, and Windows Mail to replace Outlook Express. Despite this, Windows Vista was critically panned for its poor performance on older hardware and its at-the-time high system requirements. Windows 7 followed in 2009 nearly three years after its launch, and despite it technically having higher system requirements,[6][7] reviewers noted that it ran better than Windows Vista.[8] Windows 7 removed many applications, such as Windows Movie Maker, Windows Photo Gallery and Windows Mail, instead requiring users to download separate Windows Live Essentials to gain some of those features and other online services. Windows 8, which was released in 2012, introduced many controversial changes, such as the replacement of the Start menu with the Start Screen, the removal of the Aero interface in favor of a flat, colored interface as well as the introduction of "Metro" apps (later renamed to Universal Windows Platform apps), and the Charms Bar user interface element, all of which received considerable criticism from reviewers.[9][10][11] Windows 8.1, a free upgrade to Windows 8, was released in 2013.[12]