HOGESCHOOL ROTTERDAM

Real-Time Operating Systems

ROS01

Minor Embedded Systems

Week 3
Cooperative Scheduling

Planning ROS01

- Week 1: Introduction – Blinking leds
- Week 2: Super loop construct with an ISR
- **Week 3: Cooperative Scheduling**
- Week 4: Pre-emptive Scheduling
- Week 5: Using TI-RTOS
- Week 6: Schedulability Analyses, Priority Assignment
- Week 7: Response Time Analyses
- Week 8: Finalizing Final Assigment

Overview

- Scheduling
  - Problem
  - Goal
  - Possible solution

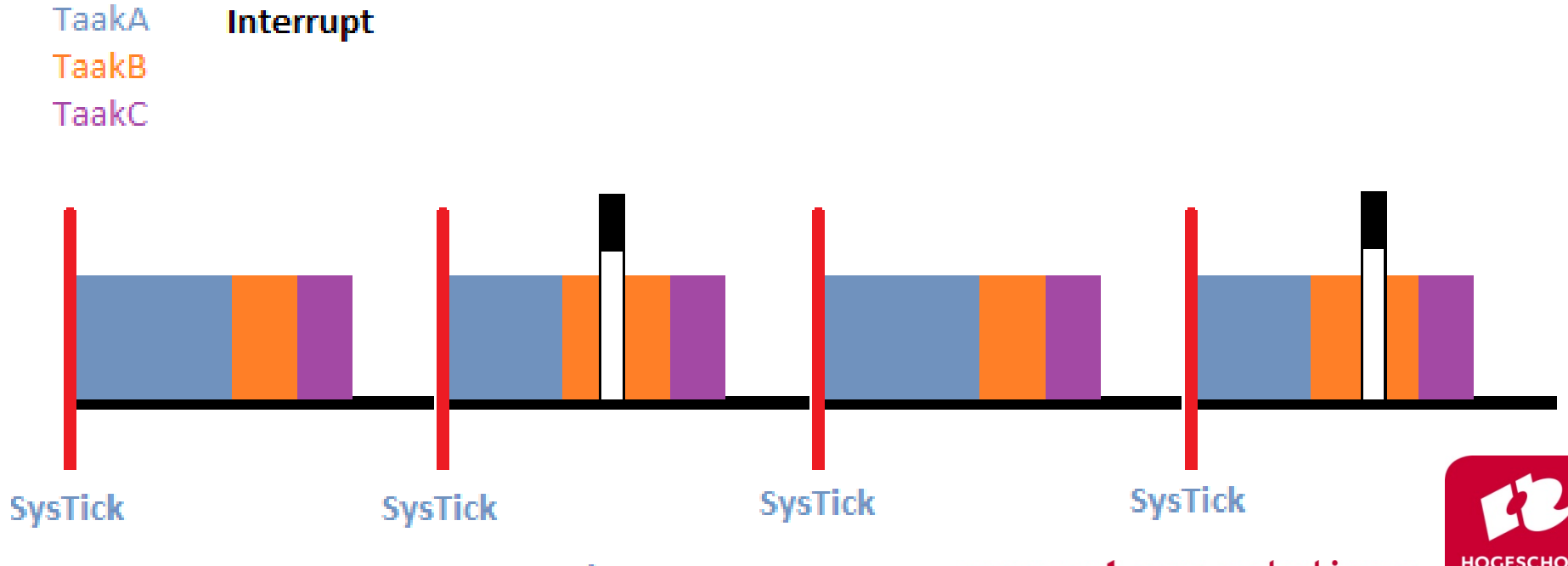
Scheduling

- Problem
  - Multiple processes require CPU time
    - Some processes need it ASAP
    - Some processes just need to happen at some point in time
  - Multiple processes require bandwidth
    - USB, Serial, SPI ....
    - Prioritization?

- Goal
  - Create a framework that'll ease (CPU) time management
  - Easy to add new processes and to share resources

Superloop Construct

- Unnecessarily runs all tasks every tick
- $\sum_t time$ < SysTick time
  - Limited amount of tasks
  - Blocking tasks will cause problems: `while (buttonIsPressed())`

