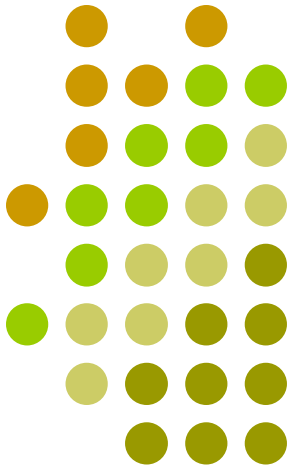
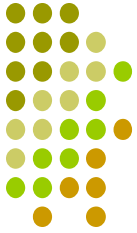


# Operating System Fundamentals





# Operating System Basics

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- The Software Core consists of the following:
  - User Interface
  - File System Management
  - Device Management
  - Boot and Installation Routines
  - Error-Handling Capability
  - Housekeeping Utilities
  - Networking Capability



# User Interface

---

- ❑ It is one of the most important parts of any operating system.
- ❑ It is the interface that allows the user to interact with the computer.
- ❑ It is the interface that allows the user to learn complicated control methods.



# File System Management

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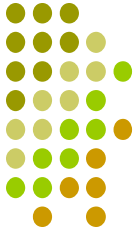
- ❑ It is responsible for creating and maintaining files.
- ❑ It is responsible for placing them on storage media, reorganizing them, ensuring their integrity, and erasing them.
- ❑ Design of the operating system determines the naming convention for files.



# Device Management

---

- ❑ The operating system controls hard drives, accept display information from graphics adapters.
- ❑ It communicate with printers and other peripheral devices.
- ❑ The operating system controls all these devices with drivers and command sequences



# Device Management (contd.)

---

- Boot and Installation Routines
  - It include boot sequence code that is accessed during system startup so that operating system can be loaded.
  
- Error-Handling Capabilities
  - It detect such problems, display error messages to alert the user, and provide the ability to recover without significant loss of data or corruption of the operating system.



# Device Management (contd.)

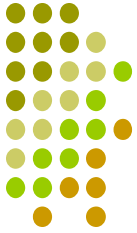
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## □ Housekeeping Utilities

- It includes software routines for defragmenting hard drives, scanning for viruses.
- It includes software for running the system at optimal performance.

## □ Networking Capability

- It provides built-in support for networking protocols.
- It provides a collection of interoperability tools part of any modern operating system.



# A Short History of MS-DOS

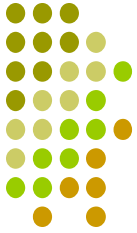
<b>Version</b>	<b>Introduced</b>	<b>Features</b>
1.0	August 1981	Distributed on one floppy disk
1.1	May 1982	Added support for 320-KB double-sided disks
2.0	March 1983	Introduced support for hard disks, directories, background printing, and the ability to add device drivers.
3.0	August 1984	Increased support for hard disks larger than 10 megabytes (MB) and 1.2-MB floppy disks





# A Short History of MS-DOS (contd.)

Version	Introduced	Features
3.1	March 1985	Added networks and file sharing
3.2	January 1986	Included support for 3.5-inch floppy disks.
3.3	April 1987	Added new commands and international support.
4.0	February 1988	Added support for hard disks greater than 32 MB, the MEM command, and MS-DOS Shell
5.0	May 1991	Added memory management tools, help, undelete, unformat, and task swapping



# A Short History of MS-DOS (contd.)

Version	Introduced	Features
6.0	March 1993	Included new features such as MEMMAKER, multiple boot configurations, Windows Unformat and Undelete, virus protection, and backup.
6.2	October 1993	Included Scandisk, Microsoft Diagnostics (MSD) utilities, and enhanced diagnostics.
7.0	December 1995	It was relegated to command-level environments included with Microsoft Windows 95.



