

# **Real Time System**

## **Third Level**

### **Lecture One**

## **Definitions of Real Time System**

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#### Goals

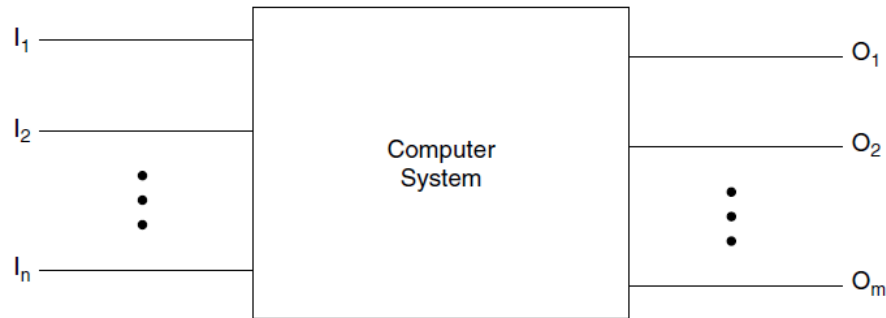
Up-on completing this lecture, the student should be able to:

- 1- Identify the concept of a Real-Time-System.
- 2- Classify different systems into hard and soft RTS

**A real-time system** is one in which the correctness of the system depends not only on the logical result of computation, but also on the time which the results are generated.

**A real-time system** is one whose logical correctness is based on both the correctness of the outputs and their timeliness.

**A system** is a mapping of a set of inputs into a set of outputs.



**Figure 1.1** A system with  $n$  inputs and  $m$  outputs.

**The response-time** is the time between the presentation of a set of inputs to a system and the realization of the required behavior, including the availability of all associated outputs, is called the response time of the system.

A real-time system must satisfy response-time constraints or risk severe consequences.

**A failed system** is a system that cannot satisfy one or more of the requirements stipulated in the formal system specification.

### **Terms Associated with RTS:**

#### ■ **Tasks**

##### ▪ **Periodic**

Time-driven. Characteristics are known a priori.

E.g.: Task monitoring temperature of a patient in an ICU.

##### ▪ **Aperiodic**

Event-driven. Characteristics are not known a priori.

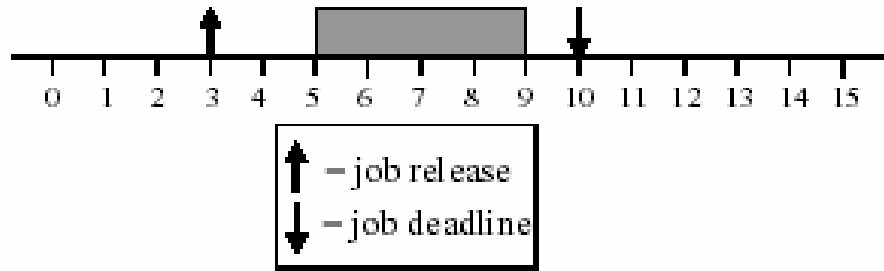
E.g.: Task activated upon detecting change in patient's condition.

■ **Release time of a job:** the time instant the task becomes ready to execute.

■ **Deadline of a job:** the time instant by which the task must complete execution.

■ **Relative deadline of a job:** Deadline - Release time.

■ **Response time of a job:** Completion time - Release time.



Job is released at time 3.  
 It's (absolute) deadline is at time 10.  
 It's relative deadline is 7.  
 It's response time is 6.

### Types of RTS:

**Hard real-time** — systems where the responses occur within the required deadline (which means failure to meet a single deadline may lead to complete and catastrophic system failure).

**Soft real-time** — systems where deadlines are important but which will still function correctly if deadlines are occasionally missed (which means performance is degraded but not destroyed by failure to meet response-time constraints).

**Firm real-time** — systems which are soft real-time but in which there is no benefit from late delivery of service (which means a few missed deadlines will not lead to total failure, but missing more than a few may lead to complete and catastrophic system failure).

### Hard RTS vs. Soft RTS

Characteristics	Hard RTS	Soft RTS
Response Time	Hard- Required	Soft- required
Peak Load Performance	Predictable	Degraded
Controlled by	Environment	Computer
Safety	Critical	Non Critical
Size of Data	Small	Large
Error Detection	Autonomous	User Assisted

**Table 1.1 A sampling of hard, soft, and firm real-time systems**

	Real-Time Classification	Explanation
Automated teller machine	Soft	Missing even many deadlines will not lead to catastrophic failure, only degraded performance.
Embedded navigation controller for autonomous robot weed killer	Firm	Missing critical navigation deadlines causes the robot to veer hopelessly out of control and damage crops.
Avionics weapons delivery system in which pressing a button launches an air-to-air missile	Hard	Missing the deadline to launch the missile within a specified time after pressing the button can cause the target to be missed, which will result in catastrophe.

