Problem: Which combination of the following features will suffice to characterize an OS as a multi-programmed OS? (i) more than one program may be loaded into main memory at the same time for execution. (ii) If a program waits for certain events such as I/O, another program is immediately scheduled for execution. (iii) If the execution of a program terminates, another program is immediately scheduled for execution

(a) (i) (b) (i) and (ii) (c) (i) and (iii) (d) (i), (ii) and (iii)

Soln. (i) Virtual memory helps to load more than one program. **[GATE-2002 : 2 Marks]**

(ii) Multi programming, wait for an I/O of one process can execute other process.

(iii) After completion of one process, other process executes, immediately.

Correct option is (d)

Distributed Operating System:

1. Distributed systems use multiple central processors to serve multiple real time application and multiple users.
2. Data processing jobs are distributed among the processors accordingly to which one can perform each job most efficiently.
3. The processors communicate with one another through various communication lines (such as high-speed buses or telephone lines).
4. These are referred as loosely coupled systems or distributed systems. Processors in a distributed system may vary in size and function. These processors are referred as sites, nodes, computers and so on.

The advantages of distributed systems are following:

- With resource sharing facility user at one site may be able to use the resources available at another.
- Speedup the exchange of data with one another via electronic mail.
- If one site fails in a distributed system, the remaining sites can potentially continue operating.
- Better service to the customers.
- Reduction of the load on the host computer
- Reduction of delays in data processing.

Real Time operating System : In real time operating system processes are submitted with deadlines (Time bound) within that time processing have to complete their execution.

1. Real time processing is always on the line whereas on line system need not be real time. The time taken by the system to respond to an input and display of required updated information is termeda as response time.
2. Real-time operating system has well-defined, fixed time constraints otherwise system will fail. For example, Scientific experiments, medical imaging systems, industrial control systems, weapon systems, robots, and home-applicance controllers, air traffic control system etc.

There are two types of real-time operating systems.

Hard real-time systems:

1. Hard real-time systems gurantee that critical tasks complete on time.
2. In hard real-time real-time systems secondary storage is limited or missing with data stored in ROM.
3. In these systems virtual memory is almost never found.

Soft real-time systems:

1. Soft real time systems are less restrictive. Critical real-time task gets priority over other tasks and retains the priority until it completes.
2. Soft real-time systems have limited utility than hard real-time systems.
3. For example, Multimedia, virtual reality, advanced Scientific Projects like undersea exploration and planetary rovers etc.

STRUCTURE OF OPERATING SYSTEM:

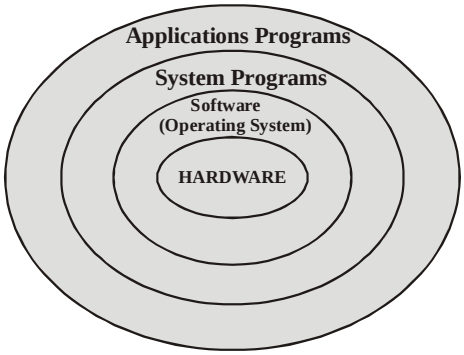

Figure : Structure of Operating Systems

Problem : A multi-user, multi-processing operating system cannot be implemented on hardware that does not support
(a) Address translation
(b) DMA for disk transfer
(c) At least two modes of CPU execution (priviledge and non-priviledge)
(d) Demand paging

Ans. (c)

Soln. The system has multi-user and multi-processing, the security is primary concern. Otherwise user program and operating system will be corrupted. That is the reason to ensure the security and protection hence two modes are required. **[GATE-1999 : 2 Marks]**

SPOOLING :

Spooling is an acronym for simultaneous peripheral operations on line. Spooling refers to putting data of various I/O jobs in a buffer. This buffer is a special area in memory or hard disk which is accessible to I/O devices. Operating system does the following activites related to distributed environment.

- OS handles I/O device data spooling as devices have different data access rates.
- OS maintains the spooling buffer which provides a waiting station where data can rest while the slower device catches up.
- OS maintains parallel computation because of spooling process as a computer can perform I/O in parallel fashion. It becomes possible to have the computer read data from a tape, write data to disk and to write out to a tape printer while it is doing its computing task.

