

Chapter 14

MS-DOS Operating System

At a Glance

Instructor's Manual Table of Contents

- Overview
- Objectives
- Teaching Tips
- Quick Quizzes
- Class Discussion Topics
- Additional Projects
- Additional Resources
- Key Terms

Lecture Notes

Overview

MS-DOS, also known simply as DOS, was developed to run single-user, stand-alone desktop computers. When the personal computer market exploded in the 1980s, MS-DOS was the standard operating system delivered with millions of these machines. In many ways, MS-DOS exemplifies early operating systems because it manages jobs sequentially from a single user.

This chapter explores the MS-DOS operating system. It begins by presenting its history and design goals. The chapter then explains how MS-DOS provided a foundation for early Microsoft Windows releases. Memory management, processor management, device management, and file management in MS-DOS operating systems are discussed. The chapter concludes with an overview of MS-DOS user interfaces.

Learning Objectives

After completing this chapter, the student should be able to describe:

- How to access MS-DOS emulators from other operating systems
- How MS-DOS provided a foundation for early Microsoft Windows releases
- The basics of command-driven systems and how to construct simple batch files
- How one processor can be shared among multiple processes
- The limitations of MS-DOS

Teaching Tips

History

1. Provide students with a brief overview of the MS-DOS operating system, pointing out that it was developed to run single-user, stand-alone desktop computers. List its advantages and disadvantages.
2. Use Table 14.1 on page 435 to explain the evolution of MS-DOS.
3. Point out that each version of MS-DOS is a standard version, meaning that later versions are compatible with earlier versions. Note that early versions of Windows (versions 1.0 through 3.1) were merely GUIs that ran on top of the MS-DOS operating system.

4. Point out that Windows operating systems continue to offer a DOS emulator. Explain and demonstrate the two ways to access this DOS emulator command prompt. For example, to open the command prompt in the Windows operating system:
 - a. Go through the Start menu: click Start, All Programs, Accessories, and then click on Command Prompt or;
 - b. In the run box type: cmd.
5. Illustrate the DOS command prompt with Figure 14.1 on page 436.

Teaching Tip	The history of MS-DOS is important. With its widespread adoption of software products such as WordPerfect and Lotus 1-2-3, MS-DOS helped novice users appreciate the power of a personal computer and spurred the growth of the industry.
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Teaching Tip	For more information on IBM PC-DOS, access the Redbook titled “PC DOS 7 Technical Update” at www.ibm.com/redbooks . Search for “PC DOS” or Redbook number GG24-4459-00.
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Design Goals

1. Provide students with a brief overview of the design goals of the MS-DOS operating system. Emphasize that this operating system was designed to accommodate a single novice user in a single-process environment.
2. Use Figure 14.2 on page 436 to illustrate the design goals pictorially.
3. Discuss the roles of standard I/O support, user commands, and the command processor. Note that examples of commands are provided in Appendix A in the text.
4. Discuss the layering approach and its significance to the design of the whole MS-DOS system.
5. Explain the three layers including their functions. The three layers include the BIOS (Basic Input/Output System), the DOS kernel, and the command processor (shell).
6. Explain the job of the command processor and its inherent weakness (it is not interpretative).
7. Note the advancements that DOS Version 4 introduced. Explain the impact of later DOS versions and IBM’s OS/2.

Teaching Tip	The layering approach is fundamental in the MS-DOS design. It allows for “protection” of the user from the detailed bits and bytes of the bare machine known as the hardware layer.
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Memory Management

1. Provide students with a brief overview of memory management in the MS-DOS operating system. Mention that to run a second job, the user must close or pause the first file before opening the second.
2. Point out that the Memory Manager uses a first-fit memory allocation scheme in early DOS versions because it is the most efficient strategy in a single-user environment.
3. Discuss briefly the two forms of main memory, ROM and RAM. Use Figure 14.3 on page 439 to explain RAM main memory in MS-DOS. Make sure students understand the significance of resident and transient parts of COMMAND.COM.

