Schedulers

ENCE464 Embedded Software and Advanced Computing

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Where we're going today

- **Scheduling in FreeRTOS**
- Static scheduling
- Non-preemptive and preemptive fixed-priority scheduling
- Preemptive dynamic-priority scheduling

Scheduling in FreeRTOS

- FreeRTOS runs a round-robin pre-emptive scheduler with task switches occurring on ticks (controlled by SysTick Interrupts)

- FreeRTOS implements multiple tasks by having the host program call a task tick method at regular short intervals
  - Interval of 1 ms to 10 ms
  - Task tick method switches tasks depending on priority and round-robin scheduling

From The Little Book of Semaphores.pdf

Static Scheduling (1)

- Example: static scheduling of tasks A, B and C
  - In a 20ms interval, task A must occur 4 times, each requiring 1ms to run
  - In a 20ms interval, task B must occur once, each requiring 7ms to run
  - In a 20ms interval, task C must occur 2 times, each requiring 3ms to run
  - Cyclic executive program with major cycle of 20ms and minor cycle of 1ms

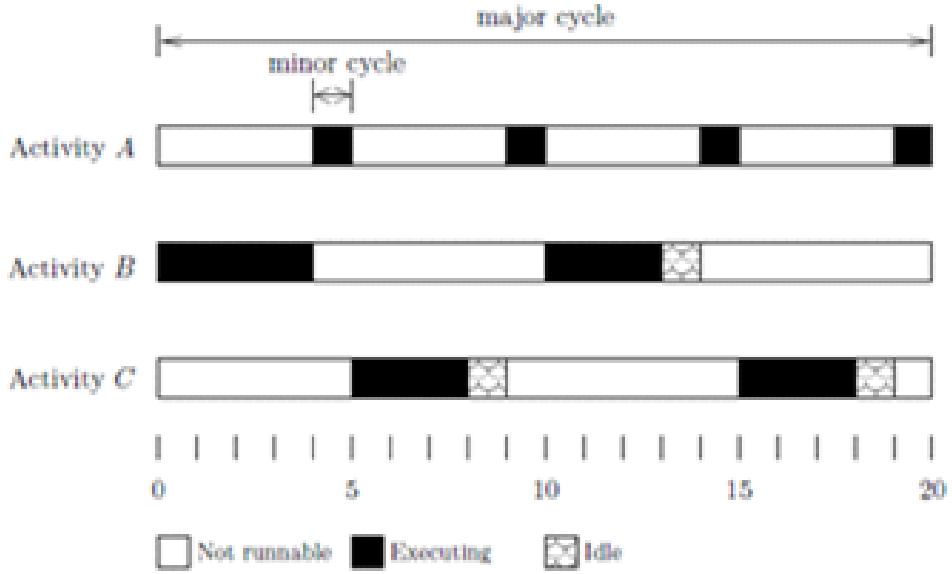

Fig. 5. A static schedule.

Static Scheduling (2)

- Advantages ☺
  - Entirely deterministic programs
    - Able to know which task is executing
  - Does not require run-time operating system to schedule tasks
    - Activity interleaving is ‘hardwired’ into the program code
- Disadvantages? ☹

Non-preemptive Fixed Priority Scheduling (1)

- Example: scheduling of tasks H, M and L
  - Task H requires 4ms to run and has a deadline of 10ms w.r.t. its arrival
  - Task M requires 7ms to run and has a deadline of 12ms w.r.t. its arrival
  - Task L requires 6ms to run and has a deadline of 19ms w.r.t. its arrival

