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OS Scheduler

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Objectives

- Evaluating different scheduling algorithms.
- Practice the use of IPC techniques.
- Best usage of algorithms, and data structures.

Platform *Linux*

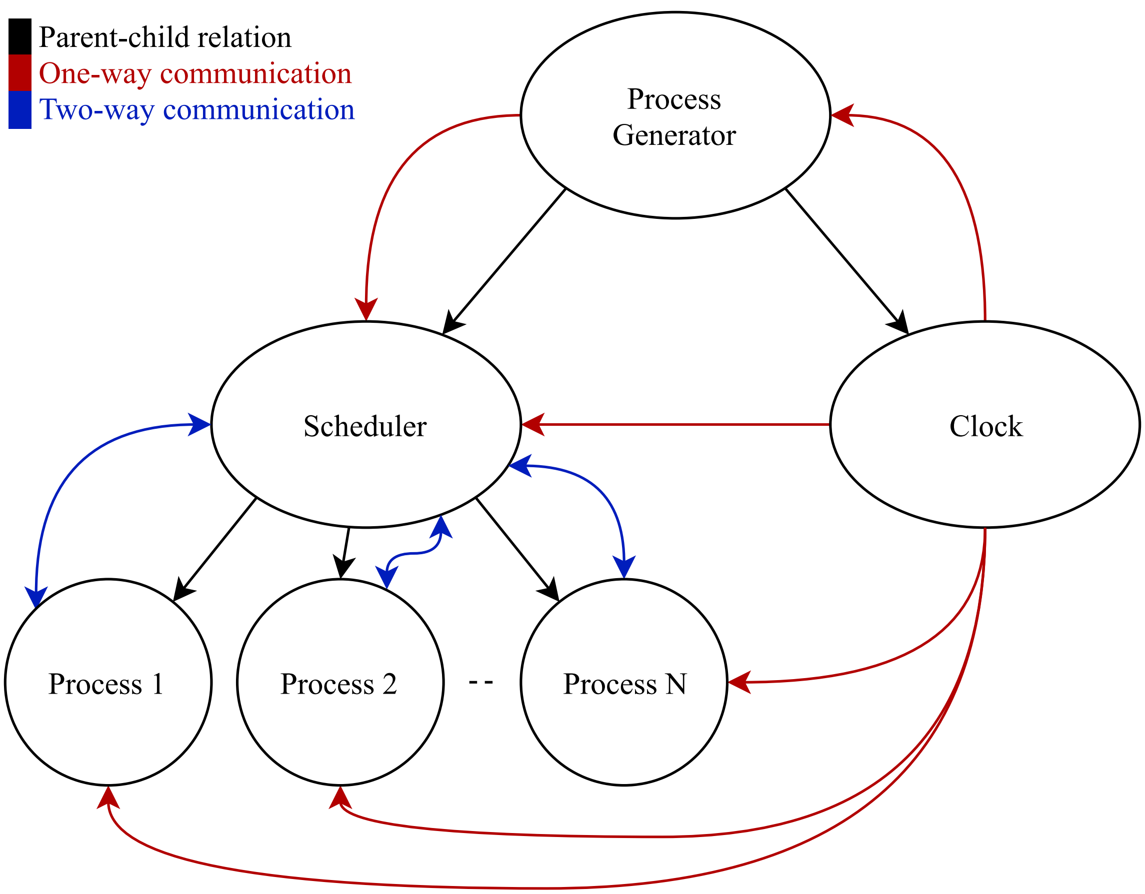
Language *C*

Introduction

A CPU scheduler determines an order for the execution of its scheduled processes; it decides which process will run according to a certain *data structure* that keeps track of the processes in the system and their status.
A process, upon creation, has one of the three states: *Running*, *Ready*, *Blocked* (doing I/O, using other resources than CPU or waiting on unavailable resource).
A bad scheduler will make a very bad operating system, so your scheduler should be as much optimized as possible in terms of memory and time usage.

System Description

Consider a Computer with 1-CPU and infinite memory. It is required to make a scheduler with its complementary components as sketched in the following diagrams.



Part I: Process Generator (Simulation & IPC)

CODE FILE *process_generator.c*

The process generator should do the following tasks...

- Read the input files (check the input/output section below).
- Ask the user for the chosen scheduling algorithm and its parameters, if there are any.
- Initiate and create the scheduler and clock processes.
- Create a data structure for processes and provide it with its parameters.
- Send the information to the scheduler *at the appropriate time* (when a process arrives), so that it will be put it in its turn.
- At the end, clear IPC resources.

