

□ Not designed for pre-emptive multitasking use--Windows has to perform many nasty tricks to allow even non-pre-emptive multitasking with non-multitasking MS-DOS and its non-multitasking device drivers.

□ Incompatible with multiprocessor platforms--MS-DOS is inherently a singleprocessor OS, so MS-DOS device drivers are utterly incapable of synchronizing access to shared resources in a multiprocessor situation.

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3.6 SECURITY

The security syntax set in MSDOS is masked on the command base and the password identifier which cannot be altered by someone who is not authorized. Password can be set for some programs starting from MSDOS like QBASIC.

The command – line is not prone to virus. Also it MSDOS cannot be used by someone who does not know the commands limiting the risk of harming the system. Group C Page 15

4.0 DESIGN ISSUES

MS-DOS Design Criteria

The primary design requirement of MS-DOS was CP/M-80 translation compatibility, meaning that, if an 8080 or Z80 program for CP/M were translated for the 8086 according to Intel's published rules, that program would execute properly under MS-DOS. Making CP/M-80 translation compatibility a requirement served to promote rapid development of 8086 software, which, naturally, Seattle Computer was interested in. There was partial success: those software developers who chose to translate their CP/M-80 programs found that they did indeed run under MS-DOS, often on the first try. Unfortunately, many of the software developers Seattle Computer talked to in the earlier days preferred to simply ignore MSDOS. Until the IBM Personal Computer was announced, these developers felt that CP/M-86 would be *the* operating system of 8086/8088 computers. Other concerns crucial to the design of MS-DOS were speed and efficiency. Efficiency primarily means making as much disk space as possible available for storing data by minimizing waste and overhead. The problem of speed was attacked three ways: by minimizing the number of disk transfers, making the needed disk transfers happen as quickly as possible, and reducing the DOS's "compute time," considered overhead by an application program. The entire file structure and disk interface were developed for the greatest speed and efficiency. The last design requirement was that MS-DOS be written in assembly language. While this

characteristic does help meet the need for speed and efficiency, the reason for including it is much more basic. The only 8086 software-development tools available to Seattle Computer at that time were an assembler that ran on the Z80 under CP/M and a monitor/debugger that fit into a 2K-byte EPROM (erasable programmable read-only memory). Both of these tools had been developed in house. Group C Page 16

5.0 IMPLEMENTATION

MSDOS is a single-user operating system. MS-DOS employs a command line interface and a batch scripting facility via its command interpreter, `command.com` (all operations to be carried out must be written through commands); without the knowledge of those commands, the user cannot execute a job. Despite its command-line interface, it is easy to learn. The commands of MSDOS are not case sensitive. MSDOS is supported and embedded in other operating system like *Microsoft windows, MacOs*; it can be launched in windows by:

- (i) Start -> All programs -> accessories -> command prompt or
- (ii) Start -> run -> type **cmd** -> ok

The MSDOS contains five files (`IO.SYS`, `MSDOS.SYS`, `COMMAND.COM`, `CONFIG.SYS` and `AUTOEXEC.BAT`). The commands in MSDOS can be categorized in two forms:

INTERNAL and **EXTERNAL** commands.

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Internal commands are executed without loading a separate program file. `Command.com` is responsible for the execution of internal commands and the special batch commands. Internal commands are part of the command processor always available to be used. External command exists as executable files handled by separate programs from the DOS diskette. Each program is a member of the `.COM` or `.EXE` family. An external command can only be used when the disk containing the program is in drive. They can be used for peripheral devices like printer. A file's full name is called **FILESPEC**. The **FILESPEC** for a disk file has four parts: *drive name, directory name, file name and extension*. Characters like. “ / \ [] : | < > + = ; , cannot be used in naming files because they mean other things in MSDOS. When you start up DOS, the current directory is automatically the root directory. The `CD` will change the current directory. Other folders in the root directory are called sub – directories. A file in any directory can be accessed by typing:

cd ROOT DIRECTORY\SUB-DIRECTORY (Level 1)\ SUB-DIRECTORY (level2)...\filename.ext. CLASSIFYING MS-DOS COMMANDS

Either internal or external command will be specified for each command of MSDOS in this text. MS-DOS commands fall roughly into three categories;
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1. **Environment Commands:** These report on or affect the operating system environment. Examples are CLS (clear screen), TIME, DATE, VER (display MS-DOS version number), and HELP.

