1 Concurrent Processes

- Activation of one or more processes at the same time.
- Two types of concurrency normally discussed :

  Apparent or Pseudo Concurrency : A single hardware processor is switched between processes by interleaving.

  Over a period of time this gives the *illusion* of concurrent execution of the processes.

  Real Concurrency : Multiple hardware processors are present in the machine, and the OS can schedule tasks onto the processors.

  Usually, processors are much less than the number of processes.

2 Example of Concurrent Activity

Processes

Activities being performed :

Order Clerk
Bagger
Cook
Cashier
Customers

Shared Communication Areas

Order list turntable
Cooked Hamburger bin
Checkout counter

3 Real Time Operating Systems

- System must respond to external stimuli within a **finite** and *specified time.*
- *Correctness* depends not only on **logical result** BUT also on **response time**.
- **Problem** : *Shedule all activities to meet some requirements.*
- **Hard Real Time** : Absolutely imperative that responses occur within specified deadlines. Late result $\equiv$ failure.
- **Soft Real Time** : Response times are important, but system will still function if deadlines are missed.
- **Embedded System** : Systems which are interfaced to some external physical equipment, and perform monitoring and control.
  The computer is *PART* of the overall system, and hence Real Time.

Real Time systems are used for :
Hard : *Nuclear Power Stations, Flight Control, Missile Guidance*
Soft : *Train or Airline Reservation*
Embedded : *Washing Machine, Chemical plant control etc*

Distinction between OS and R/T systems are quite blurred

4 Distributed and Parallel Operating Systems

- Facilitate use of geographically distributed resources.
- Supports communication between a job or between different jobs.
- **Information** sharing is of most significance.
- Support for parallel applications wishing to obtain speedup of computationally intensive tasks.
- Supports synchronisation of activities to coordinate sharing of information.
- Use of primitives defined within OS, such as RPC (Remote Procedure Call) to support distributed activities.
- Efficient Communication primitives between activities also supported.

Move towards the development of

Object Oriented (OO) Methodologies or OO Frameworks to support distributed applications

5 Non Determinism in Operating Systems

Operating and Real Time systems are non-deterministic, in that they must respond to events that occur in an unpredictable order, and at unpredictable times. Such as results generated from I/O devices.

- The way an Operating system switches between processes cannot be pre-determined, since the events which cause the switches are not deterministic.
- The interleaving of instructions, executed by a processor, from a set of processes is non-deterministic

The **Events or Interrupts** cause process switches, such as *an I/O completion interrupt causing the OS to switch to an I/O handling process.*