# Understanding DOS

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- ❑ DOS was designed to provide operating system services for the original IBM PC.
- ❑ DOS was designed to work as a stand-alone operating system, lacking any native networking support



## Understanding DOS (contd.)

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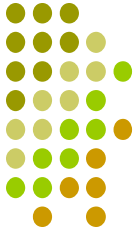
- It used a command-line user interface and required few files present on the system to run basic services.
- The user interface involved simply typing an appropriate command following the prompt in the proper syntax and pressing Enter.



# DOS Boot Sequence and Files

---

- It includes three core programs that are required to make a drive or floppy disk bootable and load the operating system into memory:
  - IO.SYS. The interface between the hardware and the operating system code
  - MSDOS.SYS. The main operating system code
  - COMMAND.COM. The interface between the user and the operating system code.



## DOS Boot Sequence and Files (contd.)

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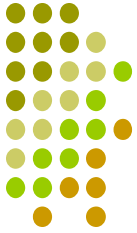
- Three files can be seen as layers, each taking an area of responsibility.
- IO.SYS can be considered the lowest layer, acting as an intermediary between the various hardware components and the software environment



## DOS Boot Sequence and Files (contd.)

---

- ❑ MSDOS.SYS is the middle layer. It not only provides key logic but also basic commands for opening and closing files, navigating the file system, and other common tasks.
- ❑ COMMAND.COM provides support for the operating system's direct interaction with the user, accepting commands and performing the necessary steps for execution.



# DOS Boot Sequence and Files

---

- ❑ These three core files would make a system operational.
- ❑ MS-DOS used two optional startup files to process custom commands required by the user, hardware devices, or applications.
- ❑ These files were the following:
  - CONFIG.SYS. Loads extra hardware and device drivers not built into IO.SYS
  - AUTOEXEC.BAT. Loads TSR programs selected by the user and sets up environment variables such as TEMP and PATH

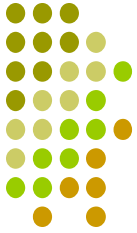




## DOS Boot Sequence and Files (contd.)

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- ❑ When power is first applied to the system, the computer performs the POST, a series of self-checks stored in permanent read-only memory.
- ❑ The ROM BIOS (read-only memory basic input/output system) on the motherboard looks for an operating system.
- ❑ It checks for the presence of IO.SYS and MSDOS.SYS.
- ❑ The locations to be checked are defined in the CMOS



## DOS Boot Sequence and Files (contd.)

---

- ❑ Operating system processes the CONFIG.SYS file to configure the system environment, including special memory management overlays and hardware drivers.
- ❑ COMMAND.COM is loaded
- ❑ Operating system processes the AUTOEXEC.BAT file (if present).
- ❑ AUTOEXEC.BAT loads programs and user-defined settings.
- ❑ It presents the active-drive prompt and waits for a command.



# The DOS File System

---

- ❑ The file was the primary unit of data storage on the computer.
- ❑ Files were organized into directories.
- ❑ File and directory names were up to eight characters long and files could have a three-letter extension following a period.
- ❑ Names were not case-sensitive.



# The DOS File System (contd.)

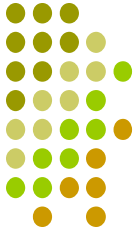
<b>Extension</b>	<b>File Type</b>	<b>Used For/Meaning</b>
.exe	Program/application files	Executable files
.com	Program files	Command files
.sys	System files	To define and configure options
.bat	Batch files	A text file that can be run to execute a series of commands or launch programs.



# The DOS File System (contd.)

---

<b>Extension</b>	<b>File Type</b>	<b>Used For/Meaning</b>
.txt	Text files	Plain ASCII (American Standard Code for Information Interchange) data
.doc	Document files	Word processing file text with formatting.
.drv	Driver files	Software that configures a hardware device.