**Characteristics of RTS:**

**Deterministic** operations are performed at predetermined times.

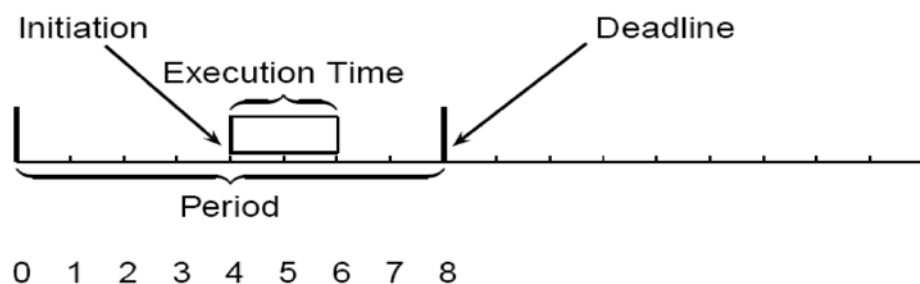
**User control** user specifies priority, what processes must always reside in main memory.

**Reliability** degradation of performance may have catastrophic consequences.

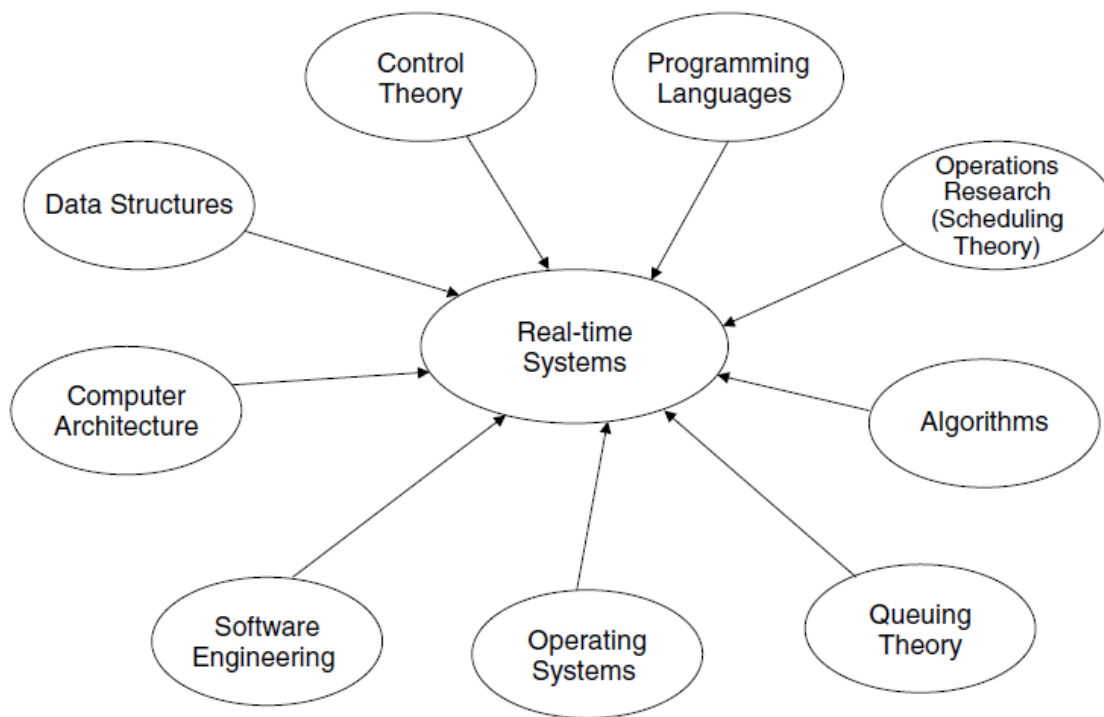
**Typical RTS Task Model:**

Each task a triplet: (execution time, period, deadline), usually, deadline = period, and can be initiated any time during the period.

- $P=(2,8,8)$

**Real-Time System Design Issues:**

Real-time systems are a complex sub discipline of computer systems engineering that is strongly influenced by control theory, software engineering, and operations research. Figure 1.5 depicts just some of the disciplines of computer science and electrical engineering that affect the design and analysis of real-time systems.



**Figure 1.5** Disciplines that impact on real-time systems engineering.

The design and implementation of real-time systems requires attention to numerous problems. These include:

1. The selection of hardware and software.
2. Specification and design of real-time systems and correct representation of temporal behavior.
3. Understanding the nuances of the programming language(s) and the real time implications resulting from their translation into machine code.
4. Maximizing of system fault tolerance and reliability through careful design.
5. The design and administration of tests.
6. Finally, measuring and predicting response time and reducing it.

Of course, the engineering techniques used for hard real-time systems can be used in the engineering of all other types of systems.

Summary:

- 1- Real-time systems are about correct and timely output.
- 2- The number of errors is the real differentiator between hard and soft RTS.

Questions:

- 1- What is an RTS ?
- 2- What is a soft RTS ?
- 3- What is a hard RTS ?