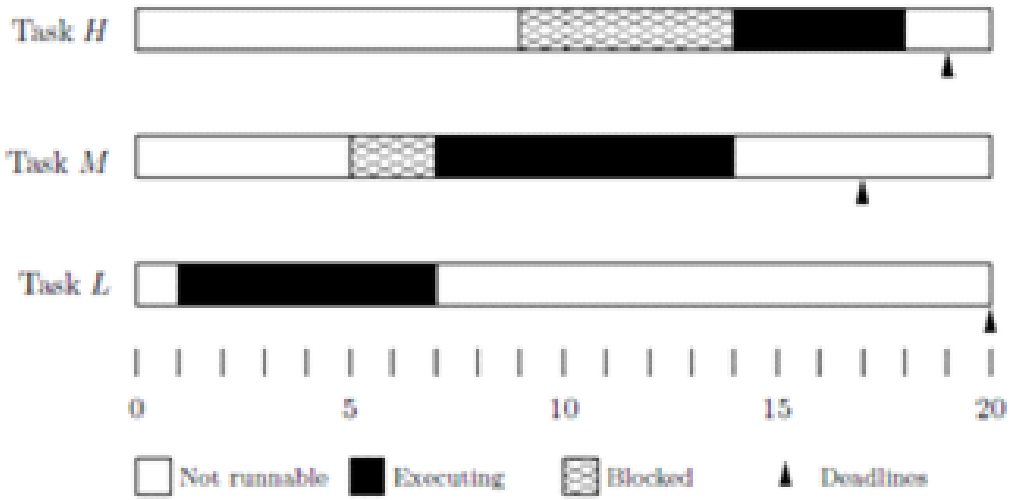

Fig. 6. Non-preemptive fixed-priority scheduling.

Non-preemptive Fixed Priority Scheduling (2)

- Advantages ☺
  - Simple to implement
  - Schedulability can be analyzed formally
  - Tasks can be designed to act relatively independently
- Disadvantages? ☹

Preemptive Fixed Priority Scheduling (1)

- Example: scheduling of tasks H, M and L
  - Task H requires 4ms to run and has a deadline of 10ms w.r.t. its arrival
  - Task M requires 7ms to run and has a deadline of 12ms w.r.t. its arrival
  - Task L requires 6ms to run and has a deadline of 19ms w.r.t. its arrival

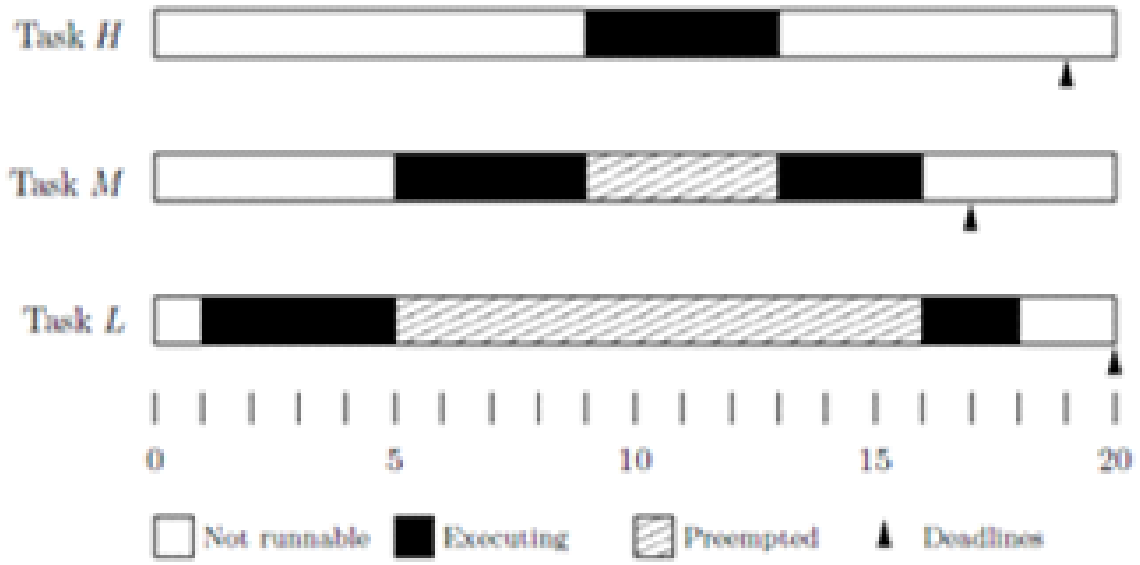

Fig. 7. Preemptive fixed-priority scheduling.

