Embedded Systems Programming

RT Task Model
(Module 22)

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Event and Time-Driven Threads

`pthread_create ( ... )`
`taskSpawn (name, priority, options, stacksize, main, ...)`

- **Initialization**
- **External trigger?**
  - ISR: to set/clear events
  - Take actions and change system state

- **Task initialization**
  - `start_time=time()`
  - **Computation**
  - `Sleep(period - (time() - start_time))`
Multiple Events in One Thread

```c
void compute()
{
    if (event1) then action1;
    if (event2) then action2;
    if (event3) then action3;
    .
}

or
{
    for (i=0, i<n, i++)
        if event[i] then action[i];
}
```

```c
void compute()
{
    if (event1) then action1;
    else if (event2) then action2;
    else if (event3) then action3;
    .
}

or
{
    for (i=0, i<n, i++)
        if event[i] then {
            action[i];
            break;
        }
}
```
Task model

- **Periodic task** $T_i$: (examples ??)
  - constant (or bounded) period, $p_i$: inter-release time between two consecutive jobs
  - phase $\phi_i$, utilization $\mu_i = e_i / p_i$, deadline (relative) $D_i$

- **Aperiodic and sporadic**: (examples ??)
  - uncertain interarrival times but with a minimum separation
  - aperiodic: with a soft or no deadline
  - sporadic: with a hard deadline
### Terminology: Temporal Parameters

- **Release time:**
  - fixed [r], jitter [r-Δ, r+Δ], sporadic or aperiodic

- **Execution time:**
  - uncertainty from memory refresh, contention due to DMA, cache misses, interrupts, OS overhead
  - execution path variations

- **WCET:** a “deterministic” parameter for the worst-case execution time
  - a conservative measure
  - an assumption to make scheduling and validation easier
  - how can you measure the WCET of a job?
Terminology

- **Hard deadline**: late result is little or no value, or may lead to disaster
  - need to validate (can you guarantee it?)

- **Soft deadline**: late result may still be useful
  - probability of missing deadlines
  - 95% of telephone switch connects in 10 seconds

- **How serious is serious?**

- **Tardiness**:
  - \( \min\{0, \text{deadline} - \text{completion time}\} \)

- **Usefulness**:
  - function of tardiness