# The Evolution of Microsoft Windows

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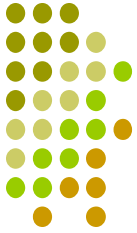
- ❑ Microsoft Windows (through Windows 3.x) was not complete operating systems, but operating environments which used MS-DOS as a foundation.
- ❑ Windows Version 1.0 was released in 1985.
- ❑ Windows Version 2.0 was released in 1987.
- ❑ Windows 3.1 in 1992 became popular operating environment.
- ❑ 16-bit version of Windows was Windows 3.11, released in the fall of 1993.



## The Evolution of Microsoft Windows (contd.)

---

- ❑ Windows 95 was released as a full-fledged 32-bit operating system.
- ❑ The applications written to meet current Windows standards provide a common user interface, including the following components:
  - The menu system offers the same basic commands for file, print, copy, and save operations.
  - Selecting text or objects with the pointing device or keystroke commands is done in a consistent manner.



# The Evolution of Microsoft Windows (contd.)

---

- Clicking and dragging mouse functions are the same.
- The sides of most application areas provide scroll bars for displaying text and graphics not currently visible in the window
- Windows can be overlapped and resized to make the best use of the screen area.

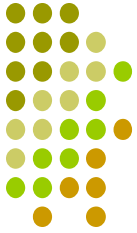




# The Evolution of Microsoft Windows (contd.)

---

- Data can be cut and pasted among applications, and data held in one file can be accessed and used by another program.
- It allows the user to have more than one application open and switch among them



# Operating Modes

---

- Early operating systems were designed for 8088 processors.
- With 80286 processors, the CPU was able to address more than 1 MB of RAM which allowed development of windows to operate the CPU in several modes to make use of the memory.



# Operating Modes (contd.)

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- The different operating modes are:
  - Real mode
  - Standard mode
  - Widows Runtime Version
  - 386 Enhanced mode



# Real Mode

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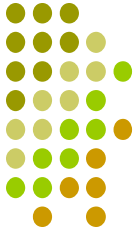
- ❑ Early Windows were designed only for starting programs and managing files while operating within the MS-DOS limit of 1 MB of RAM.
- ❑ A MS-DOS mode of 1MB is called real mode.
- ❑ Some MS-DOS applications and hardware still require the use of real mode.



## Standard Mode

---

- ❑ Windows 2.0 made use of the 286-level protected mode of operation.
- ❑ In Protected mode Windows could address up to 16 MB of RAM
- ❑ In standard mode windows takes control of many of the hardware functions.
- ❑ It eliminated the need for programs to write the code directly to control devices since windows could handle the hardware functions.



# Windows Runtime Version

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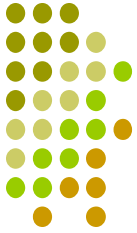
- Runtime Version of Windows allowed applications like Aldus PageMaker which provided Windows environment to run on a computer that did not have the full version of Windows installed.



## 386 Enhanced Mode

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- With Intel 80386 CPU, the 386 protected mode allowed addressing up to 4 gigabytes (GB) of memory
- It supported virtual memory, and allowed multiple MS-DOS programs to run simultaneously.



# Windows Resource Management

---

- ❑ Windows is a resource manager.
- ❑ It manages resources include memory, video, serial ports, and sound.
- ❑ It communicates between a device and the operating system through device drivers.
- ❑ Applications requiring access to resource called standardized subroutines called the application programming interface (API).

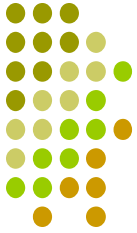




## Windows Resource Management (contd.)

---

- ❑ A program loads a small piece called a stub in conventional memory.
  - ❑ It makes a request to the operating system for RAM (usually through a file named KRNL386.EXE), which then allocates the amount of RAM as long as it is available.
  - ❑ It is known as segment.
  - ❑ Windows provides more memory by creating a special file (called a swap file) on the hard disk drive to act as a "virtual" RAM chip.
  - ❑ It is known as virtual memory.
-



## Windows for Workgroups 3.11

---

- ❑ Windows for Workgroups was an upgrade to Windows 3.1.
- ❑ It has few enhancements, such as better networking capabilities for sharing files and printers.
- ❑ It also includes two utility programs: Schedule+ and Mail Service.



