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Software Engineering

Chapter Four
Real –time software design (3 hours)

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4. Real –time software design (3 hours)

4.1. System design

4.2. Real-time operating systems

4.3. Monitoring and control systems
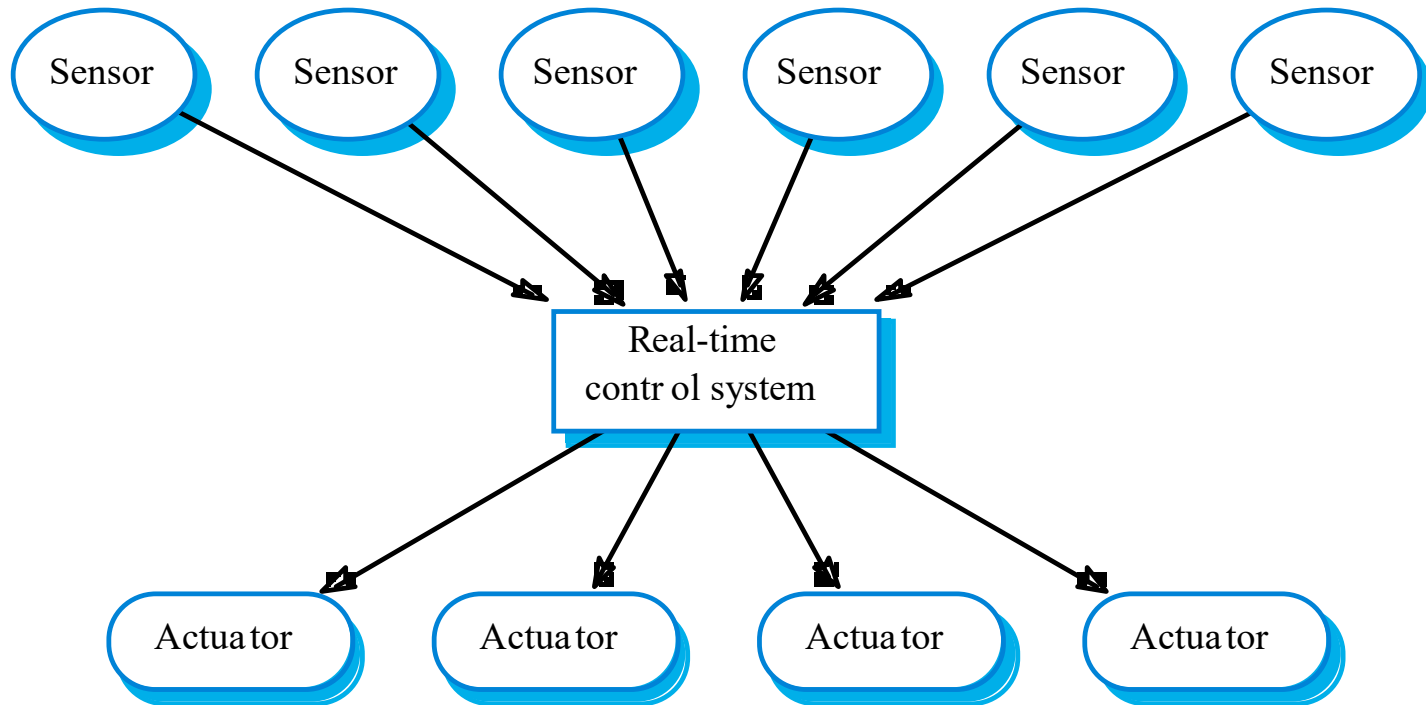
4.4. Data acquisition systems

What is Real Time ?

" Real time in operating systems:

The ability of the operating system to provide a required level of service in a bounded response time"

A real-time system model

A real-time system model

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A **sensor** is a device that receives and responds to a signal.

An **actuator** is a device that converts energy into motion. The control signal is relatively low energy and may be electric voltage or current, pneumatic or hydraulic pressure, or even human power. ...