□ **BREAK** (internal): Used from the DOS prompt or in a batch file or in the CONFIG.SYS file to set (or display) whether or not DOS should check for a Ctrl + Break key combination.

BREAK =on|off

□ **CLS** (internal) – clears screen: Clears (erases) the screen. **CLS**

□ **DATE AND TIME** (internal): Displays and/or sets the system date. **DATE mm-dd-yy** or **DATE**

□ **GRAPHICS** (external): Provides a way to print contents of a graphics screen display.

GRAPHICS [printer type][profile] [/B][/R][/LCD][/PB:(id)] [/C][/F][/P(port)]

□ **MODE** (external): Sets mode of operation for devices or communications.

MODE n

MODE LPT#[:][n][,][m][,][P][retry]

MODE [n],m[,T]

MODE (displaytype,linetotal)

MODE COMn[:][baud][,][parity][,][databits][,][stopbits][,][retry]

MODE LPT#[:]=COMn [retry]

MODE CON[RATE=(number)][DELAY=(number)]

MODE (device) CODEPAGE PREPARE=(codepage) [d:][path]filename

MODE (device) CODEPAGE PREPARE=(codepage list) [d:][path]filename

MODE (device) CODEPAGE SELECT=(codepage)

MODE (device) CODEPAGE [/STATUS]

MODE (device) CODEPAGE REFRESH

- VER (internal): Displays the DOS version number. **VER**
- SELECT (external): Formats a disk and installs country-specific information and keyboard codes (starting with DOS Version 6, this command is no longer available).

SELECT [d:] [d:][path] [country code][keyboard code]

2. Directory and File Commands: These manipulate files. Examples are COPY, DEL (delete), TYPE (display file to screen) and, DIR (directory - or list all files in current directory). It can be further divided into three (3);

(a) Commands for disk maintenance

- BACKUP (external): Makes a backup copy of one or more files. (In DOS Version 6, this program is stored on the DOS supplemental disk.)

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BACKUP d:[path][filename] d:[/S][/M][/A][/F:(size)] [/P][/D:date] [/T:time] [/L:[path]filename]

- RESTORE (external): Restores to standard disk storage format files previously stored using the BACKUP command.

RESTORE d: [d:][path]filename [/P][/S][/B:mm-dd-yy] [/A:mm-ddyy][/E:hh:mm:ss] [/L:hh:mm:ss] [/M][/N][/D]

- RECOVER (external): Resolves sector problems on a file or a disk. (Beginning with DOS Version 6, RECOVER is no longer available).

RECOVER [d:][path]filename or RECOVER d:

- VERIFY (internal): Turns on the verify mode; the program checks all copying operations to assure that files are copied correctly.

VERIFY on|off

- FORMAT (external): Formats a disk to accept DOS files. **FORMAT d:[/1][/4][/8][/F:(size)] [/N:(sectors)] [/T:(tracks)][/B/S][/C][/V:(label)] [/Q][/U][/V]**

□ SYS (external): Transfers the operating system files to another disk.

SYS [source] d:

□ CHKDSK (external): Checks a disk and provides a file and memory status report.

CHKDSK [d:][path][filename] [/F][/V]

□ DISKCOPY (external): Makes an exact copy of a diskette.

DISKCOPY [d:] [d:][/1][/V][/M]

□ DISKCOMP (external): Compares the contents of two diskettes.

DISKCOMP [d:] [d:][/1][/8]

□ LABEL (external): Creates or changes or deletes a volume label for a disk.

LABEL [d:][volume label]

□ VOL (internal): Displays a disk's volume label.

VOL [d:] (b) Commands for directory control

□ DIR (internal): Displays directory of files and directories stored on disk.

**DIR [d:][path][filename] [/A:(attributes)] [/O:(order)]
[/B][/C][/CH][/L][/S][/P][/W]**

□ ASSIGN (external): Redirects disk drive requests to a different drive.

ASSIGN A:=B: [...] /sta

□ MKDIR (internal): Creates a new subdirectory.

MKDIR (MD) [d:]path

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□ CHDIR (internal): Displays working (current) directory and/or changes to a different directory.

