Examples of exercises
Use case: Sleepduring

ARCOS

Operating Systems Design

Degree in Computer Engineering

University Carlos III of Madrid

Exercise
statement (1/2)

There is a HW system that includes a clock device. That clock generates an interruption on each tick.

An multi-process OS with a non-preemptive kernel needs to implement a new system call:

```
int sleepLater (int waitfor_s, int sleep_s);
```

This system call allows the calling process to continue executing (if not get blocked for any other reason) for *waitfor_s* seconds, and afterwards, it will sleep for *sleep_s* seconds.

Exercise
statement (2/2)

You are asked to:

a) Implement using pseudocode the required kernel feature.
   You will have to include in your answer:
   - All data structures required or modified
   - Interfaces with implemented functions
   - Events used

Exercise
solution

1. Initial approach:
    1. Draw a diagram of initial system state
    2. Modify the diagram to incorporate the exercise requirements
2. Answer the proposed questions
3. Review the answers

Exercise
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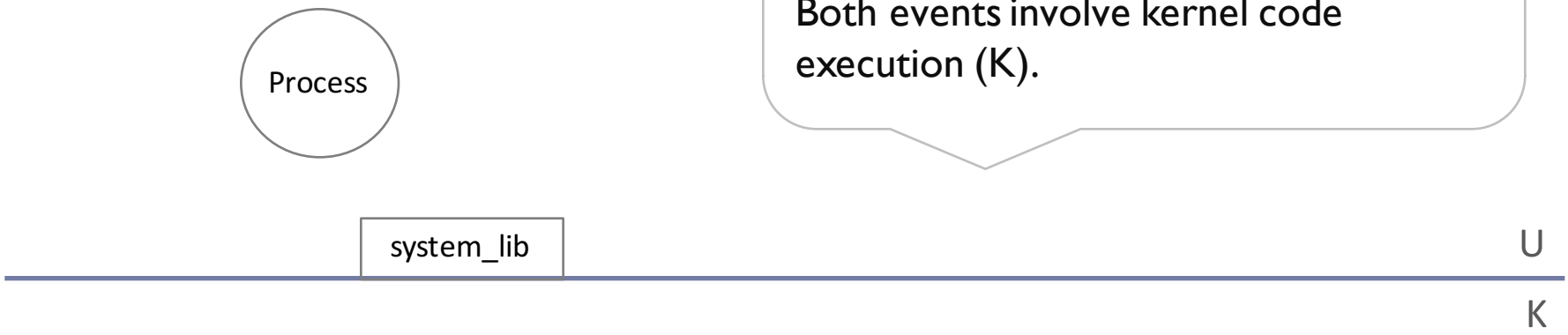
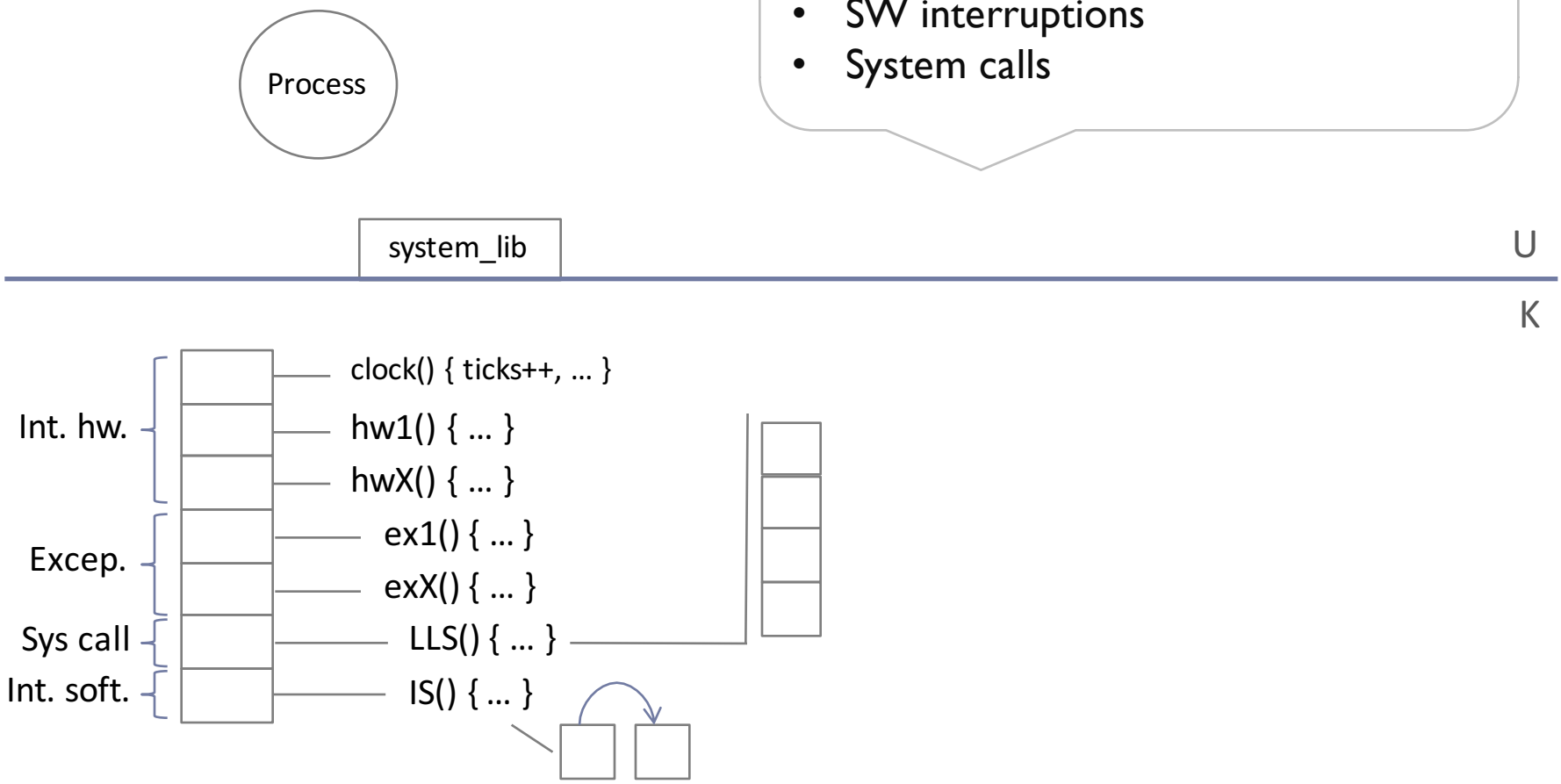
Exercise
solution