When the control signal is received, the **actuator** responds by converting the energy into mechanical motion

Sensor/actuator processes

Sensor

Actuator

Stimulus

Response

Sensor control

Data processor

Actuator control
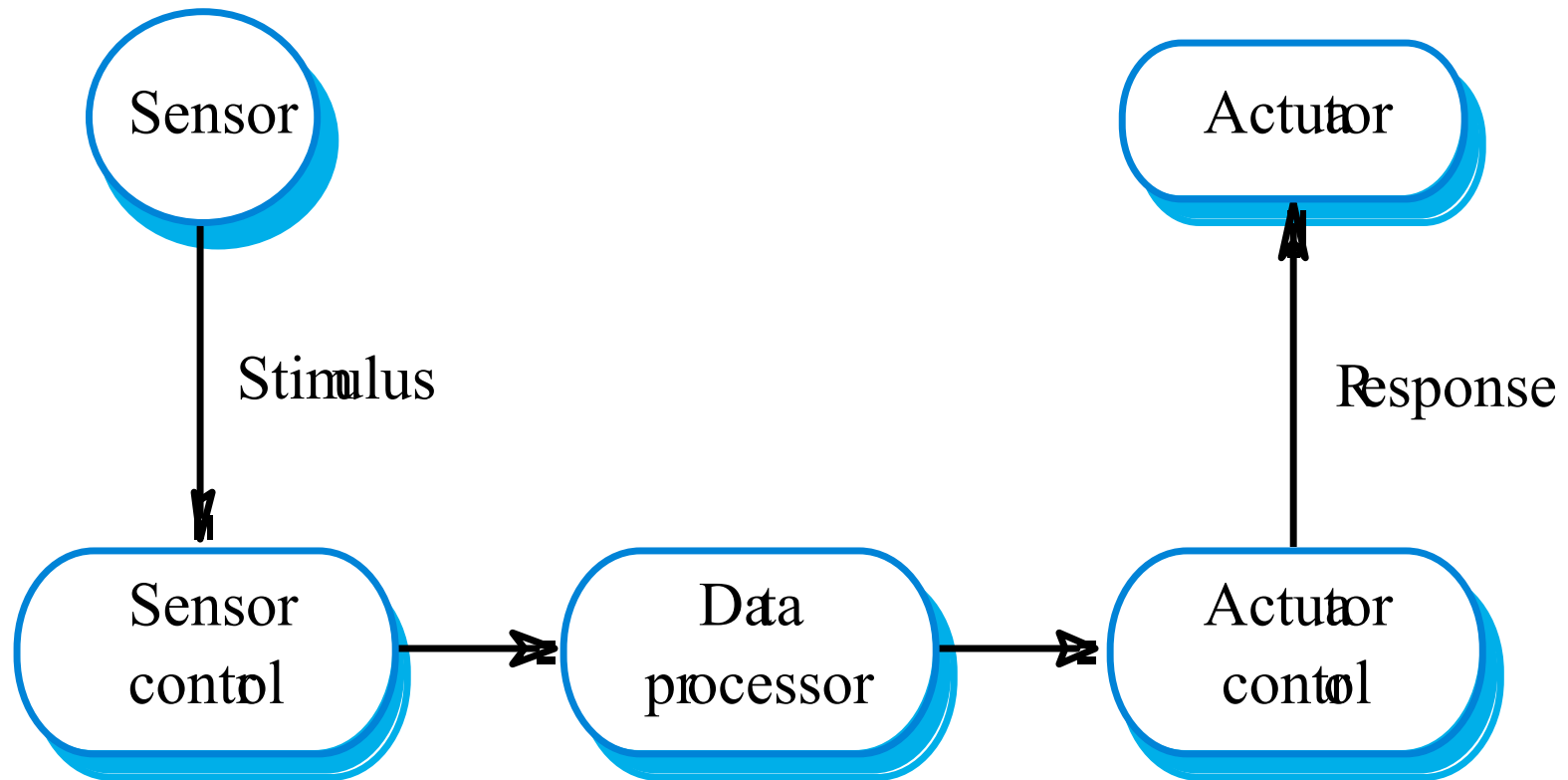
System elements

- Sensor control processes
  - Collect information from sensors. May buffer information collected in response to a sensor stimulus.