CHDIR (CD) [d:]path or CHDIR (CD)[..]

□ RMDIR (internal): Removes a subdirectory.

RMDIR (RD) [d:]path

□ TREE (external): Displays directory paths and (optionally) files in each subdirectory.

TREE [d:][path] [/A][/F]

□ PATH (external): Sets or displays directories that will be searched for programs not in the current directory.

PATH; or **PATH [d:]path[;][d:]path[...]**

□ JOIN (external): Allows access to the directory structure and files of a drive through a directory on a different drive.

JOIN d: [d:]path or **JOIN d: [/D]**

□ SUBST (external): Substitutes a virtual drive letter for a path designation.

SUBST d: d:]path or **SUBST d: [/D]**

(c) **Commands for file control:**

□ COPY (internal): copies source file to target file and appends file.

COPY [d:][path]source [d:][path][target] [/V]

Or COPY [d:][path]filename+[d:][path]filename[...][d:][path][filename] [/V]

□ COMP (external): Compares two groups of files to find information that does not match. **COMP [d:][path][filename] [d:][path][filename]**

[/A][/C][/D][/L][/N:(number)]

□ RENAME (internal): Changes the filename under which a file is stored.

RENAME (REN) [d:][path]filename [d:][path]filename

□ ERASE/DELETE (internal): Deletes (erases) files from disk.

DEL (ERASE) [d:][path]filename [/P]

□ TYPE (internal): Displays the contents of a file.

[d:][path]filename

□ PRINT (external): Queues and prints data files.

PRINT [/B:(buffersize)] [/D:(device)] [/M:(maxtick)] [/Q:(value)]

[/S:(timeslice)] [/U:(busytick)] [/C][/P][/T] [d:][path][filename] [...]

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□ ATTRIB (external) : Sets or displays the read-only, archive, system, and hidden attributes of a file or directory.

ATTRIB [d:][path]filename [/S]

ATTRIB [+R|-R] [+A|-A] [+S|-S] [+H|-H] [d:][path]filename [/S]

3. **Utilities:** These perform some useful function. Examples are FORMAT (format a diskette) and EDIT (invoke MS-DOS text editor).

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6.0 STRENGTH AND WEAKNESS

Strengths of Microsoft Disk Operating System

(a) It has a good User interface

MS-DOS employs a command line interface and a batch scripting facility via its command interpreter, command.com. MS-DOS was designed so users could easily substitute a different command line interpreter

(b) MS-DOS compatibility with other Microsoft operating systems users also desired a graphical user interface. Many programs running under MS-DOS tried to fill the void by creating their own graphical interface, such as Microsoft Word for DOS, XTree, and the Norton Shell. However, this required duplication of effort and did not provide much consistency in interface design (even between product lines). Non-Microsoft efforts to provide a consistent interface.

(c) It has command line interpreter which is the most efficient way to manage files and run a computer program. It can be used to run program like JAVA and C++, MYSQL.

(d) Software Base

There is a huge software base for developing software in DOS, which is another major strength.

Weakness of MS-DOS

(a) MSDOS is a single user operating system.

(b) It does not support features like multi-tasking and multi-processing.

(c) DOS doesn't have built-in capability for scheduling or multithreading.

(d) You must also install interrupt handlers directly into the software application, and API calls tend to be through software interrupts rather than some other more direct procedural method instead.

(e) Equipment vendors supporting DOS tend to follow an approach of either providing raw spec sheets for their equipment or writing a pre-compiled binary object library that has to be linked into your software using a specific compiler.

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CONCLUSION

MSDOS is a powerful operating system. Though it is an old operating system yet not outdated and versions of it are being released. There is a huge software base for developing software in DOS, which is another major strength. DOS controls the computer's hardware and provides an environment for programs to run. Everything you can do with a GUI can be done at the DOS prompt. It can be used to execute specific programs directly from the command prompt like sql queries, C++, C# and Java programs because it interface between with computer hardware and software effectively.

CHAPTER 5: MACINTOSH OPERATING SYSTEM

INTRODUCTION

Mac OS is a Graphical User Interface based operating system designed for Apple's Macintosh Computer. Mac OS was named by the company Apple as "Mac System Software" in the beginning, a specially designed operating system only for 68000 first Motorola processors. With own Macintosh hardware, Mac OS takes up a special role in the world of desktop systems.