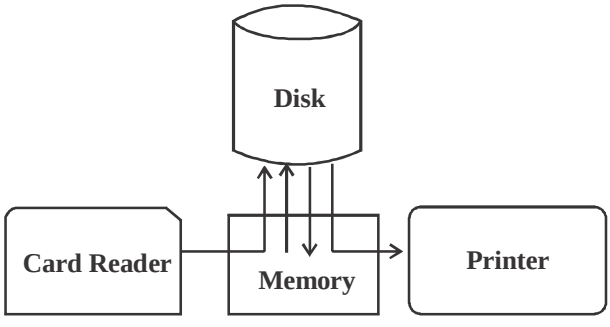

Figure : Spooling

Advantages

- The spooling operation uses a disk as a very large buffer.
- Spooling is capable of overlapping I/O operation for one job with processor operations for another job.

Problem : Which of the following is an example of spooled device ? **[GATE-1996 : 1 Mark]**
(a) A line printer used to print the output of a number of jobs

(b) A terminal used to enter input data to a running program
(c) A secondary storage device in a virtual memory system
(d) A graphic display device

Soln. Spooled devices are those which fetches data from job waiting area one by one and spool means simultaneous peripheral operation on line, so printer is a spooling device.

Correct option is (a)

Problem: Which of the following is an example of a spooled device ? **[GATE-1998 : 1 Mark]**

(a) The terminal used to enter the input data for the C program being executed
(b) An output device used to print the output of a number of jobs
(c) The secondary memory device in a virtual storage system
(d) The swapping area on a disk used by the swapper

Soln. Spooled devices is output device used to print the output of jobs.

Correct option is (b)

OPERATING SYSTEM KERNEL:

- The part of the OS which handles all of the details of sharing and device handling is called the kemel or core.
- The kernel is not something which can be used directly, although its services can accessed through system calls. What needed is a user interface or command line interface (CLI) which allows users to log onto the machine and manipulate files, compile programs and execute them using simple commands.
- Since this is a layer of software which wraps the kernel in more acceptable clothes, it is called a shell around the kernel.

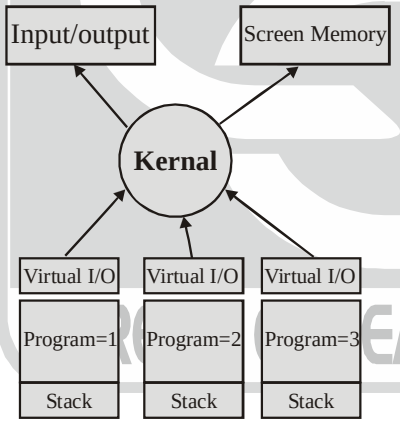

Figure: Kernel Overview

Kernel Model: In kernel mode, the executing code has complete and understricted access to the underlying hardware it can execute any CPU instruction and reference any memory address.
Kernel mode is generally reserved for the lowest-level, most trusted function of the operating system. Crashes in kernel mode are catastropic : they will halt the entire PC.

Usermode: In username, the executing code has no ability to directly access hardware or reference memory. Code running is user mode must delegate to system APIs to access hardware or memory. One to the protection afforded by this sort of solution, crashes in user mode or a always reversable. Most of the code running on your computer will execute in user mode.

Problem : A computer handles several interrupt sources of which the following are relevant for this question.

- Interrupt from CPU temperature sensor (raises interrupt if CPU temperature is too high)
- Interrupt from Mouse (raises interrupt if the mouse is moved or a button is pressed)
- Interrupt from keyboard (raises interrupt when a key is pressed or released)

- Interrupt from Hard Disk (raises interrupt when a disk read is completed)

Which one of these will be handled at the **HIGHEST** priority ?

(a) Interrupt from Hrad Disk (b) Interrupt from Mouse
(c) Interrupt from Keyboard (d) Interrupt from CPU temperature sensor

Ans. (d)

Soln. Interrupt from CPU temperature sensor is given top priority to protect system resources. When CPU temperature is too high, the BIOS initiate an interrupt and informs the Operating System. OS gives top priority to this interrupt and immediately shuts down the system. **[GATE-2011 : 1 Mark]**

SYSTEM CALLS:

- The system call is the means by which a process requests a specific kernel service.
- Whenever application program need the service of OS then it calls system calls.
- System calls provide an interface to the services made available by operating system.
- Typically written in a high-level language (C, C++, and Perl).
- Mostly accessed by programs via a high-level application program interface (API) rather than direct system call use.