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

- Actuator control processes
  - Generates control signals for the actuators.

WHAT IS RTOS ?

- It responds to inputs immediately(Real-Time).

- Here the task is completed within a specified time delay.

- In real life situations like controlling traffic signal or a nuclear reactor or an aircraft, The operating system has to respond quickly

Soft RTOS…

- In a soft real-time system, it is considered undesirable, but not catastrophic, if deadlines are occasionally missed.

- Also known as "best effort" systems

- Examples:
  - multimedia transmission and reception,
  - networking, telecom (cellular) networks,
  - web sites and services
  - computer games.

Examples:

- Weather stations have many sensors for reading temperature, humidity, wind speed, etc. The readings should be taken and transmitted at regular intervals, however the sensors are not synchronized. Even though a sensor reading may be early or late compared with the others it can still be relevant as long as it is close enough.

Hard RTOS…

- A hard real-time system has time-critical deadlines that must be met; otherwise a catastrophic system failure can occur.

- Absolutely, positively, first time every time

- Requires formal verification/guarantees of being to always meet its hard deadlines (except for fatal errors).

- Examples:
  - air traffic control
 - Nuclear power plant control

Hard Real-Time

Examples:

- Air France Flight 447 crashed into the ocean after a sensor malfunction caused a series of system errors. The pilots stalled the aircraft while responding to outdated instrument readings. All 12 crew and 216 passengers were killed.

- Mars Pathfinder spacecraft was nearly lost when a priority inversion caused system restarts. A higher priority task was not completed on time due to being blocked by a lower priority task.Problem was corrected and the spacecraft landed successfully.