In user space (U) processes perform system calls through *system_lib* or provoke exceptions.
Both events involve kernel code execution (K).



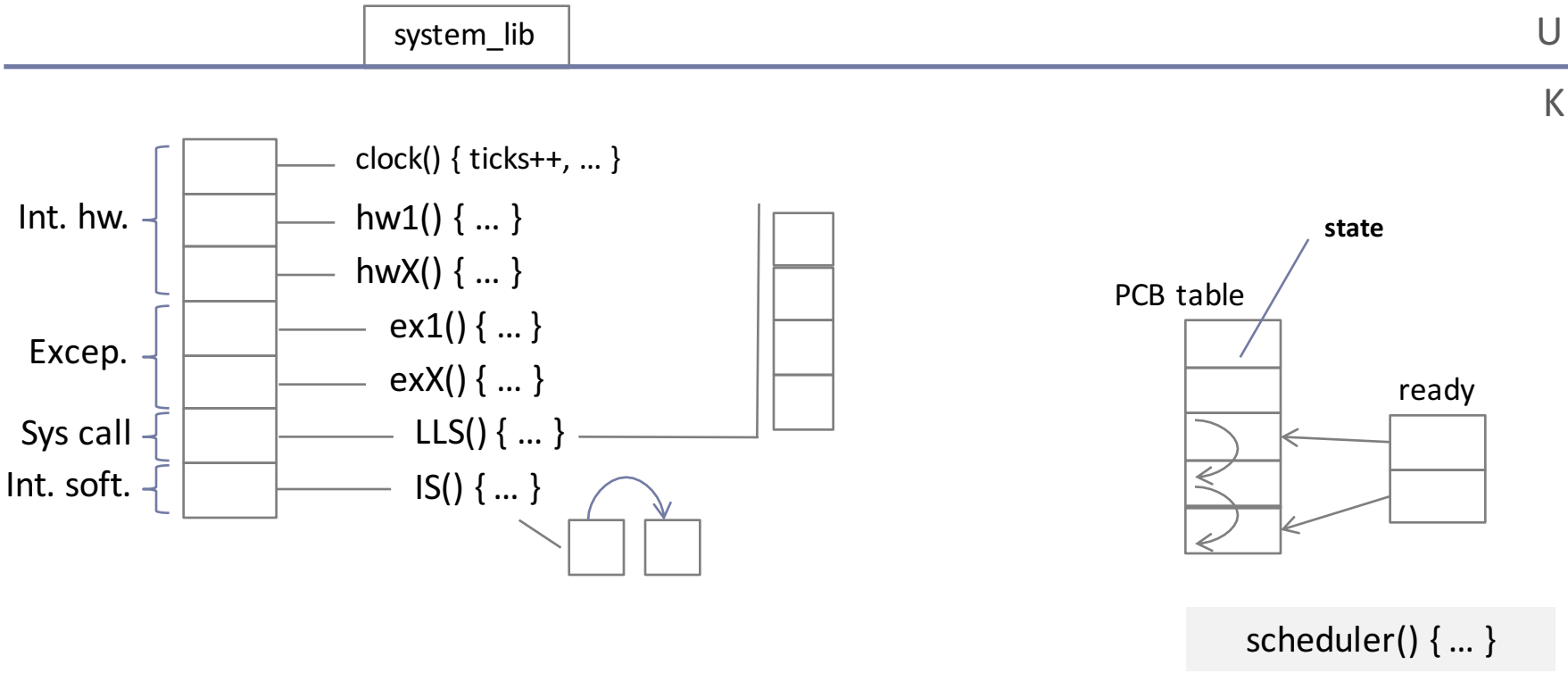
Exercise
solution

Lesson 2: operating system working
- HW interruptions
- Exceptions
- SW interruptions
- System calls