# Windows 95, Windows 98, and Windows Me

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- ❑ Windows 95 supports Plug and Play technology, which allows the operating system to detect new hardware automatically.
- ❑ Windows Me offers improved reliability and recovery, enhanced Plug and Play support, and extended multimedia capability.



# Windows NT

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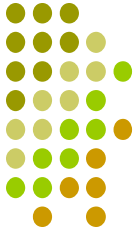
- ❑ In 1993 Microsoft released Windows NT.
- ❑ It was aimed primarily at the professional scientific, engineering, and design markets.
- ❑ Windows NT provides three levels of operating systems
  - Workstation. A powerful, robust operating system with limited networking to allow the user to share printers and files.



## Windows NT (contd.)

---

- ❑ Server. A complete LAN (local area network) host with a variety of sophisticated features for managing users and access to printers, files.
- ❑ Advanced Server. The enterprise edition includes all the tools in the Server edition, as well as additional tools for complex network environments.



# Windows 2000

---

- ❑ It is the replacement for Windows NT, adding Plug and Play support, better multimedia tools, and advanced Internet support.
  
- ❑ It comes in four versions
  - Windows 2000 Professional
  - Windows 2000 Server
  - Windows 2000 Advanced Server
  - Windows 2000 Datacenter Server

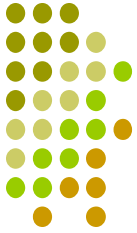


# The Command Prompt and DOS Mode Operations

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## □ The COMMAND Command

- Like UNIX dos has a command-line or text-based user interface.
- The user has to memorize and type commands.
- It eliminates the need for 32-bit drivers and high memory management.
- It an excellent tool when troubleshooting an ailing PC



# The COMMAND Command

---

- ❑ The command mem is used to see the memory usage of the current system configuration.
- ❑ Type the command mem to see the output of it.
- ❑ The appearance and information presented by the command prompt can be modified in several ways to meet your personal preferences and needs.





# The COMMAND Command (contd.)

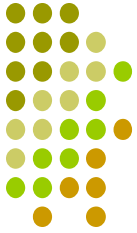
```
C:\D:\WINNT\System32\command.com

C:\>mem

      655360 bytes total conventional memory
      655360 bytes available to MS-DOS
      630048 largest executable program size

     1048576 bytes total contiguous extended memory
           0 bytes available contiguous extended memory
      941056 bytes available XMS memory
           MS-DOS resident in High Memory Area

C:\>_
```



# Working with the Prompt

- Type the command PROMPT /? or HELP PROMPT and press enter.
- The output of the command is displayed as follows:
  - C:\>help prompt
    - Changes the command prompt.
    - PROMPT [text]
    - text Specifies a new command prompt.
    - Prompt can be made up of normal characters and the following special codes:
      - \$D Current date
      - \$G > (greater-than sign)
      - \$N Current drive
      - \$P Current drive and path
      - \$S (space)
      - \$T Current time
    - Press any key to continue . . .



# Internal and External Commands

---

- ❑ External commands are programs that exist as separate files.
- ❑ To execute the command the system should know the complete path to its location.
- ❑ The internal commands are built into the operating system such as DIR, COPY, etc...
- ❑ The following table lists examples of commonly used internal MS-DOS commands:



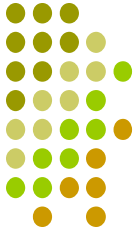
# Internal Dos Commands

Command	Function
CHDIR or CD	Changes the directory
CHKDSK	Examines the file allocation table (FAT) and directory structure on a drive, checking for errors and inconsistencies
CLS	Clears the screen
COPY	Copies files or disks
DATE	Changes the system date
DEL	Deletes files
DIR	Lists a directory of files



# Internal Dos Commands (contd.)

Command	Function
DIR /P	Views directories one page at a time
DIR /W	Displays wide format in columns
DIR /W /P	Displays large directories in columns one page at a time
DISKCOMP	Compares two disks
MKDIR or MD	Makes a directory.
PROMPT	Changes the appearance of the cursor.
RENAME or REN	Renames a file



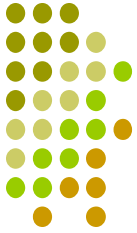
# Internal Dos Commands (contd.)

