Introduction to Operating Systems

0.1 Definition

A program that acts as an intermediary between a user and the hardware

0.2 Goals

- Execute user programs
- Make solving user programs easier
- Make the computer system convenient to use
- Use the resources of the systems fairly and efficiently

0.3 Components

An operating system is a:

- **Resource allocator**: Responsible for the management of the computer system resources
- **Control Program**: Controls the execution of user programs and operation of the I/O devices
- **Kernel**: The one program that runs all the time

A process is a unit of execution; an abstraction that is used to support the discussion and study of operating systems
Resources needed by the process include: CPU time, memory, files and I/O devices
The resources may be allocated at the start of a process or as it executes
Executes (performs its work) using its associated resources; a collection of instructions that carry out a reasonable task.

The operating system is responsible for process management including:

- Process creation and deletion
- Process holding and resuming
- Mechanisms for process synchronization

1 The process concept

A process includes:

- Code: text section
- Current activity, represented by the program counter and the content of the CPU's registers
- Data stack: Temporary data such as local variables
- Data section: Global variables
- Heap: Memory allocated while the process is running

2 Process Control Block

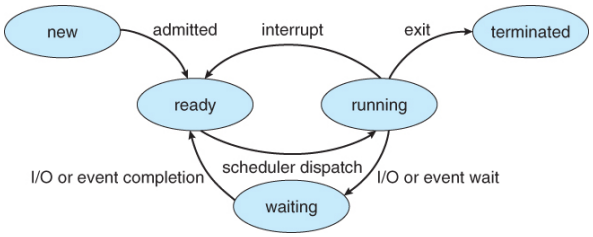
Information about each process is represented by a process control block (PCB) including

- Unique identifier
- State
- CPU Utilisation
- CPU scheduling information
- Memory usage
- Other information

3 Process state

As a process executes, it changes state:

- New - The process is being created
- Running - instructions are being executed
- Waiting - The process is waiting for some event to occur
- Ready - The process is ready to be dispatched to the CPU
- Terminated - The process has completed its execution, or some other event causing termination



4 Process Creation

A new process, as a parent processes, can create a number of child processes, which, in turn create other processes, forming a tree of processes.

Resource sharing: three possible cases:

- The parent and child processes share all resources
- The child process shares a subset of the parent's resources
- The parent and child process share no resources

Execution: two possible cases:

- The parent and child execute concurrently
- The parent waits until the child terminates

5 Process Termination

The process executes its last statement and asks the operating system to delete it:

- Outputs the data from the child's process to parent
- The child process's resources are de-allocated by operating system

The parent process may terminate execution of the child processes if:

- The child process has exceeded its allocated resources
- The task assigned to child is no longer required
- The parent itself is terminating (cascade termination)

6 The Kernel

Aim: To provide an environment in which processes can exist

Four essential components:

- Privileged instruction set
- Interrupt mechanism
- Memory protection
- Real time clock

The kernel consists of:

- The first-level interrupt handler: to manage interrupts
- The dispatcher: to switch the CPU between processes
- Intra operating system communications

7 Interrupts

7.1 Definition

An interrupt is a signal from either hardware or software of an event that will cause a change of process, for example:

- **Hardware**: Triggers an interrupt by sending a signal to the CPU via the system bus e.g. I/O event
- **Software**: Triggers an interrupt by sending a system call for some action by the operating system

Interrupt Routines: OS routines that execute whenever an interrupt occurs

8 First level interrupt handler

The function of the FLIH is to:

- Determine the source of the interrupt (prioritise)
- Initiate servicing of the interrupt (selection of suitable process of the dispatcher)

9 Privileged instructions

Some instructions must be accessible only to the operating system: **privileged instruction set**.

Privileged instructions include functions such as:

- Managing interrupts
- Performing I/O
- Halting a process

10 Dual mode

Aim: To distinguish between execution of operating system code and user defined code. We do not let the user execute instructions that could cause harm.

Two modes:

- User mode
- Kernel mode

11 Privileged Instructions

Switching from user mode to kernel mode occurs when:

- A user process calls on the operating system to execute a function needing a privileged instruction
- An interrupt occurs
- An error condition occurs in the user process
- An attempt is made to execute a privileged instruction while in user mode

12 The dispatcher

- Assigns processing resources for processes
- Is later initiated when
  - A current process cannot continue
  - The CPU may be better used elsewhere, for instance:
    * After an interrupt changes a process state
    * After a system call which results in the current process not being able to continue
    * After an error which causes a process to suspend