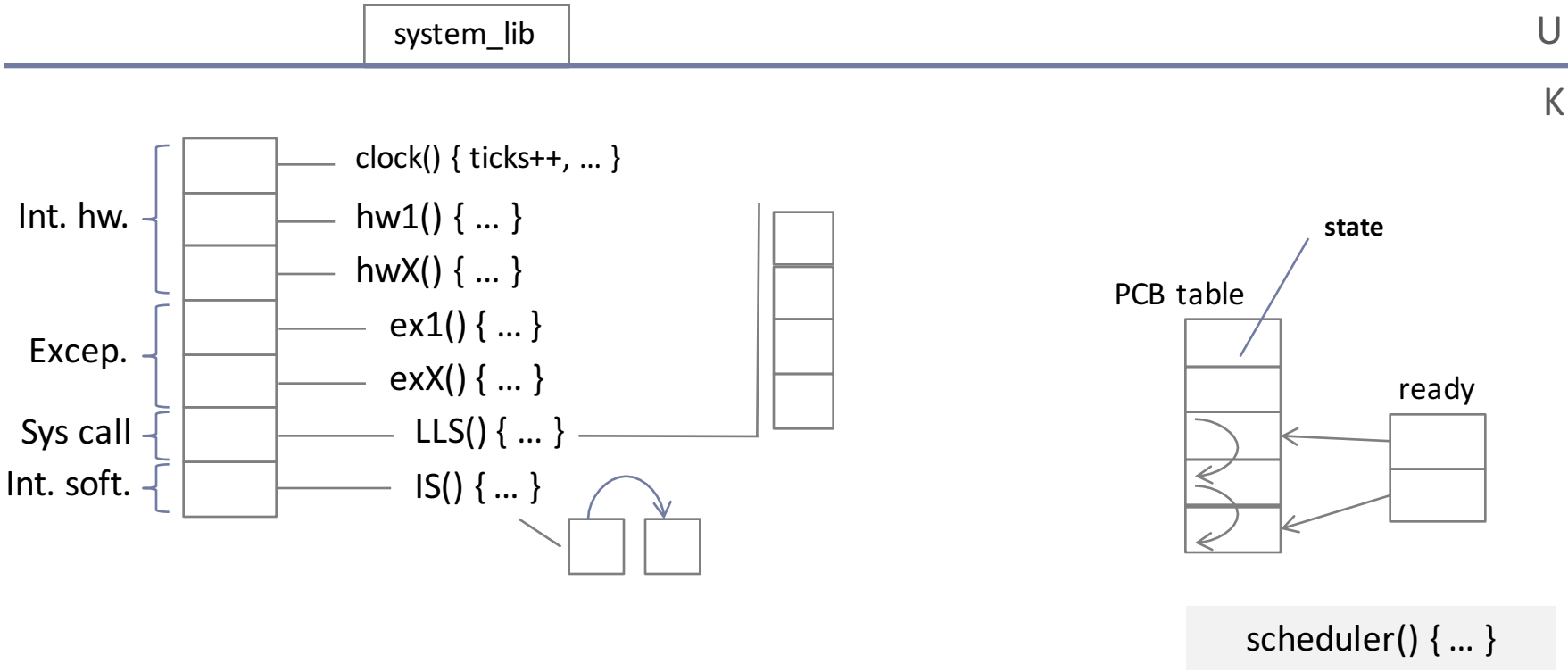
Exercise
solution

Lesson 3b: process management
- PCB table
- Ready-state queues
- scheduler



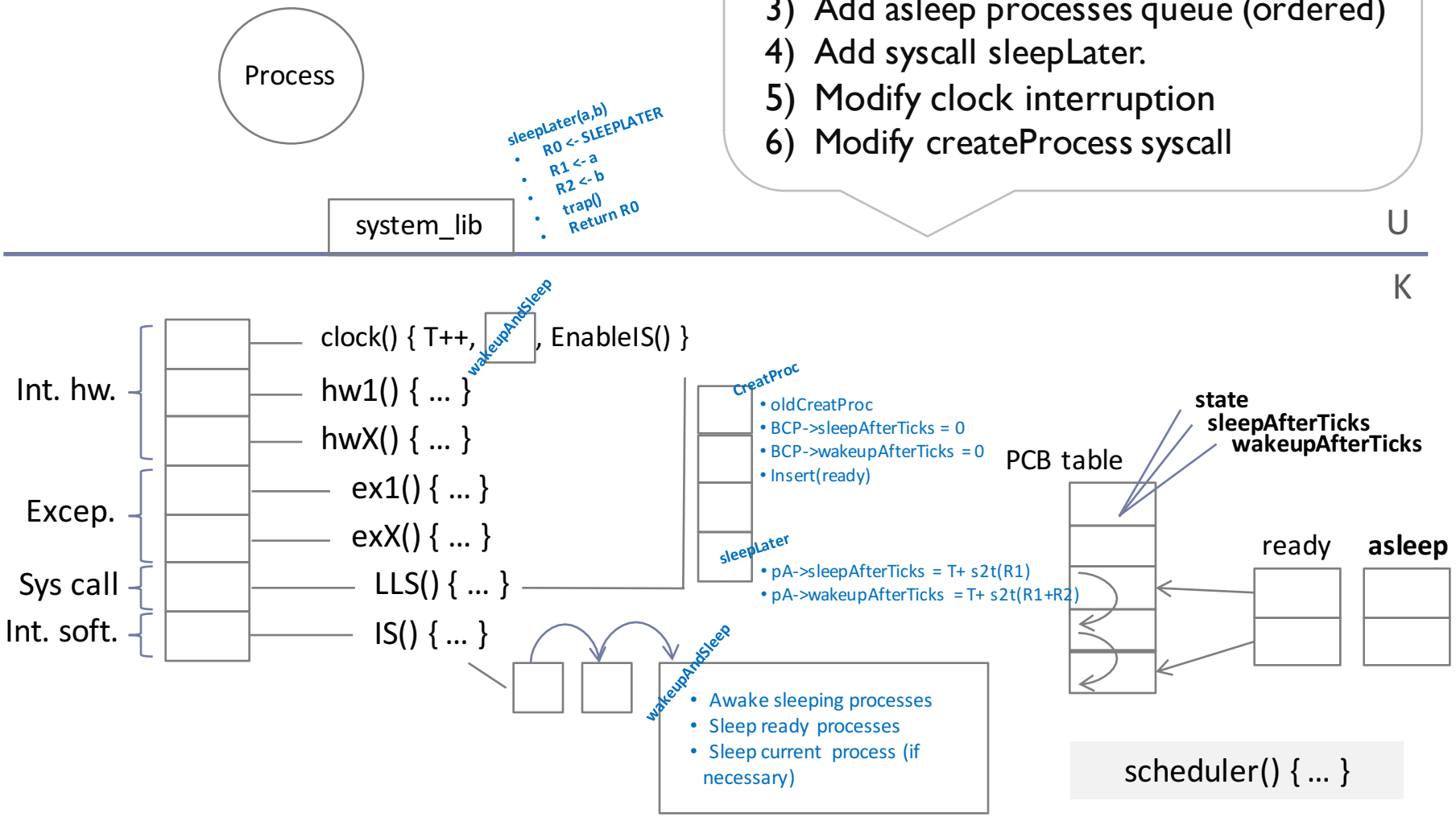
Exercise
solution

Initial structure completed



Exercise
solution

Adding sleepLater to the kernel:
1) Add 'sleepAfterTicks' field to PCB
2) Add 'wakeupAfterTicks' field to PCB
3) Add asleep processes queue (ordered)
4) Add syscall sleepLater.
5) Modify clock interruption
6) Modify createProcess syscall



Exercise
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Exercise
solution

Based on the proposed approach, answer the questions

Data structures:

- PCB:
  - sleepAfterTicks
  - wakeupAfterTicks
  - State: add a new state ASLEEP
- Add a new queue:
  - Sleeping processes queue

Exercise
solution

Funcions:

int createProcess(…)

- Set sleepAfterTicks and wakeupAfterTicks to null values
- return createProcess_base(…)

int sleepAfter (int waitfor_s, int sleep_s)

- current->wakeupAfterTicks = Ticks + SecondsToTicks(waitfor_s+sleep_s);
- current->sleepAfterTicks = Ticks + SecondsToTicks(waitfor_s);

clock_hw_interruption()

- Ticks = Ticks + 1;
- Insert_Software_Interruption(IntSwWakeupAndSleep)
- Software_Interruption();

Exercise
solution

IntSwWakeupAndSleep()