Teaching Tip	Refer to the following Web site for an overview of memory-management functionality in MS-DOS: http://support.microsoft.com/kb/q95555/
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Main Memory Allocation

1. Provide students with an overview of main memory allocation in different versions of MS-DOS. Point out that Version 1.0 of MS-DOS gave all available memory to the resident application program, whereas with Version 2.0, MS-DOS began supporting dynamic allocation, modification, and release of main memory blocks by application programs.
2. Discuss the two factors that determine the amount of memory each application program actually owns.
3. Point out that programs with the COM extension are given all of the Transient Program Area (TPA) whether or not they need it, while programs with the EXE extension are only given the amount of memory they need.
4. Using examples such as those provided on page 440, explain that two programs cannot be run at the same time in MS-DOS.
5. Explain the task performed by a Memory Manager when a program that is already running needs more memory. Be sure to mention that the shrinking and expanding of memory allocation during execution can be done only from programs written in either assembly language or C.

Memory Block Allocation

1. Discuss briefly the memory block allocation schemes used in different versions of MS-DOS, including first-fit, best-fit, and last-fit.
2. Explain briefly the size of the block and the information contained in the first five bytes that define the block's structural characteristics. Use Tables 14.2 and 14.3 on page 441 as a guide.
3. Discuss the sequences of steps in MS-DOS when a request for memory comes in. Use Figure 14.4 on page 442 to demonstrate a free/busy block list.
4. Discuss the consequences of a broken list. Note the characteristics of well-designed and poorly designed programs in terms of memory block allocation. Explain how two contiguous free memory blocks are immediately merged into one block and linked to a list.

Processor Management

1. Explain that the Processor Manager has the relatively simple task of allocating the processor to the resident job when it is ready for execution.

Process Management

1. Provide students with an overview of process management in the MS-DOS operating system. Remind students that MS-DOS was designed for a single-user, single-task environment, and therefore does not support reentrant code, which is the basis for multitasking.
2. Explain that there is no interleaving in MS-DOS systems, so there is no need for sophisticated algorithms or policies to determine which job will run next or for how long.
3. Point out that in MS-DOS, each job runs in complete segments and is not interrupted midstream. Multitasking is an illusion handled by the synchronization of tasks using interrupt handlers.

Teaching Tip	Explain the illusion of multiprogramming in MS-DOS further. It allows a parent program to go to sleep while the child runs along on its own. These programs look and feel like multitasking operations because they retain their memory area and run executable programs, but they are not both in the running state at the same time. The synchronization between the parent and child tasks is handled through interrupt handlers.
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Interrupt Handlers

1. Provide students with a brief overview of interrupt handlers in MS-DOS. List three types of interrupts: internal hardware interrupts, external hardware interrupts, and software interrupts. Explain how these are created and whether or not they can be modified.
2. Discuss Terminate and Stay Resident (TSR) interrupt handlers and their utility. Provide examples of these interrupt handlers.
3. Discuss the tasks performed by the CPU when it encounters an interrupt. Point out that the CPU uses the eight-bit number placed on the system bus by the interrupting device to get the address of the appropriate interrupt handler.

Device Management

1. Provide students with an overview of device management in MS-DOS. Discuss various features such as the following: it handles requests on a first-come, first-served basis; it does not support reordering requests; etc.
2. Give a background of the type of simple device system for which MS-DOS was written.
3. Explain why device drivers are the only items needed by the Device Manager to make the system work in MS-DOS.
4. Explain BIOS, which is the portion of the Device Manager that handles the device driver software.
5. Discuss briefly the fact that installable device drivers are a salient feature of MS-DOS design.

Quick Quiz 1

1. Which of the following contains the routines needed to interface with disk drives?
 - a. BIOS
 - b. DOS Kernel
 - c. Resident part of COMMAND.COM
 - d. Transient part of COMMAND.COM

Answer: b

2. Which of the following correctly describes the main memory allocation in MS-DOS? (Choose all that apply.)
 - a. Programs with the COM extension are given all of the TPA, whether or not they need it.
 - b. Programs with the EXE extension are given all of the TPA, whether or not they need it.
 - c. Two programs cannot be run at the same time.
 - d. The amount of memory each application program actually owns does not depend on the size of the TPA.