Command	Function
RMDIR or RD	Deletes a directory if the directory is empty.
TIME	Changes the system time
TYPE	Displays (types) a text file.
VER	Displays the version of MS-DOS in use



# External Dos Commands

Command	Function
DISKCOPY	Makes a copy of a complete disk. Requires that both the source and the destination disk have the same format.
EDIT	Invokes the text editor program
FORMAT	Prepares a disk for receiving files. It places a root directory on the disk.
FORMAT /S	Formats a disk as a system disk.
UNDELETE	Recovers a deleted file if the disk has not been modified since the file was deleted.
XCOPY	Copies the contents of one disk to another disk. Does not require both disks to have the same format.



# DOS Mode Navigation and File Management

---

- ❑ DOS file system uses a tree structure for its directories, which is based on a concept of root and branches.
- ❑ The primary volume on a drive is called the root.
- ❑ Directory contain files and directories which is called branch
- ❑ The root directory does not have a name.
- ❑ It is represented by a backslash (\).
- ❑ The following table represents important terms.

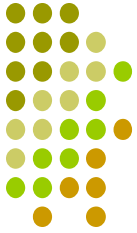




# DOS Mode Navigation and File Management

(contd.)

<b>Term</b>	<b>Description</b>
Backslash (\)	It is used to separate each directory level
Cursor	It indicates the place where the next character will be inserted
Case sensitivity	MS-DOS commands are not case-sensitive.
Default drive	The default drive is the active drive. The current default drive is indicated by the MS-DOS prompt
Directory	They are locations for storing files. Every disk contains a main directory known as the root directory.
DOS prompt	It displays the active drive letter & is ready to accept the next command.



# DOS Mode Navigation and File Management

(contd.)

<b>Term</b>	<b>Description</b>
Drive pointers	DOS assigns letters to each drive during the boot process.
Entering commands	Type a command and press Enter to execute it
Error messages	Brief technical messages that are displayed when an error occurs.
Filenames	A filename is made up of three parts—a name of up to eight characters, a period, and an extension of up to three characters.



# DOS Mode Navigation and File Management

(contd.)

Term	Description
Greater than (>)	To indicate that a command can be redirected to an output device.
Path	The path consists of the drive name, the location of the file in the directory structure, and the filename
Prompt	User interface provided by COMMAND.COM to signal to the user that the computer is ready to receive input
Switches	It is used to invoke special functions



# DOS Mode Navigation and File Management

(contd.)

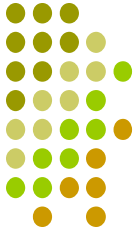
<b>Term</b>	<b>Description</b>
Syntax	It is the arrangement and interrelationship of words in phrases and sentences.
Wildcards	It is used to expand a search for a file. The question mark (?) matches any character in a specified position, and the asterisk (*) matches any number of characters up to the end of the filename or extension.



# Working with CONFIG.SYS and AUTOEXEC.BAT

---

- ❑ AUTOEXEC.BAT and CONFIG.SYS files are used during the boot process to execute commands and load legacy drivers in many versions of Windows.
- ❑ The following table lists several CONFIG.SYS settings and their functions.



