WE18.1

Video explanation of solution is provided below the problem.

Devices and Interrupts

3 points possible (ungraded)
A computer system has three devices whose characteristics are summarized in the following table:

Device	Service time	Interrupt frequency	Deadline
D1	400us	1/(800us)	800us
D2	250us	1/(1000us)	300us
D3	100us	1/(800us)	400us

Service time indicates how long it takes to run the interrupt handler for each device. The maximum time allowed to elapse between an interrupt request and the end of the execution of the interrupt handler is indicated by the deadline.

1. If a user-mode program P takes 100 seconds to execute when interrupts are disabled, approximately how long will P take to run when interrupts are enabled?

   Approximate time for P to run with interrupts enabled (seconds):

   800 Answer: 800

   Explanation
   Device D1 has a service time of 400us and an interrupt frequency of 1/(800us). This means that device D1 uses up 400/800 or 50% of the cpu time.
   Device D2 has a service time of 250us and an interrupt frequency of 1/(1000us), so it uses for 250/1000 or 25% of the cpu time.
   Device D3 has a service time of 100us and an interrupt frequency of 1/(800us), so it uses 100/800 or 12.5% of the cpu time.
   The remaining time is available for the program to run. So the program runs for 12.5% or 1/8 of the cpu time. Hence, a program that would take 100 seconds to run without interrupts, will take 800 seconds to run with interrupts.

2. Can the requirements given in the table above be met using a **weak** priority ordering among the interrupt requests? If so give priority ordering for D1, D2, D3 or select device(s) whose deadlines cannot be met. Select all that apply.

   Weak priority ordering or list device(s) with missed deadlines:

   - [ ] D1 > D2
   - [ ] D1 > D3
   - [ ] D2 > D1
   - [ ] D2 > D3
   - [ ] D3 > D1
   - [ ] D3 > D2
   - [ ] D1 misses deadline
   - [x] D2 misses deadline
   - [x] D3 misses deadline

Calculator

Explanation
In a weak priority system a running process does not get preempted even if it has a lower priority than the new interrupt. In this system, if D1 is running then D2 and D3 may miss their deadline. This can occur because both D2 and D3 have deadlines that are less than the latency of D1 plus their own latency.

3. Can the requirements given in the table above be met using a **strong** priority ordering among the interrupt requests? If so give priority ordering for D1, D2, D3 or select device(s) whose deadlines cannot be met. Select all that apply.

Strong priority ordering or list device(s) with missed deadlines:

- [ ] D1 > D2
- [ ] D1 > D3
- [x] D2 > D1 ✔
- [x] D2 > D3 ✔
- [x] D3 > D1 ✔
- [ ] D3 > D2
- [ ] D1 misses deadline
- [ ] D2 misses deadline
- [ ] D3 misses deadline

Explanation
In a strong priority system a running process **does** get preempted if it has a lower priority than the new interrupt. In part A, we determined that given the frequency and service times of these interrupts, there is enough time to schedule them all and still have some time left over for user processes. This means that a strong priority ordering must be possible. Knowing that, ordering the devices such that a device with a shorter deadline has higher priority than a device with a higher deadline, results in a valid strong priority ordering of D2 > D3 > D1. Note that in this example, this is the only valid strong prioirty ordering that satisfies all the deadline constraints.

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Answers are displayed within the problem

Devices and Interrupts

Start of transcript. Skip to the end.

For this problem, assume that we have a computer system that has three devices D1, D2, and D3.

Each of these devices can cause interrupts in our system

Calculator

This table summarizes the interrupt characteristics of our three devices.

For each device, we are given its service time which is the amount of time it takes to service an interrupt for that particular device.

0:00 / 0:00 1.0x

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