



# **MONITORING AND CONTROL SYSTEM**

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# Monitoring and control systems

- Important class of real-time systems
- Continuously check sensors and take actions depending on sensor values
- Monitoring systems examine sensors and report their results
- Control systems take sensor values and control hardware actuators



# Burglar Alarm system

- Designed to detect intrusion, unauthorized entry
- Used in residential, commercial, industrial, and military for protection against burglary (theft).





# Burglar Alarm system

- A system is required to monitor sensors on doors and windows to detect the presence of intruders in a building
- When a sensor indicates a break-in, the system switches on lights around the area and calls police automatically
- The system should include provision for operation without a mains power supply





# Burglar Alarm system

- **Sensors**

- Movement detectors, window sensors, door sensors.
- 50 window sensors, 30 door sensors and 200 movement detectors
- Voltage drop sensor

- **Actions**

1. When an intruder is detected, **police are called automatically.**
2. **Lights are switched on** in rooms with active sensors.
3. An **audible alarm** is switched on.
4. The system switches automatically to **backup power when a voltage drop** is detected.



IR Movement Sensor



Door Sensor



# RT System Design Process

1. **Identify stimuli** and associated **responses**
2. **Define the timing constraints** associated with each stimulus and response
3. **Allocate system functions** to concurrent processes
4. **Design algorithms** for stimulus processing and response generation
5. **Design a scheduling system** to meet their deadlines
6. Integrate with Real Time Executives



# Stimuli to be Processed & Responses

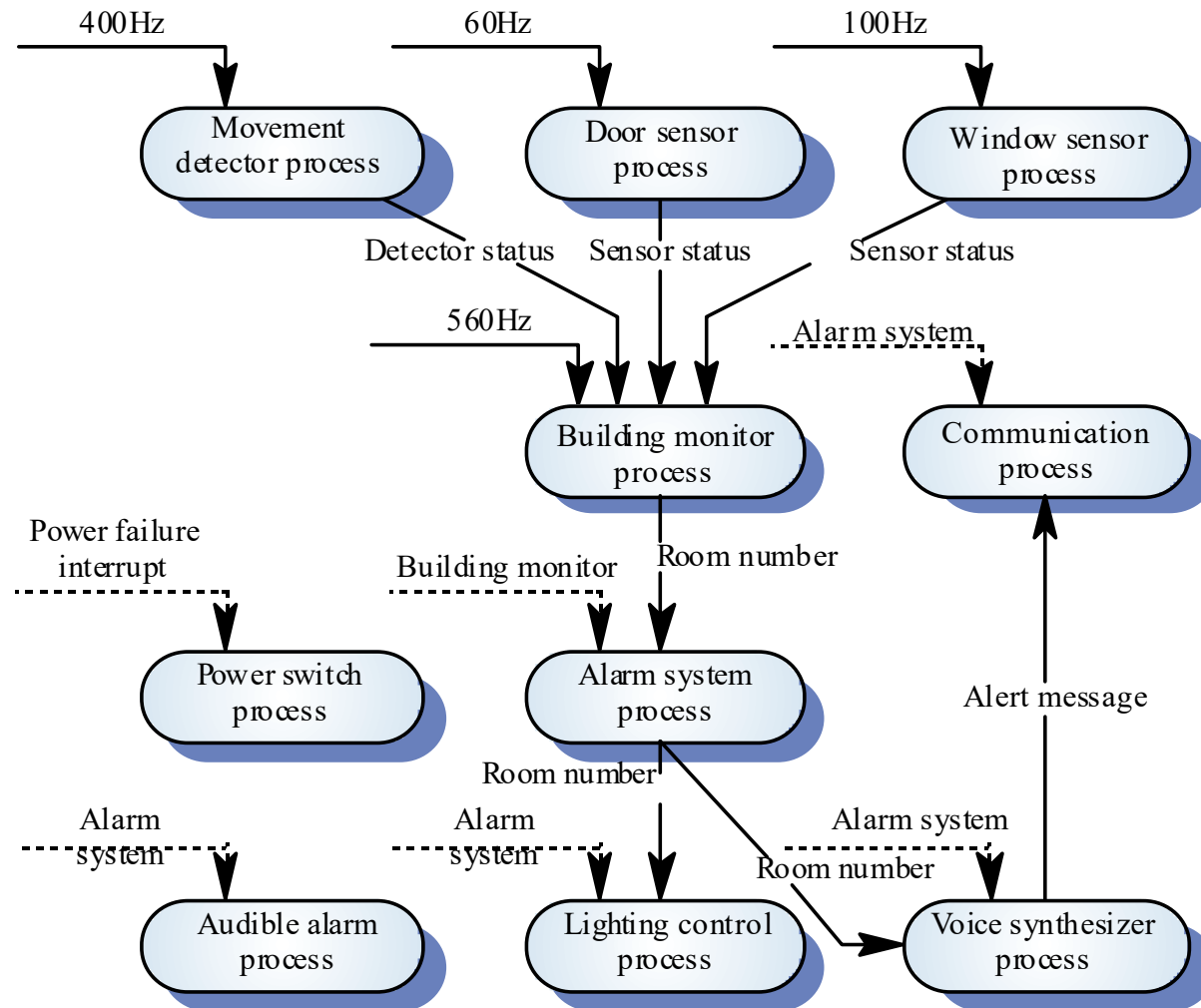
- **Power failure**
  - Generated **aperiodically** by a circuit monitor.
  - When received, the system must **switch to backup power within 50 ms**
- **Intruder alarm**
  - Stimulus **generated by system sensors**
  - Response is to call the police,
  - switch on building lights
  - and the audible alarm