Answer: a and c

3. (True or False) Device channels are not a part of MS-DOS.

Answer: True

File Management

1. List different file organization schemes supported in MS-DOS. Point out that although sequential files can have either variable-length or fixed-length records, direct and indexed sequential files can only have fixed-length records.

Filename Conventions

1. Using examples as provided on pages 445 and 446, explain the filename conventions used in MS-DOS. Make sure students clearly understand the difference between the relative name and absolute name of a file, and when each is used.
2. Be sure to point out that DOS is not case sensitive, so filenames and commands can be entered in uppercase, lowercase, or a combination of both.

Managing Files

1. Provide students with a brief overview of how files are managed in the MS-DOS operating system. Point out that the earliest versions of MS-DOS kept every file in a single directory, which makes the file retrieval process slow and cumbersome. Microsoft implemented a hierarchical directory structure in Version 2.0: an inverted tree directory structure with the root at the top of the tree.
2. Discuss the concepts of formatting into 512-byte sectors, cylinders, and clusters in the MS-DOS operating system.
3. Discuss briefly three special areas that a FORMAT command creates on the disk, such as the boot record, the root directory, and the FAT (file allocation table). Outline the information contained in each of these areas.
4. Use the examples shown in Figure 14.5 and Figure 14.6 on page 448 to illustrate these concepts.
5. Discuss the utility of the AUTOEXEC.BAT file.

6. Point out that for each file, the directory includes the first sector/cluster location in the File Allocation Table so it can be accessed quickly. The FAT links every sector for each file.
7. Use the example shown in Figure 14.7 on page 449 to illustrate these concepts pictorially.
8. Discuss several other features of file management, such as how MS-DOS looks at data in a disk file as a continuous string of bytes, supports noncontiguous file storage, and dynamically allocates disk space to a file. Point out that compaction became a feature of MS-DOS Version 6.0 with the inclusion of DEFRAG.EXE. Discuss the use of the CHKDSK command.
9. Point out that security features are not built into MS-DOS, and that data is kept secure by keeping the computer physically locked up or by removing the disks and keeping them in a safe place.

Teaching Tip	Refer to the following Web site for an overview of directory and subdirectory limitations in MS-DOS: http://support.microsoft.com/default.aspx?scid=kb;en-us;39927
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Teaching Tip	Refer to the following Web site for more information on the AUTOEXEC.BAT file: www.computerhope.com/ac.htm
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User Interface

1. Explain briefly the user interface in MS-DOS, which is a command-driven interface. Use Table 14.4 on page 450 to explain some of the most common commands. Point out that user commands include some or all of the following elements, in this order: command, source-file, destination-file, and switches.
2. Discuss briefly COMMAND.COM, including its resident part and transient part.

Teaching Tip	Refer to the following Web site for a detailed list of MS-DOS commands, including their syntax and use: www.computerhope.com/overview.htm
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Batch Files

1. Explain that by creating customized batch files, users can quickly execute combinations of DOS commands to configure their systems, perform routine tasks, or make it easier for nontechnical users to run software.
2. Discuss the use of the autoexec.bat file.
3. Use Figure 14.8 on page 452 to illustrate the running and contents of a batch file.

Redirection

1. Explain, using examples, the redirection command, which is used to redirect output from one standard input or output device to another. Point out that redirection works in the opposite manner as well. Discuss the “append” command.

Filters

1. Explain, using examples, various filter commands, such as SORT and MORE. Provide different examples to illustrate the use of the SORT command to arrange files in ascending order (numerically or alphabetically), in reverse order, or to sort the files by column.

Pipes

1. Explain, using examples, the pipe command. Point out, using examples, that it is possible to combine pipes and other filters.

