

1. For lower-level services, an operating system and middleware rely upon different underlying providers. An operating system makes use of the features supported by the hardware to provide the services of its API, whereas middleware utilizes the features supported by an underlying operating system to provide its API services.
2. A thread is any sequence of programmed actions, as well as a fundamental unit of concurrency. A process is a container that holds one or more running threads, and it also protects them from unwanted interactions with unrelated threads running concurrently on the same computer.
3. Security is, personally, the most engaging topic, both because I have always been foremost concerned with the privacy of my own electronics and because it seems to be the foundation by which all operating systems are designed.
4. Total elapsed time:
 - a. $[(10 \text{ ms})100 + 1 \text{ ms}] + 1 \text{ ms} + 1 \text{ s} = 1001 \text{ ms} + 1 \text{ ms} + 1 \text{ s} = 2.001 \text{ seconds}$
 - b. $(10 \text{ ms} + 1 \text{ ms} + 2 \text{ ms} + 1 \text{ s})100 = 101.3 \text{ seconds}$
 - c. The multi-thread program in part (b) is more efficient because it achieves the goal of responsiveness that is

often exemplified with a server hosting multiple clients. Over time, the program described in part (a) could take longer than that in part (b) if more threads, with similar time deficits, are running.

5. The sleeping thread cannot print its message while the main thread is waiting for user input. The main thread cannot read input, kill the second thread, and print a message in the early part of the child thread's five second sleep.

6.

Thread Order	Thread 1 Turnaround (seconds)	Thread 2 Turnaround (seconds)	Thread 3 Turnaround (seconds)	Average (seconds)
123	1	3	6	3.33
132	1	4	6	3.67
213	3	2	6	3.67
231	5	2	6	4.33
312	4	6	3	4.33
321	6	5	3	4.67

Thread order 123 has the shortest average turnaround time of ~3.33 seconds. The scheduling policy that produces this order is the rate monotonic scheduling, in which threads meet their deadlines under the assignment that shorter-processed threads are prioritized over longer-processed ones.