# Timing Requirements

Stimulus/Response	Timing requirements
Stimulus & Timing	
Power fail interrupt	must be completed within a deadline of 50 ms.
Door alarm	should be polled twice per second.
Window alarm	should be polled twice per second.
Movement detector	should be polled twice per second.
Response & Timing	
Audible alarm	should be switched on within 1/2 second of an alarm being raised
Lights switch	should be switched on within 1/2 second of an alarm being raised
Communications	The call to the police should be started within 2 seconds of the alarm
Voice synthesiser	A synthesised message should be available within 4 seconds of an alarm

# Process Architecture



Source: Software Engineering, Ian Sommerville



# Building Monitor Process 1

```
// See http://www.software-engin.com/ for links to the complete  
// Java code for this example
```

```
class BuildingMonitor extends Thread {
```

```
    BuildingSensor win, door, move ;
```

```
    Siren    siren = new Siren () ;
```

```
    Lights   lights = new Lights () ;
```

```
    Synthesizer synthesizer = new Synthesizer () ;
```

```
    DoorSensors doors = new DoorSensors (30) ;
```

```
    WindowSensors    windows = new WindowSensors (50) ;
```

```
    MovementSensors movements = new MovementSensors (200) ;
```

```
    PowerMonitor pm = new PowerMonitor () ;
```

```
    BuildingMonitor()
```

```
{
```

```
    // initialise all the sensors and start the processes
```

```
    siren.start () ; lights.start () ;
```

```
    synthesizer.start () ; windows.start () ;
```

```
    doors.start () ; movements.start () ; pm.start () ;
```

```
}
```