The first version was "System 1" and appeared bundled with the Mac in 1984. The classic desktop is designed as a single user operating system and almost completely hides the full path to files and directories. The graphic representation is reduced to the essence. Overall the interface is very easy to use and does not need the right mouse button for user interaction.



Starting with System 3.0, the used filesystem, Hierarchical File System was used officially, which does not differ between uppercase and lowercase letters.

System 5.0 was the first release to run several programs with the integrated MultiFinder at the same time. In 1988, system 6.0 came onto the market. It requires 1 MB RAM and can address up to 8 MB. The file system can organize hard disks up to 2 GByte with 65,536 files. Optionally applications run with the multi Finder in cooperative multitasking. For word processing are programs such as WriteNow, MacWrite II, and Microsoft Word 4.0 available. In May 1991, system 7 came into existence. The new operating system needed 2 MB RAM, optionally it can be switched to 32-bit depending from the used hardware. New is the direct support of networks with file exchange, AppleScript as scripting language and display of colors. Balloons provide help for the user to use the interface. The TrueType fonts are scalable to any size.

The System Software 7.5 appeared in 1994 and requires at least 4 MB RAM. It was running both on 68000-Macs and Power Macintosh. In September 1996, the update System 7.5.5 includes all available bug fixes, Open Transport 1.1.2, current Ethernet driver and support for storage drive volumes up to 4 GB. With release 7.6 the company Apple changed the name from Mac Software System to Mac Operating System in 1997. Mac OS 8 by Apple appeared in July 1997. As minimum requirements are specified a 68040 or PowerPC processor, 32 MB RAM

and 120 MB of free disk space. The CTRL key is used to display a specific context menu for different actions. It makes it easier to copy files. **Mac OS 8.1**, Informations are stored more efficiently on the file system. The file system can handle up to 2 billion files with a current file size of up to 2 GB.

Mac OS 8.5 further optimized the stability and speed of the operating system, AppleScript is now up to 5 times faster than the previous version. The graphical display is accelerated by new QuickDraw routines. Copying files has become faster and increase the disk throughput. A tool for system maintaining detects and fixes errors on the file system automated. Following applications are included in current version: Finder 8.5 QuickTime Pro 3, Open Transport 2, Internet Explorer 4.01, Outlook Express 4.01, e.t.c.

The operating system Mac OS 9 has been developed under the name Sonata and released to the 23. October 1999. The installation requires 32 MB RAM with virtual memory. The free disk storage should be 150 up to 400 MB depending on the installation type. 50 new features are added in comparison to the previous version. This includes support for multiple users with password and access management for files and settings. The login is available through authentication by voice. **MAC OS X**

The operating system core Darwin is open source, Mac OS X works with preemptive multi-tasking and includes beside the new Graphical user interface (GUI) Aqua the classic GUI from Mac OS 9.



Mac OS X 10.0 came out in March 2001. To install are 128 MB RAM (256 MB RAM starting from Mac OS X 10.3.9) and 1.5 GB hard disk space (3.0 GByte starting from Mac OS X 10.2) provided. Mac OS X 10.5 requires at least 512 MB RAM and 9 GByte of free disk space.

- 32-bit or 64-bit processing
- **Field** of **Application**
- digital photography
- 2-D and 3-D animations
- video processing

- audio processing

Structure

- supports QuickTime
- graphical user interaction with the finder
- graphical representation by Quickdraw

Information

Considerable performance and comfort improvements were carried out in version **Mac OS X 10.1**. The surface reacts quicker at user interaction, the system start was accelerated and the OpenGL performance increased noticeable.

Mac OS X 10.3 has now a GUI in metallic scheme and the optimized Finder. The use and access in heterogeneous networks was further simplified. 12 million MacOS X user were counted in October 2004.

According to Apple **Mac OS X 10.4** brings more than 200 new features. Features are the fast, system-wide and index-based search function named Spotlight, the Dashboard for easy access to small programmes (Widgets), the Automator for the simplified composition of Applescripts for the automation of tasks. The Web browser Safari in version 2.0 now contained. Further novelty is the delivery at a DVD medium, an installation of CD-ROM is no longer possible.