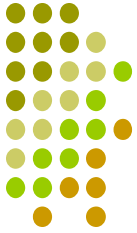
# CONFIG.SYS Commands

Setting	Function
BUFFERS	Allocates reserved memory for transferring information to and from the hard disk.
COUNTRY	Enables MS-DOS to use country conventions for times, dates, and currency
DEVICE	Loads a device driver into memory
DEVICEHIGH	Loads a device driver into upper memory
DOS	Loads part of MS-DOS into upper memory area



# CONFIG.SYS Commands (contd.)

Setting	Function
FCBS	Specifies the number of file control blocks (FCBs) that MS-DOS can have open at the same time.
FILES	Specifies the number of files that MS-DOS can hold open concurrently
INSTALL	Loads a memory-resident program
LASTDRIVE	Specifies the maximum number of drives the computer can access
MOUSE.SYS	Loads a mouse driver
NUMLOCK	Specifies whether the Num Lock key is on or off when MS-DOS starts



# CONFIG.SYS Commands (contd.)

Setting	Function
SHELL	Specifies the name and location of the command interpreter. The interpreter converts the typed command to an action. The default for MS-DOS is COMMAND.COM
SWITCHES	Specifies special options in MS-DOS. The /n switch will disable the use of the F5 and F8 keys to bypass startup commands (used for security).

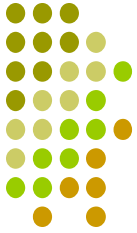




# AUTOEXEC.BAT Commands

- The following table lists several commands that are often used in an AUTOEXEC.BAT file.

Setting	Function
ECHO	Displays commands as they are executed.
PAUSE	Stops the execution of AUTOEXEC.BAT and displays the message "Strike any key to continue."
PATH	Defines the search path for program commands
SET	Displays, sets, or removes MS-DOS environment variables.
SMARTDRV	Provides disk caching



# AUTOEXEC.BAT Commands (contd.)

Setting	Function
KEYB	Configures a keyboard for a specific language
SHARE	Starts the Share program, which will install the file sharing and locking capabilities.
DOSKEY	Loads the DOSKEY program
MOUSE.EXE	Loads a mouse driver
PROMPT	Sets the display of the command prompt



# File System Basics

---

- ❑ A component of the operating system that acts as an interface with hardware storage devices, and organizes data on them in a form that can be used by the system and applications.
- ❑ There are several file systems on a modern PC.
- ❑ It defines file naming conventions, file size.



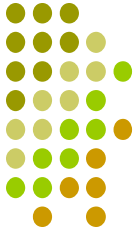
# Key Terms

<b>Term</b>	<b>Definition</b>
Block	A set of contiguous bits that make up a definable quantity of information on storage media.
Boot disk	A system device (usually a hard drive, floppy drive, or CD-ROM drive) that is used to start a computer.
Boot sector	The sector on a disk containing a small amount of information that defines the devices layout, identifies the file system, and allows the drive to be declared a boot device.
Cluster	The number of disk sectors that can be treated as a single object by the operating system.



# Key Terms (contd.)

Term	Definition
Dual boot	It is a system that has been configured so that it can operate using more than a single operating system or file system.
End-of-file (EOF) marker	This is the last bit of information contained in the file.
Encryption	A method of encoding data, in a form that can be read only by using the decoding mechanism.
File	Data collected and stored as a single unit on some form of mass storage medium.
FAT	The linked list system used to track disk space currently in use.



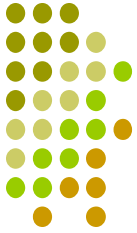
# Key Terms (contd.)

<b>Term</b>	<b>Definition</b>
File format	The way the file content is formatted for individual files within a file system.
File handle	An integer value set by the file system to denote an open file.
File locking	A feature in a network file system that allows an individual file to be locked so that two instances cannot be open for modification at the same time.
Filename	The identifier used to label the individual file for use by the operating system or user.



# Key Terms (contd.)

<b>Term</b>	<b>Definition</b>
Folder	The equivalent of a directory that is used to hold a collection of files in the Windows file system.
Format	Preparing a disk for use by a file system.
Low-level format	It is used to prepare the media for partitioning and high-level formatting by a file system. It is performed using firmware or software provided by the drive or disk controller manufacturer.
Master boot record	A specific sector on the first partition of the drive containing executable code and information about the operation of the start process for a given operating system.