Additional Commands

1. Describe, using examples, three additional commands often used in MS-DOS: FIND, PRINT, and TREE. Be sure to point out that these are “traditional” MS-DOS commands, and some of the switches or options used with these commands might not work in Windows DOS-like emulators.
2. Use Figure 14.9 on page 455 to illustrate the TREE command.

Quick Quiz 2

1. Which of the following commands sends a directory listing to the printer?
 - a. PRN > DIR
 - b. PRN < DIR
 - c. DIR > PRN
 - d. DIR < PRN

Answer: c

2. Which of the following commands causes the standard output from one command to be used as standard input to another command?
 - a. Filters
 - b. Pipes
 - c. Redirection
 - d. TreeAnswer: b

3. The _____ contains status information about the disk's sectors: which are allocated, which are free, and which can't be allocated because of formatting errors.
Answer: File Allocation Table (FAT)

Class Discussion Topics

1. Inquire as to how many students have worked with MS-DOS in the past, and how they felt about the experience. What were some of the challenges that they faced in attempting to write batch files? Do they still use MS-DOS? If yes, for what purpose?
2. Have students discuss memory and file management in MS-DOS operating systems. Ask them to compile a list of their strengths and weaknesses in comparison to those in today's commonly used operating systems.

Additional Projects

1. Have students research online to find new or enhanced features in MS-DOS 6.22. Ask them to discuss briefly the advantages of these enhanced features.
2. Have students research how to make the mouse functional in MS-DOS.

Additional Resources

1. Microsoft.com (Search for MS-DOS):
www.microsoft.com
2. Download MS-DOS 6.2 Step-up Files:
www.microsoft.com/downloads/details.aspx?familyid=96CC3197-B7E5-4B31-BADB-DDAAC771295F&displaylang=en
3. IBM (Search for PC DOS or PC-DOS):
www.ibm.com
4. Computerhope.com:
www.computerhope.com/msdos.htm

5. Computer History Museum (software timeline):
www.computerhistory.org/timeline/?category=sl
6. FreeDOS Project (FreeDOS aims to be a complete, free, 100% MS-DOS compatible operating system):
www.freedos.org

Key Terms

- **Batch file:** a file that includes a series of commands that are executed in sequence without any input from the user. Contrasts with an interactive session.
- **BIOS:** an acronym for basic input output system, a set of programs that are hardcoded on a chip to load into ROM at startup.
- **Bootstrapping:** the process of starting an inactive computer by using a small initialization program to load other programs.
- **Command-driven interface:** an interface that accepts typed commands, one line at a time, from the user. It contrasts with a menu-driven interface.
- **Compaction:** the process of collecting fragments of available memory space into contiguous blocks by moving programs and data in a computer's memory or secondary storage.
- **Device driver:** a device-specific program module that handles the interrupts and controls a particular type of device.
- **Extension:** the part of the filename that indicates which compiler or software package is needed to run the files.
- **File allocation table (FAT):** the table used to track segments of a file.
- **Filter command:** a command that directs input from a device or file, changes it, and then sends the result to a printer or display.
- **First-fit memory allocation:** a main memory allocation scheme that searches from the beginning of the free block list and selects for allocation the first block of memory large enough to fulfill the request. It contrasts with best-fit memory allocation.
- **Interrupt handler:** the program that controls what action should be taken by the operating system when a sequence of events is interrupted.
- **Multitasking:** a synonym for multiprogramming, a technique that allows a single processor to process several programs residing simultaneously in main memory and interleaving their execution by overlapping I/O requests with CPU requests.
- **Path:** the sequence of directories and subdirectories the operating system must follow to find a specific file.
- **Pipe:** a symbol that directs the operating system to divert the output of one command so it becomes the input of another command. In MS-DOS, the pipe symbol is |.
- **Redirection:** an instruction that directs the operating system to send the results of a command to or from a file or other device other than a keyboard or monitor. In MS-DOS, the redirection symbols are < and >.
- **System prompt:** the signal from the operating system that it is ready to accept a user's command, such as C:\> or C:\Documents>.
- **Working directory:** the directory or subdirectory that is currently the one being used the home directory.