First since the 10th January 2006 is MacOS X 10.4.4 next to the PowerPC version available for Intel based Macs. On the 6. June 2005 Steve jobs announced the switch to Intel processors. As further details became known that Apple had developed Mac OS X since 2000 internally also for the Intel platform.

Apple released the successor **MacOS X 10.5**, Leopard at the 26 october,2007. With more than 300 innovations MacOS offers the user an enhanced user interface with virtual desktops, a fast file preview and Dock with 3D effect.ose snapshot. The security of the operating system and applications is improved by 11 enhancements. The first update with bug fixes was released with Mac OS X 10.5.1 by Apple on November 15th, 2007. It contains general bug fixes for the operating system to improve stability, better compatibility and safety.

Mac OS X 10.5.2 came with 125 bug fixes and smaller optimizations on January 24th, 2008.

Mac OS X 10.6 is a Mac computer with Intel Core 2 Duo processor with at least 1 GB memory and 5 GB free space ahead. This operating system no longer exists as PowerPC execution. Apple placed the focus development on performance and

stability. It supports up to 16 TByte memory, it is optimized for multi core processors, and is a pure 64-bit operating system. With the technology OpenCL graphics processor can speed up in specific applications calculation

PROCESS MANAGEMENT

Mac OS implemented non-preemptive multitasking. Although the scheduling algorithm was simple in the absence of preemption, it supported process priorities. A process could only be created by another process, except the initial process, which was created by the operating system as the “shell” process upon booting. The shell process ran the *Desktop Manager* application by default. The system’s process management API included calls for creating, terminating, suspending, and resuming.

Technical History of Apple’s Operating Systems processes.

Terminating a process also resulted in the termination of all its descendants. Examples of MAC process-management system calls included the following.

- make_process
- kill_process
- activate_process
- suspend_process
- info_process
- setpriority_process
- yield_process
- sched_class

System-level exceptions resulted in the termination of a process—a side effect of the execution of default exception handlers. Processes could install custom exception handlers, which were invoked with detailed exception context. Examples of Lisa exception-management system calls included the following.

- enable_excep
- disable_excep
- declare_excep_hdl
- signal_excep

Interprocess Communication

By default, a process was not allowed to access the logical address space of another process. Interprocess communication was possible through multiple mechanisms such as events, shared files, and shared memory. *Events* were structured messages consisting of a system-attached header and a sender-provided data block, transmitted between processes over named *channels*. A process could listen on a channel, waiting for messages to arrive. Alternatively, a process could register an exception handler and arrange for an exception to be generated upon message arrival.

Mac OS X Internals

Examples of mac event-channel management system calls included the following.

- `make_event_chn`
- `kill_event_chn`
- `open_event_chn`
- `close_event_chn`
- `wait_event_chn`

CHAPTER SIX: WINDOWS OPERATING SYSTEM

INTRODUCTION

Microsoft Windows is a series of software operating systems and graphical user interfaces produced by Microsoft. Microsoft first introduced an operating environment named Windows in November 1985 as an add-on to MS-DOS in response to the growing interest in graphical user interfaces (GUIs). Microsoft Windows came to dominate the world's personal computer market, overtaking Mac OS, which had been introduced previously. At the 2004 IDC Directions conference, it was stated that Windows had approximately 90% of the client operating system market. The most recent client version of Windows is Windows Vista; the most recent server version is Windows Server 2008. Vista's successor, Windows 7 (currently in public beta) is slated to be released between July 1, 2009 and June 30, 2010.

The term **Windows** collectively describes any or all of several generations of Microsoft operating system products. These products are generally categorized as follows:

✓ **History of Microsoft Windows**

Microsoft has taken two parallel routes in its operating systems. One route has been for the home user and the other has been for the professional IT user. The dual routes have generally led to home versions having greater multimedia support and less functionality in networking and security, and professional versions having inferior multimedia support and better networking and security.

The first version of Microsoft Windows, version 1.0, released in November 1985, lacked a degree of functionality and achieved little popularity, and was to compete with Apple's own operating system. Windows 1.0 is not a complete operating system; rather, it extends MS-DOS. Microsoft Windows version 2.0 was released in November, 1987 and was slightly more popular than its predecessor. Windows 2.03 (release date January 1988) had changed the OS from tiled windows to overlapping windows. The result of this change led to Apple Computer filing a suit against Microsoft alleging infringement on Apple's copyrights.

