7.7 SUMMARY

- An operating system is an interface between the hardware of a computer and the user that facilitates the execution of programs and access to hardware and software resources. Two major design goals of an operating system are efficient use of hardware and ease of use of resources.
- Operating systems have gone through a long history of evolution: batch systems, time-sharing systems, personal systems, parallel systems, and distributed systems.
- A modern operating system has at least four functional areas: memory manager, process manager, device manager, and file manager. An operating system also provides a user interface.
- The first responsibility of a modern computer system is memory management. Memory allocation must be controlled by the operating system. Memory management techniques can be divided into two categories: monoprocessing and multiprogramming. In monoprocessing, most of the memory capacity is dedicated to one single program. In multiprogramming, more than one program can be in memory at the same time.
- The second responsibility of an operating system is process management. A process is a program in execution. The process manager uses schedulers and queues to manage processes. Process management involves synchronizing different processes with different resources. This may potentially create resource deadlock or starvation. Deadlock occurs when the operating system does not put resource restrictions on processes; starvation can happen when the operating system puts too many resource restrictions on a process.
- The third responsibility of an operating system is device or input/output management. There are limitations on the number and speed of input/output devices in a computer system. Because these devices are much slower compared with the CPU and memory, when a process accesses an input/output device, it is not available to other processes. The device manager is responsible for the efficient use of input/output devices.
- The fourth responsibility of an operating system is file management. An operating system uses a file manager to control access to files. Access is permitted only by processes or users that are allowed access to specific files, and the type of access can vary.
- Two common operating systems with some similarities are UNIX and Linux. UNIX is a multiuser, multiprocessing, portable operating system made up from four parts: the kernel, the shell, a standard set of utilities, and application programs. Linux has three components: a kernel, system utilities, and a system library.
- A popular family of operating systems from Microsoft is referred to as Windows NT. Windows NT is an object-oriented, multi-layer operating system. It uses several layers, including a hardware abstract layer (HAL), executive layer, and an environment subsystem layer.

7.8 PRACTICE SET

Review questions
1. What is the difference between an application program and an operating system?
2. What are the components of an operating system?
3. What is the difference between monoprocessing and multiprogramming?
4. How is paging different from partitioning?
5. How is demand paging more efficient than regular paging?
6. How is a program related to a job? How is a job related to a process? How is a program related to a process?
7. Where does a program reside? Where does a job reside? Where does a process reside?
8. What is the difference between a job scheduler and a process scheduler?
9. Why does an operating system need queues?
10. How does deadlock differ from starvation?
Exercises

1. The deadlock occurs when a process requests a resource, which is currently locked by another process. This situation is known as deadlock.

2. The process becomes a process only when it requests access to the CPU.

3. If the requested I/O operation is successful, the process returns to the ready state.

4. If the requested I/O operation is unsuccessful, the process returns to the blocked state.

5. The process remains in the ready state until it is selected by the operating system and executed.

6. If I/O is the only process executing, it cannot be preempted.

7. The process must be in the ready state to be selected by the operating system.

8. The process must be in the ready state to be selected by the operating system.

9. The process must be in the ready state to be selected by the operating system.

10. The process must be in the ready state to be selected by the operating system.

11. A process is multiprogrammed with swapping.

12. The process must be in the ready state to be selected by the operating system.

13. Multiprogramming requires a multiprogramming technique.

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30. A process is multiprogrammed with swapping.

31. A process is multiprogrammed with swapping.

Multiple-choice Questions

1. A process is selected by the operating system and executed.
2. Every process is a program occupying a contiguous space in memory.
3. Which multiple instructions are executed in memory?
   - a) parallel
   - b) sequential
   - c) concurrent
   - d) distributed

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31. A process is multiprogrammed with swapping.
25. The ______ scheduler creates a process from a job and changes a process back to a job.
   a) job
   b) process
   c) virtual
   d) queue

26. The ______ scheduler moves a process from one process state to another.
   a) job
   b) process
   c) virtual
   d) queue

27. To prevent ______, an operating system can put resource restrictions on processes.
   a) starvation
   b) synchronization
   c) paging
   d) deadlock

28. ______ can occur if a process has too many resource restrictions.
   a) Starvation
   b) Synchronization
   c) Paging
   d) Deadlock

29. The ______ manager is responsible for archiving and backup.
   a) memory
   b) process
   c) device
   d) file

30. The ______ manager is responsible for access to I/O devices.
    a) memory
    b) process
    c) device
    d) file

**Exercises**

31. A computer has a monoprogramming operating system. If the size of memory is 64 MB and the memory-resident part of the operating system needs 4 MB, what is the maximum size of program that can be run by this computer?

32. Redo Exercise 31 if the operating system automatically allocates 10 MB of memory to data.

33. A monoprogramming operating system runs programs that on average need 10 microseconds access to the CPU and 70 microseconds access to the I/O devices. What percentage of time is the CPU idle?

34. A multiprogramming operating system uses an apportioning scheme and divides the 60 MB of available memory into four partitions of 10 MB, 12 MB, 18 MB, and 20 MB. The first program to be run needs 17 MB and occupies the third partition. The second program needs 8 MB and occupies the first partition. The third program needs 10.5 MB and occupies the second partition. Finally, the fourth program needs 20 MB and occupies the fourth partition. What is the total memory used? What is the total memory wasted? What percentage of memory is wasted?

35. Redo Exercise 34 if all programs need 10 MB of memory.

36. A multiprogramming operating system uses paging. The available memory is 60 MB divided into 15 frames, each of 4 MB. The first program needs 13 MB. The second program needs 12 MB. The third program needs 27 MB.
   a) How many frames are used by the first program?
   b) How many frames are used by the second program?
   c) How many frames are used by the third program?
   d) How many frames are unused?
   e) What is the total memory wasted?
   f) What percentage of memory is wasted?

37. An operating system uses virtual memory but requires the whole program to be in physical memory during execution (no paging or segmentation). The size of physical memory is 100 MB. The size of virtual memory is 1 GB. How many programs of size 10 MB can be run concurrently by this operating system? How many of them can be in memory at any time? How many of them must be on disk?