1.5 Clock-Based & Event-Based Systems:

- ❖ Synchronization between the external processes and internal actions (tasks) carried out by the computer may be defined in terms of the passage of time, or the actual time of day, in which case the system is said to be **"Clock-based system"** or it may be defined in terms of events, and the system is said to be **"Event-based system"**.
- ❖ If the relationship between the actions in the computer and the system is much more loosely defined, then the system is said to be **"interactive system".**

1.6 Real-Time systems can be classified as:

1.6.1 Clock-Based Tasks: (Cyclic and Periodic):

- ❖ The completion of the operations within the specified time is dependent on the number of operations to be performed and the speed of the computer.
- ❖ Synchronization is usually obtained by adding a clock to the computer system , and using a signal from this clock to interrupt the operation of the computer at predetermined fixed time interval .

Plant time constant → sampling time (Ts) → Interrupt

1.6.2 Event-Based Tasks: (A periodic):

- ❖ Action is to be performed not at particular times or time intervals but in response to some event. The system must respond within a given max. time to a particular event .
- ❖ Events occur at non-deterministic intervals and event-based tasks are referred to as “a periodic” task.

1.6.3 Interactive Systems:

- ❖ They represent the largest class of RTSs such as automatic bank tellers, reservation systems for hotels, airlines and car rental……etc.
- ❖ The real-time requirement is usually expressed in terms such as “the average response time must not exceed ……”
- ❖ Example: an automatic bank teller system might require an average response time not exceeding 20 sec.

1.7 Classification of Programs:

A real-time program is defined as a program for which the correctness of operation depends on the logical results of the computation and the time at which the results are produced.

In general there are three types of programming:

1. **Sequential**: Actions are ordered as a time sequence, the program behavior depends only on the effects of the individual actions and their order.

2. **Multi-tasking**: Actions are not necessarily disjoint in time, it may be necessary for several actions to be performed in parallel.

3. **Real-Time**: Actions are not necessarily disjoint in time, and the sequence of some of program actions is not determined by the designer but the environment (by events occurring in the outside world which occur in real-time and without reference to the internal operations of the computer).

A real-time program can be divided into a number of tasks but communication between the tasks can not necessarily wait for a synchronization signal. The environment task can not be delayed.

In RT programs, the actual time taken by an action is an essential factor in the process of verification.

NOTES:

- ✓ RTSs have to carry out both periodic activities.
- ✓ RTSs have to satisfy time constraints that can be either:
  - ~ A hard constraint , or
  - ~ A soft (average value) constraint.
- ✓ RT software is more difficult to specify, design and construct than non real-time software.

1.8 Computer Control Real Time Systems

The activates being carried out by a computer, in a RTS, will include the following:

- ♣ Data acquisition.
- ♣ Sequence control.
- ♣ Direct digital control (DOC).
- ♣ Supervisory control (SC).
- ♣ Data analysis.
- ♣ Data storage.
- ♣ Human-computer interface (HCI).

The objectives of using a computer in a RTS will include the following:

1. Efficiency of operation.
2. Ease of operation.
3. Safety.
4. Improved products.
5. Reduction in waste.
6. Reduce environment impact.
7. Reduction in direct labor.

1.9 Real-Time Computer Control System Elements

1. Sensor control processes

- ♣ Collect information from sensors. May buffer information collected in response to a sensor stimulus.

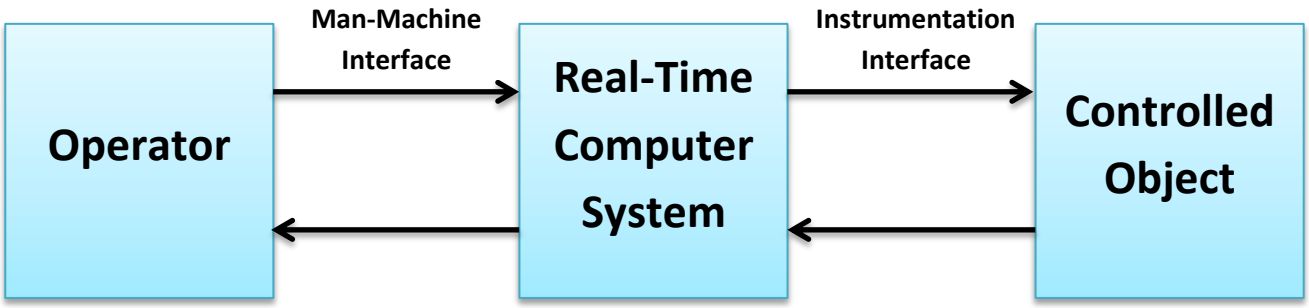
2. Data processor

- ♣ Carries out processing of collected information and computes the system response.

3. Actuator control processes

- ♣ Generates control signals for the actuators.
- ♣ Man-machine interface: input devices, e.g. keyboard aned output devices, e.g. display.
- ♣ Instrumentation interface: sensors and actuators that transform between physical signals and digital data.
- ♣ Most control systems are hard real-time.
- ♣ Deadlines are determined by the controlled object, i.e. the temporal behavior of the physical phenomenon.