A Windows for Workgroups 3.11 desktop

Microsoft Windows version 3.0, released in 1990, was the first Microsoft Windows version to achieve broad commercial success, selling 2 million copies in the first six months. It featured improvements to the user interface and to

multitasking capabilities. It received a facelift in Windows 3.1, made generally available on March 1, 1992. Windows 3.1 support ended on December 31, 2001.

In July 1993, Microsoft released Windows NT based on a new kernel. NT was considered to be the professional OS and was the first Windows version to utilize preemptive multitasking.[citation needed]. Windows NT would later be retooled to also function as a home operating system, with Windows XP.

On August 24, 1995, Microsoft released Windows 95, a new, and major, consumer version that made further changes to the user interface, and also used preemptive multitasking. Windows 95 was designed to replace not only Windows 3.1, but also Windows for Workgroups, and MS-DOS. It was also the first Windows operating system to use Plug and Play capabilities. The changes Windows 95 brought to the desktop were revolutionary, as opposed to evolutionary, such as those in Windows 98 and Windows Me. Mainstream support for Windows 95 ended on December 31, 2000 and extended support for Windows 95 ended on December 31, 2001.

The next in the consumer line was Microsoft Windows 98 released on June 25, 1998. It was substantially criticized for its slowness and for its unreliability compared with Windows 95, but many of its basic problems were later rectified with the release of Windows 98 Second Edition in 1999. Mainstream support for Windows 98 ended on June 30, 2002 and extended support for Windows 98 ended on July 11, 2006.

As part of its "professional" line, Microsoft released Windows 2000 in February 2000. The consumer version following Windows 98 was Windows Me (Windows Millennium Edition). Released in September 2000, Windows Me implemented a number of new technologies for Microsoft: most notably publicized was "Universal Plug and Play."

In October 2001, Microsoft released Windows XP, a version built on the Windows NT kernel that also retained the consumer-oriented usability of Windows 95 and its successors. This new version was widely praised in computer magazines. It shipped in two distinct editions, "Home" and "Professional", the former lacking many of the superior security and networking features of the Professional edition. Additionally, the first "Media Center" edition was released in 2002,[20] with an emphasis on support for DVD and TV functionality including program recording and a remote control. Mainstream support for Windows XP ended on April 14, 2009. Extended support will continue until April 8, 2014.

In April 2003, Windows Server 2003 was introduced, replacing the Windows 2000 line of server products with a number of new features and a strong focus on security; this was followed in December 2005 by Windows Server 2003 R2.

On January 30, 2007 Microsoft released Windows Vista. It contains a number of new features, from a redesigned shell and user interface to significant technical changes, with a particular focus on security features. It is available in a number of different editions, and has been subject to some criticism.

✓ **Early versions**

Windows 1.0, Windows 2.0, and Windows 2.1x

The history of Windows dates back to September 1981, when the project named "Interface Manager" was started. It was announced in November 1983 (after the Apple Lisa, but before the Macintosh) under the name "Windows", but Windows 1.0 was not released until November 1985. The shell of Windows 1.0 was a program known as the MS-DOS Executive. Other supplied programs are Calculator, Calendar, Cardfile, Clipboard viewer, Clock, Control Panel, Notepad, Paint, Reversi, Terminal, and Write. Windows 1.0 does not allow overlapping windows, due to Apple Computer owning this feature. Instead all windows are tiled. Only dialog boxes can appear over other windows.

Windows 2.0 was released in October 1987 and featured several improvements to the user interface and memory management. Windows 2.0 allowed application windows to overlap each other and also introduced more sophisticated keyboard-shortcuts. It could also make use of expanded memory.

Windows 2.1 was released in two different flavors: Windows/386 employed the 386 virtual 8086 mode to multitask several DOS programs, and the paged memory model to emulate expanded memory using available extended memory. Windows/286 (which, despite its name, would run on the 8086) still ran in real mode, but could make use of the high memory area.

