Operating Systems

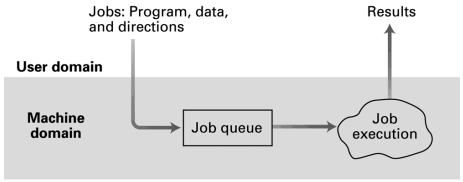
Chapter 4

Functions of Operating Systems

- Oversee operation of computer
- Store and retrieve files
- Schedule programs for execution
- Coordinate the execution of programs

- Provide an interface to the user to access machine functions

Evolution of Shared Computing

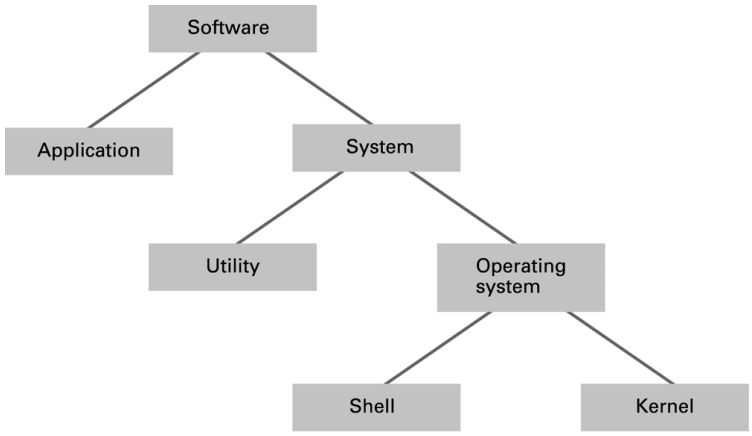


- Manual jobs
- Batch processing
- Interactive processing
  - Requires real-time processing
- Time-sharing/Multitasking
  - Implemented by Multiprogramming
- Multiprocessor machines

Types of Software

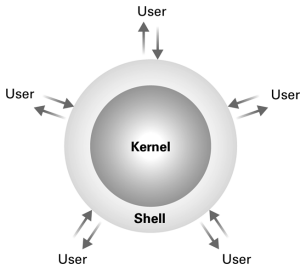
- Application software
  - Performs specific tasks for users
- System software
  - Provides infrastructure for application software
  - Consists of operating system and utility software

Software classification



Operating System Components

- **Shell:** Communicates with users
  - Text based
  - Graphical user interface (GUI)
- **Kernel:** Performs basic required functions
  - File manager
    - Where files are on the disk, clusters
  - Device drivers
    - Interface with physical devices
  - Memory manager
  - Scheduler and dispatcher



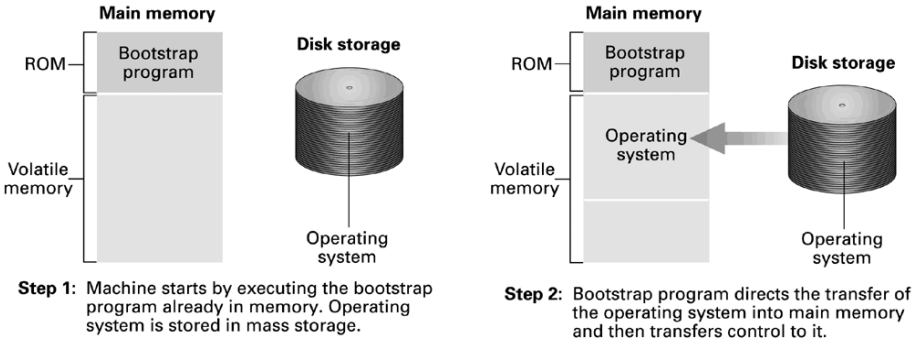
Memory Manager

- Allocates space in main memory
- May create the illusion that the machine has more memory than it actually does (**virtual memory**) by playing a "shell game" in which blocks of data (**pages**) are shifted back and forth between main memory and mass storage

Getting it Started (Bootstrapping)

- **Bootstrap:** Program in ROM (example of firmware)
  - Run by the CPU when power is turned on
  - Transfers operating system from mass storage to main memory
  - Executes jump to operating system

The booting process



BIOS – Basic I/O System – software utilities for fundamental I/O activities stored on the ROM along with the bootstrap program