Fig. below shows real time computer control components.



1.10 Control Process of Computer Based System

The development of digital computer technology has, extensively increased the use of computers for measurement and control application. The basic objective of computer based measurement and control is to acquire the information from field devices (input), and compute a logical decision to manipulate the material and energy flow of given process in a desired way to get optimal output. The expectations from a process computer compared to a general purpose computer is primarily in terms of response time, computing power, flexibility and fault tolerance, which are need to be rigid and reliable; moreover, the control of the process has to be carried out in real-time. Other difficulties encountered, mostly for process computers is to provide a solution to the problem of complexity, flexibility, and geographical separation of process elements (plant equipment) which are to be operated in a controlled manner.

Digital computer control applications in the process industries may be of passive or active type. Passive application involves only acquisition of process data (data acquisition / data logging) whereas active application involves acquisition and manipulation of data and uses it for (real time) process control. The passive application deals predominantly with monitoring, alarming and data reduction systems.

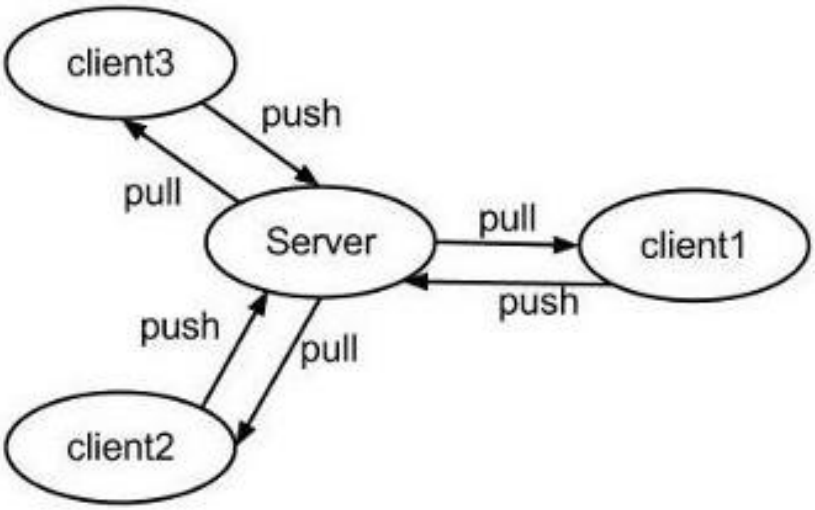
Process control computers now have the capability to implement sophisticated mathematical models. Plant managers and engineers can be provided with comprehensive information concerning the status of plant operations to aid effective operation. With the use of microprocessor-based instruments and new emerging techniques, it is possible for automatic tuning of controller parameters for best operating performance. The expert systems and advanced control techniques such as model based predictive control, are being applied with the help of computers for optimization of the process operation.

1.11 Architecture – Computer based Process Control System

Computer-aided Industrial Process can be classified on the basis of their architecture under one or more of the following:

- ♣ Centralized Computer Control.
- ♣ Distributed Computer Control.
- ♣ Hierarchical Computer Control.

Centralized Computer Control System:



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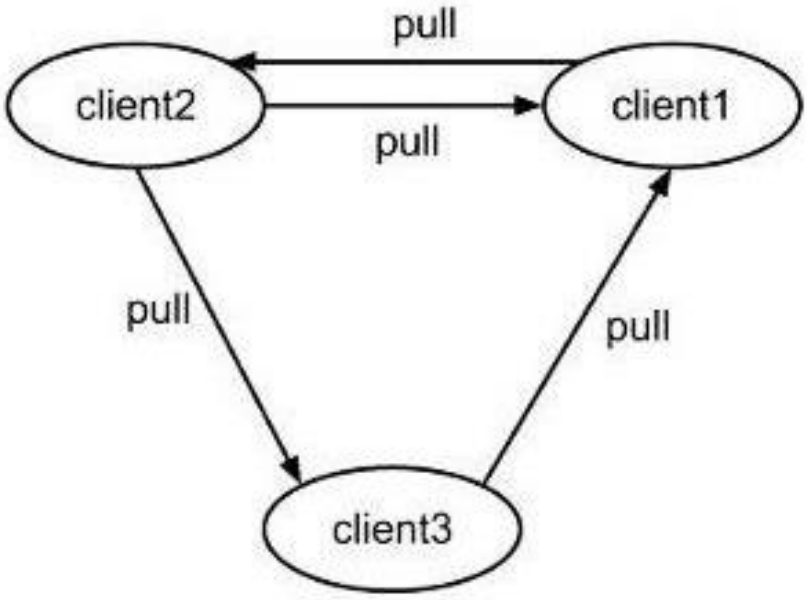
Distributed Computer Control System:



Hierarchical Control System