The early versions of Windows were often thought of as simply graphical user interfaces, mostly because they ran on top of MS-DOS and used it for file system services. However, even the earliest 16-bit Windows versions already assumed many typical operating system functions; notably, having their own executable file format and providing their own device drivers (timer, graphics, printer, mouse, keyboard and sound) for applications. Unlike MS-DOS, Windows allowed users to

execute multiple graphical applications at the same time, through cooperative multitasking.

Windows implemented an elaborate, segment-based, software virtual memory scheme, which allowed it to run applications larger than available memory: code segments and resources were swapped in and thrown away when memory became scarce, and data segments moved in memory when a given application had relinquished processor control, typically waiting for user input.

Windows 3.0 and Windows 3.1x

Windows 3.0 (1990) and Windows 3.1 (1992) improved the design, mostly because of virtual memory and loadable virtual device drivers (VxDs) which allowed them to share arbitrary devices between multitasked DOS windows. Also, Windows applications could now run in protected mode (when Windows was running in Standard or 386 Enhanced Mode), which gave them access to several megabytes of memory and removed the obligation to participate in the software virtual memory scheme. They still ran inside the same address space, where the segmented memory provided a degree of protection, and multi-tasked cooperatively. For Windows 3.0, Microsoft also rewrote critical operations from C into assembly, making this release faster and less memory-hungry than its predecessors. With the introduction of the Windows for Workgroups 3.11, Windows was able to bypass DOS for file management operations using 32-bit file access.

Windows 95, Windows 98, and Windows Me

Windows 95 featured a new user interface, supported long file names, could automatically detect and configure installed hardware (plug and play), natively ran 32-bit applications, and featured several technological improvements that increased its stability over Windows 3.1. Windows 95 uses pre-emptive multitasking and runs each 32-bit application in a separate address space. This makes it harder for a single buggy application to crash the whole system. It was still not a secure multi-user operating system like Windows NT as a strict separation between applications was not enforced by the kernel. The API was a subset of the Win32 API supported by Windows NT, notably lacking support for Unicode and functions related to security. Windows 95 was now bundled together with MS-DOS 7.0, however its role was mostly delegated to that of a boot loader.

There were several releases of Windows 95; the first in 1995, with Service Pack 1 following in December which included Internet Explorer 2.0. Subsequent versions

were only available with the purchase of a new computer and were called OEM Service Releases. OSR1 was equivalent to Windows 95 with SP1. OSR2 (also called Windows 95 B) included support for FAT32 and UDMA and shipped with Internet Explorer 3.0. OSR 2.1 included basic support for USB and OSR 2.5 (also called Windows 95 C) shipped with Internet Explorer 4.0.

Microsoft's next OS was Windows 98, which had two versions; the first in 1998 and the second, named Windows 98 Second Edition, in 1999.

In 2000, Microsoft released Windows Me (Me standing for Millennium Edition), which used the same core as Windows 98 but adopted some aspects of Windows 2000 and removed the "boot in DOS mode" option. It also added a new feature called System Restore, allowing the user to set the computer's settings back to an earlier date. Me is also the last DOS-based Windows release which does not include Microsoft Product Activation.

Windows NT family

The NT family of Windows systems was fashioned and marketed for higher reliability business use, and was unencumbered by any Microsoft DOS patrimony. The first release was MS Windows NT 3.1 (1993, numbered "3.1" to match the consumer Windows version, which was followed by NT 3.5 (1994), NT 3.51 (1995), NT 4.0 (1996), and Windows 2000 (2000). 2000 is the last NT-based Windows release which does not include Microsoft Product Activation. NT 4.0 was the first in this line to implement the "Windows 95" user interface (and the first to include Windows 95's built-in 32-bit runtimes). Microsoft then moved to combine their consumer and business operating systems with Windows XP, coming in both home and professional versions (and later niche market versions for tablet PCs and media centers); they also diverged release schedules for server operating systems. Windows Server 2003, released a year and a half after Windows XP, brought Windows Server up to date with MS Windows XP. After a lengthy development process, Windows Vista was released toward the end of 2006, and its server counterpart, Windows Server 2008 was released in early 2008. In 2009, Windows 7 and Windows Server 2008 R2 entered beta. Microsoft plans to release Windows 7 in late 2009 or early 2010.

Windows CE, Microsoft's offering in the mobile and embedded markets, is also a true 32-bit operating system that offers various services for all sub-operating workstations.