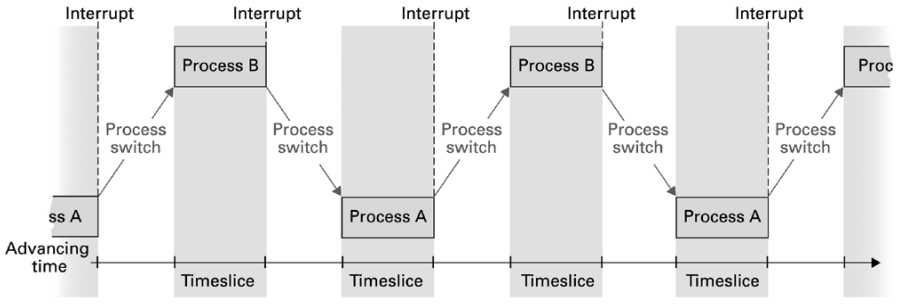
Processes

- **Process:** The activity of executing a program
- **Process State:** Current status of the activity
  - Program counter
  - General purpose registers
  - Related portion of main memory

Process Administration

- **Scheduler:** Adds new processes to the process table and removes completed processes from the process table
- **Dispatcher:** Controls the allocation of time slices to the processes in the process table
  - The end of a time slice is signaled by an interrupt.

Time-sharing between process A and process B



See Windows Task Manager for an example

Race Condition

- When two processes want to use a common shared resource a “race condition” may result and cause undesirable results
- Example: Two processes writing to the same location in memory (one to subtract 10, one to add 20)

Process 1

Load value from memory to register
Add 20
Store register back to memory

Process 2

Load value from memory to register
Subtract 10
Store register back to memory

Attempt to fix: use register 0 as “in use” flag

Process 1

```
If register 0 is 0
  Set register 0 to 1
  Load value from memory to register
  Add 20
  Store register back to memory
  Set register 0 to 0
Else
  wait until register 0 is 0
```

Process 2

```
If register 0 is 0
  Set register 0 to 1
  Load value from memory to register
  Subtract 10
  Store register back to memory
  Set register 0 to 0
Else
  wait until register 0 is 0
```

Will this fix the problem?

Handling Competition for Resources

- **Semaphore:** A "control flag"
- **Critical Region:** A group of instructions that should be executed by only one process at a time
- **Mutual exclusion:** Requirement for proper implementation of a critical region

Solution: Semaphore

In this example we use an uninterruptible Test and Set Instruction

Process 1

```
If register 0 is 0 set register 0 to 1
  Load value from memory to register
  Add 20
  Store register back to memory
  Set register 0 to 0
Else
  wait until register 0 is 0
```

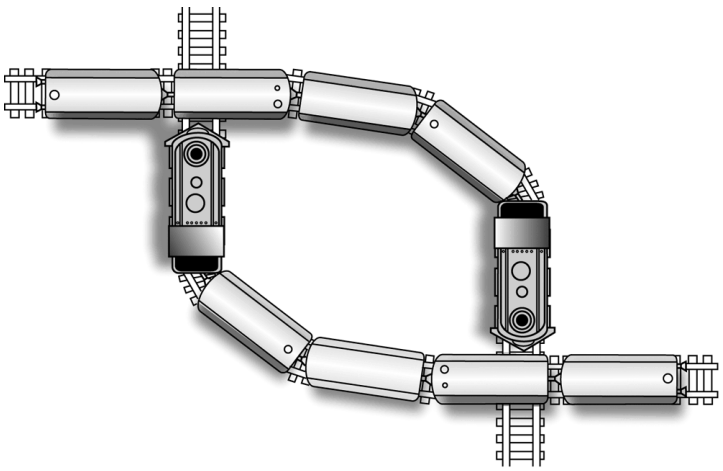
Process 2

```
If register 0 is 0 set register 0 to 1
  Load value from memory to register
  Subtract 10
  Store register back to memory
  Set register 0 to 0
Else
  wait until register 0 is 0
```

Deadlock

- Processes block each other from continuing
- Conditions required for deadlock
  1. Competition for non-sharable resources
  2. Resources requested on a partial basis
  3. An allocated resource can not be forcibly retrieved

A deadlock resulting from competition for nonshareable railroad intersections



Security

- Attacks from outside
  - Problems
    - System errors
    - Insecure passwords
    - Sniffing software
  - Counter measures
    - Auditing software
    - Firewalls, scanners

Security (continued)

- Attacks from within
  - Problem: System errors
  - Counter measures: patches, virtual machine
  - Problem: Unruly processes
  - Counter measures: Control process activities via privileged modes and privileged instructions