# Key Terms (contd.)

<b>Term</b>	<b>Definition</b>
Partition table	Indicates the logical structure (partitions) of a hard disk. The partition table is kept in the same location as the master boot record.
Primary partition	The key partition on a hard disk. This volume is usually designated the C drive.
Sector	The smallest storage unit on a disk.
Track	A series of sectors residing on a disk and arranged so that they lie at the same horizontal distance from the center of the disk.
Volume	A physical or virtual drive designated on a storage system.

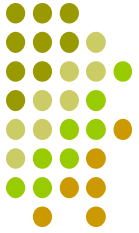




# Comparing and Choosing File Systems

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- ❑ Windows 95, Windows 98, Windows Me, Windows NT, and Windows 2000 offer choosing a file system.
- ❑ The actual choice of which file system to use can involve several factors, as follows:
  - Is the computer's storage system to be dedicated to a single operating environment, or will the machine be used for two or more operating systems?
  - How many hard drives will be installed on the system?



## Comparing and Choosing File Systems (contd.)

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- ❑ What are the sizes of the drives to be used on the system?
- ❑ How large are the expected partitions on the hard drives?
- ❑ Will the user need to make use of any legacy applications that will not support one of the newer file systems?



## Comparing and Choosing File Systems (contd.)

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- Is the owner interested in using advanced file system features only offered on newer file systems?
- Are there security considerations that require the use of a file system that provides additional controls over access to directories and files?



# FAT-Based File Systems

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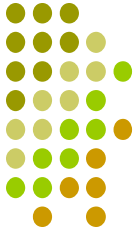
- FAT file system was developed for floppy disks.
- There are three basic varieties of the FAT file system
  - FAT12
  - FAT16
  - FAT32



# FAT16 and FAT32 Compared and Contrasted

The following table compares the various features of FAT16 with FAT32

<b>FAT16</b>	<b>FAT32</b>
It is supported by all versions of DOS, Windows 95, Windows 98, Windows NT, Windows 2000 and several versions of Unix.	It is supported by Windows 95 OSR2 (Operating System Release 2) and Windows 98 and Windows 2000
Bootable floppy can be used to boot a problem system and access all files	Cannot use a DOS or Windows 95 (other than OSR2) disk to boot and access files
It offers performance advantages on volume smaller than 250 MB.	FAT32 allocates disk space more efficiently. It often allows storing of more data compared to FAT16.



# FAT16 and FAT32 Compared and Contrasted

(contd.)

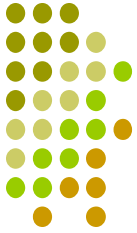
<b>FAT16</b>	<b>FAT32</b>
If the original becomes corrupted. The backup copy of the FAT has to be restored manually	It automatically employ a backup copy of a volume's FAT if the master copy becomes corrupt.
If the boot sector becomes corrupt, all data on the volume may be lost.	Provides automatic backup of the boot sector, providing a way to possibly recover the volume in the event of a boot sector failure.
Individual volume size cannot exceed 2 GB	Supports drives up to 2 terabytes (TB) in size; largest volume size is 32 GB.



# FAT16 and FAT32 Compared and Contrasted

(contd.)

<b>FAT16</b>	<b>FAT32</b>
Since it has larger cluster size which results in slower load times for applications and large data files	Smaller cluster size can result in faster load times for applications and large data files.
Dual boot of DOS and Windows, Windows NT, and Windows 98 is possible with FAT16	Dual boot with non-FAT32-supported operating systems is not supported
FAT16 is limited in the length of file names to the 8.3 convention	FAT32 supports long filenames of up to 255 characters



# The NTFS File System

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- ❑ It supports long filenames and the use of spaces in names
- ❑ NTFS is optimized for multiuser environments and provides an extra level of file security.
- ❑ The following lists detail the advantages and disadvantages of the NTFS file system.