Real-time OS components
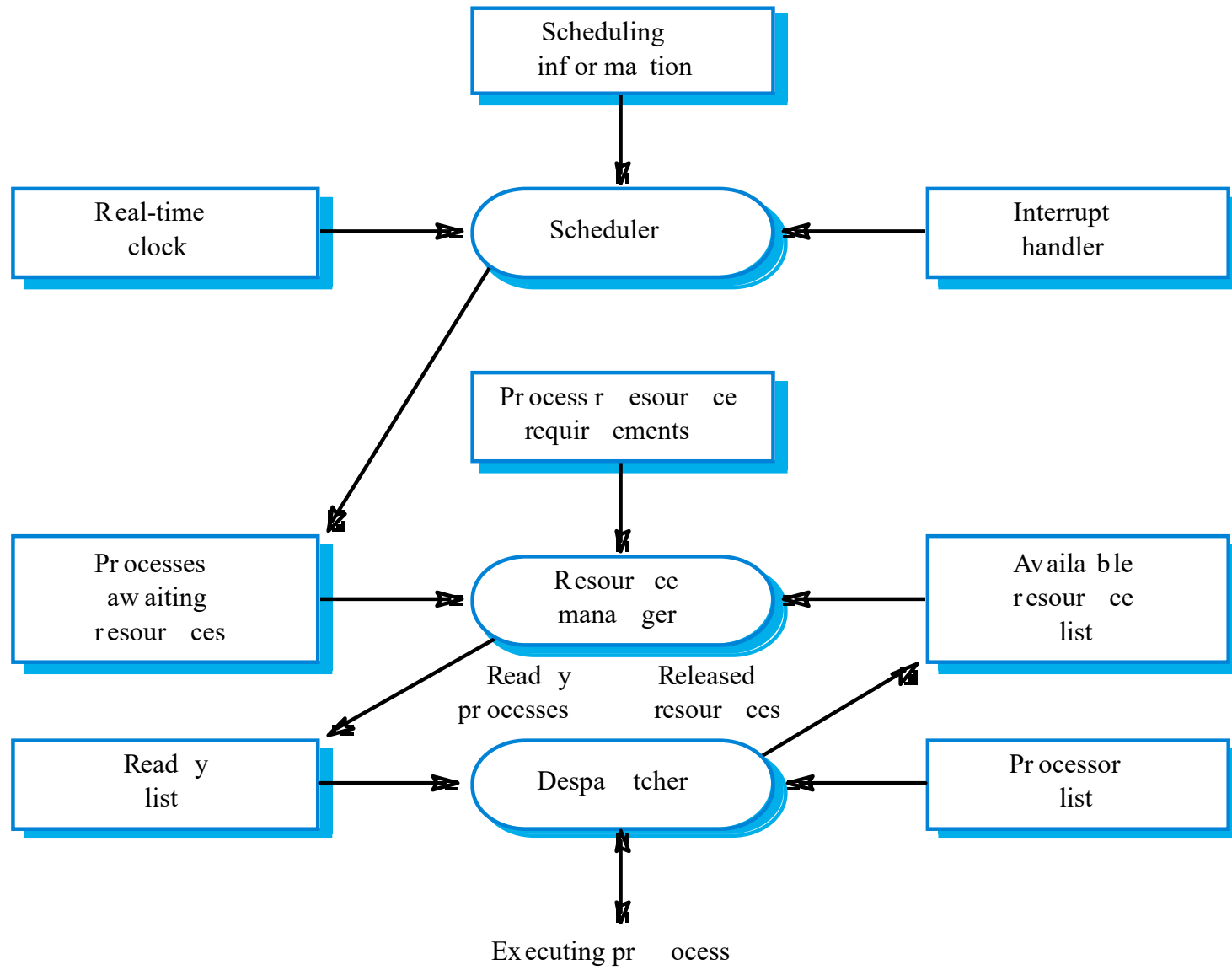
Real Time Operating system components

- Real-time clock
  - Provides information for process scheduling.
- Interrupt handler
  - Manages aperiodic requests for service.
- Scheduler
  - Chooses the next process to be run.
- Resource manager
  - Allocates memory and processor resources.
- Dispatcher
  - Starts process execution.

Batch Operating System

- In a batch operating system, we group together same type of processes and schedule it for execution

- Lets consider there are two types of files (2 Fortran Programs, 3 COBOL programs) that need to be run on the CPU. Now ,

  What Batch OS does is it groups all the files of similar type and executes it , then move on to the next "group" of files.

Hence, we first we take all the Fortran Programs (assumption) , and execute these, and next we take all the COBOL programs and executes it. By doing so , we need not to frequently switch between the compilers for different programming languages (Two in this case: 1 for Fortran , and 1 for COBOL).

Advantages of Batch OS

- Processor consumes good time while processing that mean it knows which job to process next. In real time systems we don't have expectation time of how long the job is and what is estimated time to complete it. But in batch systems the processor knows how long the job is as it is queued.

- The idle time batch system is very less.

Advantages of Batch OS

- You can assign specific time for the batch jobs so when the computer is idle it starts processing the batch jobs i.e. at night or any free time.

- The batch systems can manage large repeated work easily.

Disadvantages OF BOS

• Computer operators must be trained for using batch systems.

• It is difficult to debug batch systems.

• Batch systems are sometime costly.

• If some job takes too much time i.e. if error occurs in job then other jobs will wait for unknown time.

General OS Vs Real time OS

1. A regular OS focuses on computing throughput while an RTOS focuses on very fast response time

2. OSes are used in a wide variety of applications while RTOSes are generally embedded in devices that require real time response

3. OSes use a time sharing design to allow for multi-tasking while RTOSes either use a time sharing design or an event driven design

4. The coding of an RTOS is stricter compared to a standard OS.

!! Attendance please !!

Thank You!!!