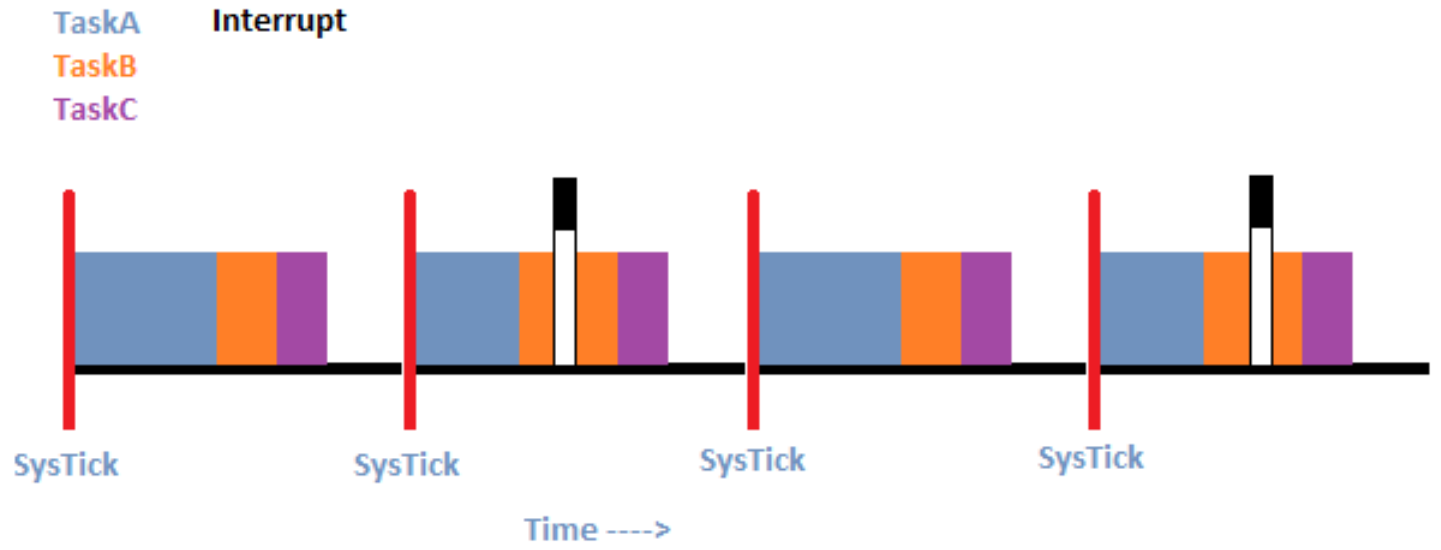


‘Complex’ Cooperative Scheduler

- Cooperative:
  - Task finishes
  - then transfers control back to the scheduler

- No fights over concurrent use of hardware
- Perfect for small amount of tasks
- Easy to maintain
- Adaption to simple version:
  - Each task gets its own period (e.g. 400 SysTicks)
  - Each task could have a priority, state, etc

Difference



Overview

- Tasklist
  - Structure (`struct`) for each task
  - Ordered by priority
  - Only execute task when ready

- Use SysTick to determine which task is READY
- Use main loop to execute all ready tasks.
- Sleep until next SysTick

Interim : Function pointer

- Syntax

```
void func(int);
void (*pointerNaarFunc)(int);
```

- To run

```
pointerNaarFunc = &func;
(*pointerNaarFunc)(42);
```

- To run (alternative)

```
pointerNaarFunc = func;
pointerNaarFunc(42);
```

Suspending a task

- Implementing a delay using SysTick
  - Change state to WAITING
  - Initialize a counter, or add to the existing period
  - Decrement the counter each tick
  - When reached zero, put into ready mode

Scheduling

- The process of selecting the task to execute next
  - What if 3 tasks are READY at the same time?
  - Which one will be selected first?

- Scheduling algorithms
  - FIFO
  - Priority based
  - Shortest Job First

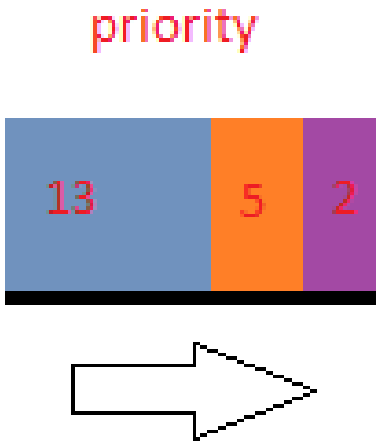
FIFO – Scheduling Algorithm

- Tasks are run in order of task-creation
  - Add most important tasks first
  - Add less important tasks later

- Pro
  - Easy!
  - No overhead in selecting
- Con
  - Fixed solution, pre-determined at compile time
  - Tasks created run-time are always last

Priority based – Scheduling Algorithm

- Use ‘priority’ number over position in task list
  - Highest priority task goes first of all READY tasks

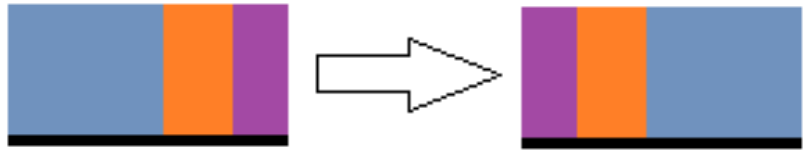


- Pro
  - Ability to work with more tasks
  - Possible to change priority real time
  - Most demanding tasks run first
- Cons
  - Means either sorting a list or traversing it
    - Increases scheduling time

Shortest Job First – Scheduling Algorithm

- First execute the task with shortest estimated run-time
  - First used in database applications, keep customers happy!

- Pro
  - Shortest average waiting time
- Con
  - Estimating (dynamic) task time
  - Longest tasks have worst reaction time



Next Week

- Pre-Emptive scheduling
- (pre-emptive) Scheduling algorithms