# Building Monitor Process 2

```
public void run () {
    int room = 0 ;
    while (true) {
        // poll the movement sensors at least twice per second (400 Hz)
        move = movements.getVal () ;
        // poll the window sensors at least twice/second (100 Hz)
        win = windows.getVal () ;
        // poll the door sensors at least twice per second (60 Hz)
        door = doors.getVal () ;
        if (move.sensorVal == 1 | door.sensorVal == 1 | win.sensorVal == 1)
        {
            // a sensor has indicated an intruder
            if (move.sensorVal == 1)         room = move.room ;
            if (door.sensorVal == 1)         room = door.room ;
            if (win.sensorVal == 1 )         room = win.room ;

            lights.on (room) ; siren.on () ; synthesizer.on (room) ;
            break ;
        }
        lights.shutdown () ; siren.shutdown () ; synthesizer.shutdown () ;
        windows.shutdown () ; doors.shutdown () ; movements.shutdown () ;

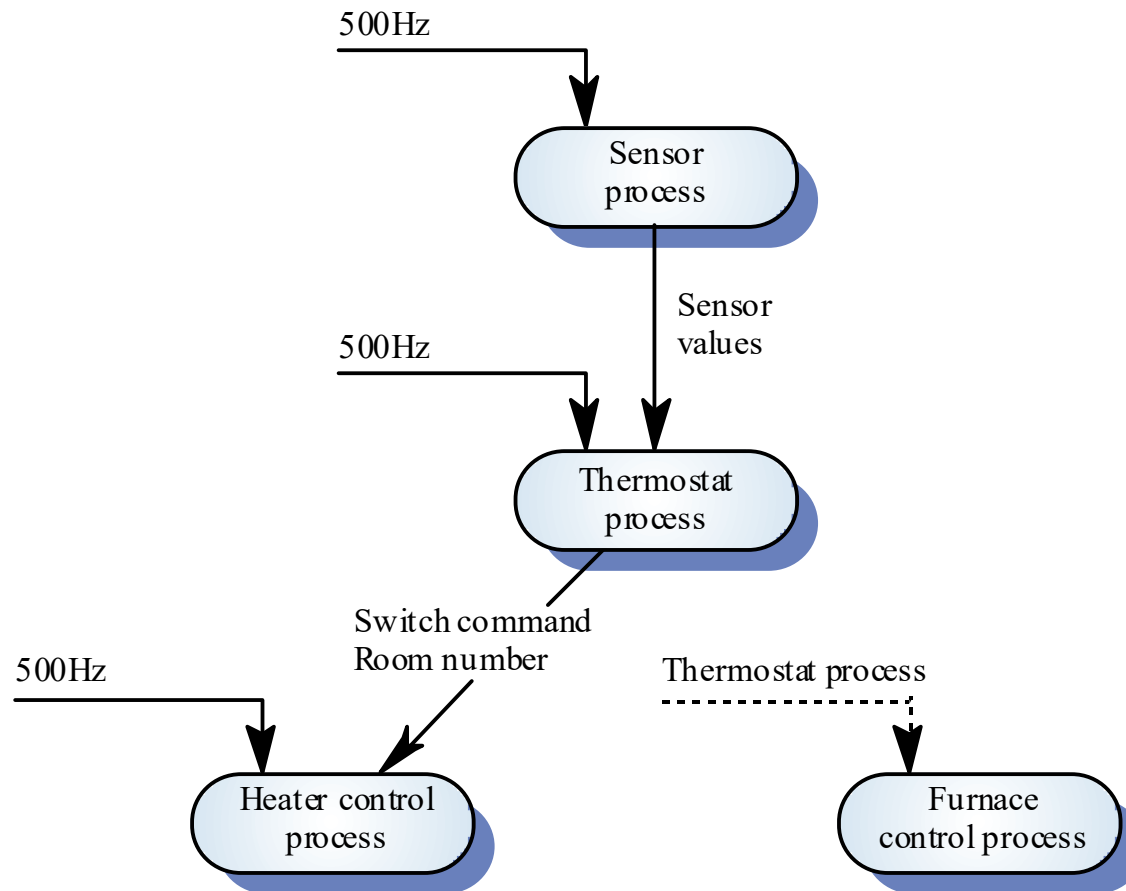
    } // run
} //BuildingMonitor
```



# Control System

- A burglar alarm system is primarily a monitoring system. It collects data from sensors but no real-time actuator control
- Control systems are similar but, in response to sensor values, the system sends control signals to actuators
- An example of a monitoring and control system is a system which monitors temperature and switches heaters on and off

# Temperature Control System



Source: *Software Engineering, Ian Sommerville*



# ASSESSMENT

## MATCH THE FOLLOWING

Match

- |                               |                   |
|-------------------------------|-------------------|
| a. Burglar Alarm System       | Control System    |
| b. Door Sensor                | Power Failure     |
| c. Aperiodic Stimuli          | Twice per second  |
| d. Temperature Control System | Monitoring System |
| e. Movement Sensor            | Periodic Stimuli  |



## Reference

*Software Engineering 6<sup>th</sup> Edition Ian Sommerville*

Thank You