Examples of System calls:

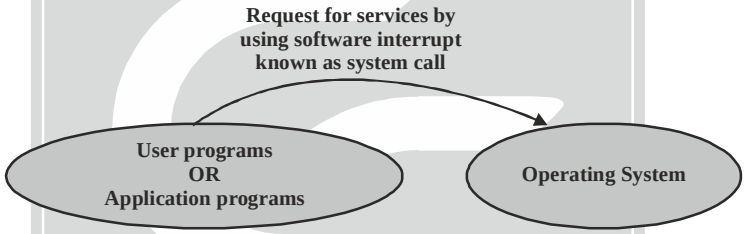

Figure: System calls

Types of System calls:

System calls can be grouped roughly into six major categories : process control, file management, device management, information maintenance and communications.

- **Process control**
  - end, abort
  - load, execute
  - create process, terminate process
  - get process attributes, set process attributes
  - wait for time
  - wait event, signal event
  - allocate and free memory.
- **File management:**
  - create file, delete file
  - open, close
  - read, write, reposition
  - get file attributes, set file attributes
- **Device management:**
  - request device, release device
  - read, write, repostion
  - get device attributes, set device attributes
  - logically attach or detach devices.
- **Information maintenance:**
  - get time or date, set time or date
  - set system data, set system data

- get process, file, or device attributes
- set process, file, or device attributes

- **Communications:**
  - create, delete communication connection
  - send, receive messages
  - transfer status information
  - attach or detach remote devices.
- **SOCKET:**
  - bind () : assigns the local IP address and port for a socket.
  - connect () : establishes a connection between the socket and the remote socket associated with socket address
  - gethostname(): returns local hostname

System programs:

System programs, also known as system utilities, provide a convenient environment for program development and execution.
Some of them are simply user interfaces to system calls; others are considerably more complex. They can be divided into these categories:

- **File management:** These programs create, delete, copy, rename, print, dump, list, and generally manipulate files and directories.
- **Status information:** Some programs simply ask the system for the date, time, amount of available memory or disk space, number of users, or similar status information. Others are more complex, providing detailed performance, logging, and debugging information. Typically, these programds format and print the output to the terminal or other output devices or files or display it in a window of the GUI. Some systems also support a registry, which is used to store and retrieve configuration information.
- **File modification:** Several text editors may be available to create and modify the content of files stored on disk or other storage devices. There may also be special commands to search contents of files or perform transformations of the text.
- **Programming language support:** Compilers, assemblers, debuggers, and interpreters for common programming languages (such as C, C++, Java, Visual Basic, and PERL) are often provided to the user with the operating system.
- **Program loading and execution:** Once a program is assembled or compiled, it must be loaded into memory to be executed. The system may provide absolute loaders, relocatable loaders, linkage editors, and overlay loaders. Debugging systems for either higher-lvel languages or machine language are needed as well.
- **Communications:** These programs provide the mechanism for creating virtual connections among processes, users, and computer systems. They allow users to send messages to one another's screens to browse web page, to send electronic mail messages, to log in remotely, or to transfer files from one machine to another.

Synchronous v/s Asynchronous I/O

Synchronous I/O : When some process require to complete its I/O operation it will move on to wait/block state and when I/O is completed then an ISR (Interrupt Service Routine) is called that will wakeup the process and put it back in ready queue.

Asynchronous I/O : When a process require some I/O to complete then it will not be blocked, it continue with its remaining part and let the I/O complete parallely

User Mode and Kernel Mode :

When we start our computer m/m is divided into two sections

(1) Kermel mode

(2) User space

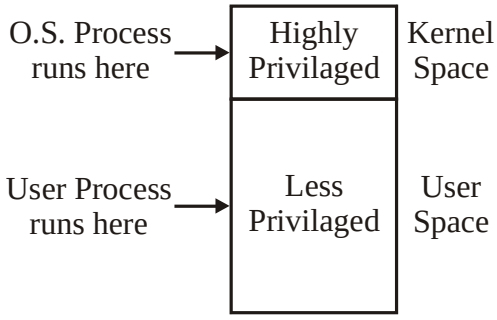

Figure: Main memory

In kernel space operating system processes can run. When any process is executing in kernel space then system will work in kernel mode. Kernel mode is highly privilaged mode. Interrupts are desalted in kernel mode.