Part II: Clock (Simulation & IPC)

CODE FILE *clk.c*

The clock module is used to emulate an integer time clock. *This module is already built for you.*

Part III: Scheduler (OS Design & IPC)

CODE FILE *scheduler.c*

The scheduler is the core of your work, it should keep track of the processes and their states and it decides - based on the used algorithm - which process will run and for how long.
You are required to implement the following THREE algorithms...

1. Non-preemptive Highest Priority First (HPF).
2. Shortest Remaining time Next (SRTN).
3. Round Robin (RR).

The scheduling algorithm only works on the processes in the *ready queue*. (Processes that have already arrived.)
The scheduler should be able to

1. Start a new process. (Fork it and give it its parameters.)
2. Switch between two processes according to the scheduling algorithm. (Stop the old process and save its state and start/resume another one.)
3. Keep a *process control block (PCB)* for each process in the system. A PCB should keep track of the state of a process; running/waiting, execution time, remaining time, waiting time, etc.
4. Delete the data of a process when it gets notifies that it finished. *When a process finishes it should notify the scheduler on termination, the scheduler does NOT terminate the process.*
5. Report the following information
   (a) CPU utilization $1 - p^n$
   (b) Average weighted turnaround time.
   (c) Average waiting time.
   (d) Standard deviation for average weighted turnaround time.
6. Generate two files: (check the input/output section below)
   (a) Scheduler.log
   (b) Scheduler.perf

Part IV: Process (Simulation & IPC)

Code File *process.c*

Each process should act as if it is CPU-bound.
Again, *when a process finishes it should notify the scheduler on termination, the scheduler does NOT terminate the process.*

Part V: Input/Output (Simulation & OS Design Evaluation)

Input File

processes.txt example

```
#id arrival runtime priority
1   1       6       5
2   3       3       3
```

- Comments are added as lines beginning with # and should be ignored.
- Each non-comment line represents a process.
- Fields are separated with *one tab character '\t'*.
- You can assume that processes are sorted by their arrival time. *Take care that 2 or more processes may arrive at the same time.*
- You can use the *test_generator.c* to generate a random test case.

Output Files

scheduler.log example

```
#At time x process y state arr w total z remain y wait k
At time 1 process 1 started arr 1 total 6 remain 6 wait 0
At time 3 process 1 stopped arr 1 total 6 remain 4 wait 0
At time 3 process 2 started arr 3 total 3 remain 3 wait 0
At time 6 process 2 finished arr 3 total 3 remain 0 wait 0 TA 3 WTA 1
At time 6 process 1 resumed arr 1 total 6 remain 4 wait 3
At time 10 process 1 finished arr 1 total 6 remain 0 wait 3 TA 10 WTA 1.67
```

- Comments are added as lines beginning with # and should be ignored.
- Approximate numbers to the nearest 2 decimal places, e.g. 1.666667 becomes 1.67 and 1.33333334 becomes 1.33.
- Allowed states: *started*, *resumed*, *stopped*, *finished*.
- TA & WTA are written only at *finished* state.
- You need to stick to the given format because files are compared automatically.

scheduler.perf example

```
CPU utilization = 100%
Avg WTA = 1.34
Avg Waiting = 1.5
Std WTA = 0.34
```

- If your algorithm does a lot of processing, processes might not start and stop at the same time instance. Then, your utilization should be less than 100%.

Guidelines

- Read the document carefully at least once.
- You can specify any other additional input to algorithms or any assumption but after taking permission from your TA.
- The user should be able to choose between different scheduling algorithms.
- You should specify how your algorithm handles ties. TIES
- Priority values range from 0 to 10 where *0 is the highest priority and 10 is the lowest priority.*
- Your program must not crash.
- You need to release all the IPC resources upon exit.
- The measuring unit of time is 1 sec, there are no fractions, so no process will run for 1.5 second or 2.3 seconds. Only integer values are allowed.
- You can use any IDE (Eclipse, Code::Blocks, NetBeans, KDevelop, CodeLite, etc.) you want of course, though it would be a good experience to use make files and standalone compilers and debuggers if you have time for that.
- Spend a good time in design and it will make your life much easier in implementation.
- The code should be clearly commented and the variables names should be indicative.

Grading Criteria

- NON compiling code = ZERO grade.
- Correctness & understanding (50%).
- Modularity, naming convention, code style (20%).
- Design complexity & data structures used (20%).
- Team work (10%).

Deliverables

You should deliver code files, test cases and report containing the following information...

- Data Structure used.
- Your algorithm explanation and results.
- Your assumptions.
- Workload distribution.
- A table for time taken for each task. *It will not affect your grade so please be honest.*

Keep the document as simple as possible and do not include unnecessary information we do not evaluate by word count!