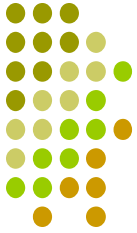




# Advantages

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- ❑ NTFS supports very large volumes up to 2 TB in size.
- ❑ It maintains a log that can be used to recover and repair a volume's content in the event of a system failure.
- ❑ The root folder volume can hold an unlimited number of files.



## Advantages (contd.)

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- It employs a B-tree file structure resulting in faster file access. B-tree data structures are often used in database applications, allowing the system to quickly trace a record or file using a branching algorithm.
- The advanced compression systems available on NTFS volumes allow users to compact individual files and folders and still read them while they are compressed.



## Advantages (contd.)

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- It allows to set security levels for individual users, groups of users, or all users on the system.
- An administrator can set disk quotas limiting the amount of space that an individual user can use for personal files.



# Disadvantages

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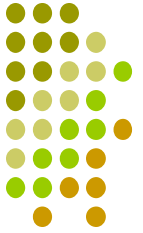
- ❑ It is not directly accessible under MS-DOS, Windows 95, or Windows 98.
- ❑ It cannot be used as a primary partition for dual boot system configurations with those operating systems.
- ❑ Partition less than 400 MB that consist mainly of small files, the additional overhead required for NTFS features may result in slower performance.



# File System Size Limitations

- The following table shows the supported volume size and default cluster size for the various operating systems.

<b>Volume Range</b>	<b>FAT16</b>	<b>FAT32</b>	<b>NTFS</b>
7 MB–16 MB	2 KB	Not supported	512 bytes
17 MB–32 MB	512 bytes	Not supported	512 bytes
33 MB–64 MB	1 KB	512 bytes	512 bytes
65 MB–128 MB	2 KB	1 KB	512 bytes



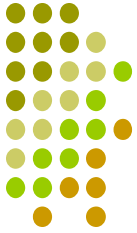
# File System Size Limitations (contd.)

<b>Volume Range</b>	<b>FAT16</b>	<b>FAT32</b>	<b>NTFS</b>
129 MB–256 MB	4 KB	4 KB	512 bytes
257 MB–512 MB	8 KB	4 KB	512 bytes
513 MB–1024 MB	16 KB	4 KB	4 KB
1025 MB–2 GB	32 KB	4 KB	4 KB
2 GB–4 GB	Not supported	4 KB	4 KB
4 GB–8 GB	Not supported	4 KB	4 KB



# File System Size Limitations (contd.)

<b>Volume Range</b>	<b>FAT16</b>	<b>FAT32</b>	<b>NTFS</b>
8 GB–16 GB	Not supported	8 KB	4 KB
16 GB–32 GB	Not supported	16 KB	4 KB
32 GB–2 TB	Not supported	Not supported	4 KB



# File System Security

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- ❑ NTFS offers significant security advantages.
- ❑ FAT offers the advantage of less overhead plus greater OS compatibility.
- ❑ File Attributes on FAT File Systems
  - A set of attributes provides a method to prevent overwriting files to hide files from being shown.

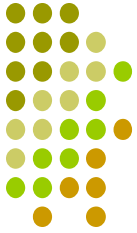




# File Attributes on FAT File Systems

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- ❑ To denote if a file has been backed up.
- ❑ File attributes can be set by using the attribute command.
- ❑ In Windows, it can be obtained by right-clicking a file and choosing the Properties option from the shortcut menu.
- ❑ The attribute command in DOS mode:
  - ❑ ATTRIB [+R | -R] [+A | -A ] [+S | -S] [+H | -H]  
[[drive:] [path] filename] [/D]]



# NTFS File and Folder Security

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- ❑ It uses permissions to control access to files and folders contained within the file system.
- ❑ The permissions apply to both local users and anyone accessing the system over the network.
- ❑ The various permissions are Full-control, Modify, Read and Execute, Read and Write.
- ❑ Advanced Permissions such as delete subfolders, create files within a folder, modify permissions, and take ownership

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