- When any user process want to get some service from operating system then first mode changes from user mode to kernel mode to get services from operating system.
- When Operating system code will always executed in kernel mode.
- Kernel mode also known as super user mode or privilaged mode.
- User processes are executed in user mode. The part of code in which operating system interaction is not required is always run in user mode.
- To change mode from user mode to kernel mode we need some privilaged instruction (like system call) and to change mode from kernel mode to user mode a non-privilaged instruction (that do not generate any interrupt) is required.

Shared Memory	Message Passing
1. Part of memory is shared between two process	1. No memory will be shared between two process
2. Usefull to transfer more amount of data	2. Usefull to transfer less amount of data
3. At time of communication kernel interaction is not required	3. Each time when message is transmitted kernel interaction is required
4. It is faster compared to message passing	4. It is slower compared to shared memory because kernel interaction is required, each time when message is transmitted

Problem : System calls are usually invoked by using

(a) a software interrupt (b) polling

(c) an indirect jump (d) a privileged instruction

Soln. System calls are invoked by using software interrupt. **[GATE-1999 : 1 Mark]**

Correct option is (a)

Problem : Which of the following system calls results in the sending of SYN packets ?

(a) socket (b) bind (c) listen (d) connect

Soln. Connect system call is responsible for synchronize the packets. **[GATE-2008 : 1 Mark]**

Correct option is (d)

SOLVED PROBLEMS

1. Multiprocessor system that computer system have are also called
   (a) Parallel systems (b) Tightly coupled systems
   (c) Loosly coupled systems (d) Both (a) and (b)

Soln. Parallel systems are those systems where we can execute more than one task symultaniously so multiprocessor systems are parallel systems.

When multiple processors are placed on a single systems motherbord than the system is called tightly coupled and when we access some resources through network (resources are not attached to the system directly) then it is called as loosly coupled.

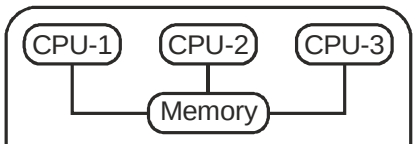

Figure: Multiprocessor systems

Multiprocessor system are tightly coupled systems.
Correct option is (d)

2. Logical extension of multiprogramming operating system is
   (a) Multitasking (b) Time sharing (c) Uni-programming (d) Both (a) and (d)

Soln. Multiprogramming + Time sharing = Multitasking
- Multitasking system also known as time sharing systems.

Correct option is (d)

3. Which of the following is an example of single programming operating system ?
   (a) MS-DOS (b) Unix (c) Window (d) Linux

Soln. MS-DOS is single programming operating system and all other are the multiprogramming operating system.
Correct option is (a)

4. Which of the following is not an function of operating system ?
   (a) Process management (b) Memory management
   (c) Device management (d) Clock management

Soln. Clock managment is done by hardware and operating system is a software.
Clock's are generated by ocssilator and decoder.
Correct option is (d)

5. Distributed operating system is
   (a) Loosly coupled operating system (b) Tightly coupled operating system
   (c) Both (a) and (b) (d) None of the above

Soln. In distributed operating system resouces are distributed over various systems connected through network so distributed systems are loosly coupled.
Correct option is (a)

6. In multiprocessor architecture of computer system _____ is shared.
   (a) Bus (b) Memory (c) Processor (d) Both (a) and (b)

Soln. In multiprocessing operating system all the CPU's share common memory and busses.
Correct option is (d)

7. User view of system depends upon the
   (a) CPU (b) Hardware (c) Interface (d) Computer organization

Soln. User view of system is the interface. Interface should be easy to understand.
Correct option is (c)

8. A multiuser, multiprocessing operatins system can't be implemented on hardware that does not support.
   (a) Address translation
   (b) DMA for disk transfer
   (c) Atleast 2 mode of CPU (privilaged and non-privilaged)
   (d) Demand paging

Soln. • Address translation is required because relocatable addresses and physical/absolute address are now different.
• Atleast 2 mode of CPU is also required for security concern so that processes can share resouces properly.
Correct option is (c)

9. Which of the following is an example of spooled device.
   (a) A line printer used to print the output of a number of jobs
   (b) A terminal used to enter input data to a running program
   (c) A secondary storage device in a virtual memory system
   (d) A graphic display device

Soln. Spooled devices are those which fatches data from job waiting area one by one and spool means symultaneous peripheral operation on line. We put all the requests in the printers buffer area from where printer take the requests are by one and complete them. So printer is an example of spooled device.
Correct option is (a)

10. Which of the following computing model is not an advantage of distributing computing environment
    (a) Cloud computing (b) Parallel computing (c) Cluster computing (d) Peer to peer computing