- proc = ExtractFirstProcess (asleep_processes_queue);
- While (Proc->wakeupAfterTicks =< Ticks)
  - proc->state = READY; // Change state **from asleep to ready**.
  - Enqueue(ready_processes_queue, proc); // Enqueue in **ready state queue**.
  - sleepAfterTicks = wakeupAfterTicks = 0; // Set sleepAfterTicks and wakeupAfterTicks to null values
  - Proc = ExtractFirstProcess (asleep_processes_queue);
- Proc = Scheduler() ; // ExtractFirstProcess (ready_processes_queue);
- While((Proc->sleepAfterTicks =< Ticks) && (Proc->wakeupAfterTicks > Ticks))
  - Proc->state = ASLEEP; // Change state **from ready to asleep**.
  - Enqueue(asleep_processes_queue, proc); // Enqueue in **asleep processes queue (decreasing order)**.
  - Proc = Scheduler();
- if ((current > sleepAfterTicks =< Ticks) && (current-> wakeupAfterTicks > Ticks))
  - current->state = ASLEEP; // Change state **from ready to asleep**.
  - Enqueue(asleep_processes_queue, current); // Enqueue in **asleep processes queue (decreasing order)**.
  - old_current = current;
  - current = Scheduler(); // ExtractFirstProcess (ready_processes_queue);
  - current->state = EXECUTION
  - Swap_ontext(old_current, current); // Activator (dispatcher)

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