Preemptive Fixed Priority Scheduling (2)

- Advantages ☺
  - Faster response to higher-priority tasks
  - Run-time operating system determines when context switches must occur
  - Schedulability can be analyzed formally
- Disadvantages? ☹

Preemptive Dynamic Priority Scheduling (1)

- Example: earliest deadline first scheduling of tasks A, B and C
  - Task A requires 4ms to run and has a deadline of 10ms w.r.t. its arrival
  - Task B requires 7ms to run and has a deadline of 12ms w.r.t. its arrival
  - Task C requires 6ms to run and has a deadline of 19ms w.r.t. its arrival

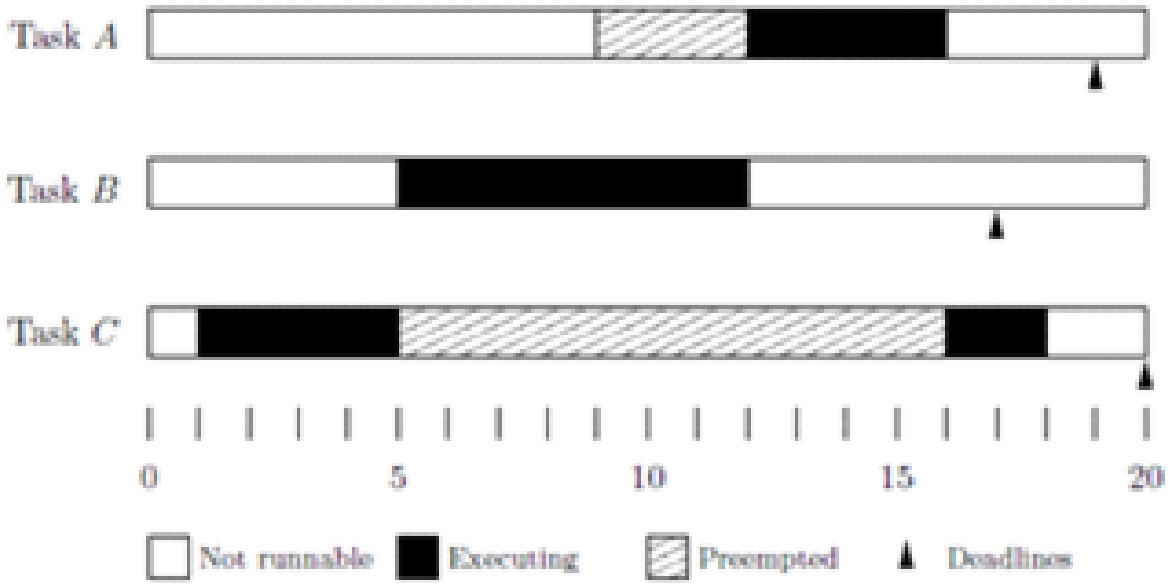

Fig. 8. Preemptive dynamic-priority scheduling.

Preemptive Dynamic Priority Scheduling (2)

- Strategies for dynamically assigning task priorities
  - Earliest deadline first
  - Least slack time first
  - Shortest execution time first
  - Largest execution time first

Summary

- Static Scheduling offers advantages of determinism and some simplicity, it cannot adequately cope with asynchronous or spasmodic events
- Non-Preemptive Fixed-Priority Scheduling allows independent tasks with low coupling, but can be vulnerable to an over-running low-priority tasks
- Preemptive Fixed-Priority Scheduling (fixed with respect to the RTOS; tasks can alter priorities) offers faster response to high prioroty tasks, and relatively stable behavior; it suffers from more jitter and more complexity than simpler schemes
- Preemptive Dynamic-Priority Scheduling (with the RTOS deciding on priorities) offers theoretical advantages, but in practice it is difficult to achieve reliable response under transient overload