Soln. Peer to Peer computing model is not an advantage of distributing computing environment.
Correct option is (d)

11. Processor needs software interrupt to
    (a) Test the interrupt system of the processor
    (b) Implemented coroutines
    (c) Obtain system services which need execution of privilaged instructions
    (d) Return from subroutines

Soln. Processor needs software interrupt to request operating system to get some system services that are highly privillaged.
Correct option is (c)

12. A CPU has 2 modes privilaged and non-privilaged in order to change the mode from privilaged to non-privilaged.
    (a) a hardware interrupt is needed
    (b) a software interrupt is needed
    (c) A privilaged instruction (which do not generate an interrupt) is needed
    (d) A non-privilaged instruction (which does not generate an interrupt) is needed

Soln. **Correct option is ( )**

13. Which combination of the following features will suffice to characterize an operating system as a multiprogrammed operating system.
    (i) More than one program may be loaded into main memory at same time for execution.
    (ii) If one program waits for certain events such as I/O another program is immediatly scheduled for execution.
    (iii) If the execution of program terminates another program is immediately scheduled for execution.
    (a) (i) only (b) (i) and (ii) (c) (i) and (iii) (d) All of the above

Soln. (i) is right because only done in multiprogrammed operating system in single programmed operating system.
(ii) is right because only done in multiprogrammed operating system not in single programmed operating system.
(iii) is false becase this property held by both single programmed as well as multiprogrammed operating system. So option (iii) do not characterize multiprogrammed operating system.
Correct option is (b)

14. Which of the following system calls result in the sending of SYN packets ?
(a) Socket (b) Bind (c) Listen (d) Connect

Soln. Connect system call is responsible for synchronize the packets.
Socket ( ) : create a new socket of a certain socket type and allocate system resource to it.
Bind ( ) : is typically used on the server side and associate a socket with a socket address structure i.e. a specified port number and ± p address.
Listen : is used on server side and causes a bound TCP socket to enter listening state.
Connect ( ) : is used client side, and assign a free local port number to a socket.
When connect is called by client following 3 way handshake happenes to establish the connection in tap.
1. The client request a connection by sending a SYN message to server.
2. The server acknowledge this request by sending SYN-ACK back to client.
3. Client respond with ACK and the connection is established.

Correct option is ( )

15. Which of the following statement about synchronous and asynchronous I/O is NOT TRUE ?
(a) An ISR is invoked on completion of I/O in synchronous I/O but not in asynchronous I/O.
(b) In both synchronous and asynchronous I/O an ISR is invoked after completion of the I/O.
(c) A process making a synchronous I/O call waits untill I/O is complete, but a process making an asynchronous I/O call does not wait for completion of I/O.
(d) In case of synchronous I/O the process waiting for the completion of I/O is woken up by the ISR that is invoked after the completion of I/O.

Soln. An ISR is generated after completion of I/O only in synchronous I/O to wakeup the process waiting to complete its I/O. In case of asynchronous I/O process do not wait to complete its I/O it will continue its execution so no ISR will generate to wakeup any process.
Correct option is (b)

16. Which of the following requires a device driver
(a) Register (b) Cache (c) Main memory (d) Hard disk

Soln. Resources which one placed on motherboard directly do not need any device drivers but resources that are attached externally like printer, keyboard, mouse, hard disk etc. needs device drivers.
Correct option is (d)

17. What is the size of unicode character in windows
(a) 8 bits (b) 16 bits (c) 32 bits (d) 64 bits

Soln. **(b)**

18. In win32 which function is used to create windows application
(a) win APP (b) win API (c) win main (d) win void

Soln. **(c)**

19. Everything below the system call interface and above the physical hardware is known as
(a) Kernel (b) Bus (c) Shell (d) Stub

Soln. **(a)**

20. Which of the following operating system better for implementing client server network
(a) Windows 95 (b) Windows 98 (c) Windows 2000 (d) All of these

Soln. **(c)**

21. Which of the following is correct value returned to the operating system upon the successful completion of a program.
(a) 0 (b) 1 (c) –1 (d) Program do not return any value

Soln. **(a)**

22. System calls are usually invoked by using
(a) a software interrupt (b) polling
(c) an indirect jump (d) a privilaged instruction

Soln. System call is an software interrupt that is generated by user program to operating system to get some highly privilaged services.
Correct option is (a)