To fully understand the difference between a single-core/single-process operating system and a multi-core/multi-processor operating system, I think it would be best to start by defining what an operating system is and what its responsibilities are. According to Stallings, (2018, p. 41) an operating system utilizes the hardware of a machine for processes in such a way that it obfuscates the intricacies of managing resources, memory, security, and scheduling from the user or developer.

A single-core operating system is a system that can only manage a single process at a time. Although the system can only offer memory, threads, I/O access, and its single processing core to one process at a time, this doesn't mean that that process can't be interrupted during a blocking phase for another process. A multi-core operating system can manage multiple processes concurrently, meaning that one process can be ran on a core at the same exact time as another process on a separate core. A single processor operating system refers to a system with a single CPU. This CPU can be single-core, or multi-core, but there is only a single central processing unit in the system. A multi-processor operating system refers to multiple CPUs tethered together in a single system. Again, these CPUs can be single-core or multiple-core, but the system itself is capable of hosting multiple CPUs.

As with anything, there are merits and pitfalls to both the multi-core operating system and the multi-processor operating system. A "Multicore Processor" refers to a single chip that has more than one processing core integrated into a single die. Each processing core can operate distinctly from its sibling cores, allowing the system to operate as though it has multiple processors. (Stallings, 2018, p.29) Here are three main advantages of a multicore system over a single core system:
1. Performance: A multicore system will outperform a single core system in that it has more processing capacity with the additional embedded processing core. This is due to the added capability to process a single task in parallel on multiple processing cores, or multiple distinct tasks concurrently on multiple processing cores.
2. Efficiency: A multicore system is more efficient in that it can delegate the task to be processed by parallel processing cores. Therefore, it takes less energy to perform a task than it would to do so on a single core. A multicore environment can also perform more tasks in low power consumption mode by using multiple processing cores. (GeeksforGeeks, 2020)
3. Multitasking: On a single core system, the machine can only operate on one action at a time. In a multicore system, the machine can handle multiple tasks independently, allowing for multiple applications to be ran concurrently without a loss in performance.

There are two common types of Multiprocessor systems, Symmetric and Asymmetric. Symmetric Multiprocessing refers to a system where multiple identical self-scheduling processors are tethered to shared memory and I/O resources. Asymmetric Multiprocessing is a system where there is a master processor that manages scheduling and operating system tasks, and the other companion processors respond to tasks distributed by the master processor (GeeksforGeeks, 2019). Regardless of which Multiprocessing system is being used, here are some benefits of using a multi-processor system over a single-processor system:

1. Performance: A system with multiple processors can out-compete a system with a single processor due to its additional hardware. Having two processors over one doesn't necessarily mean twice the processing power though. And like many things, the continued addition of processors suffers from the law of diminishing returns. "Amdahl's Law" (Stallings, 2018, E-2) states that the speed of a process is dependent upon the sequential parts of the program, and

at some point the added value of another processor doesn't outweigh the limitation of sequential processing.

2. Availability: Since the system has multiple processors, if a single processor has a hardware malfunction it won't stop the entire system from performing. Instead, the other processors can handle the load of the fallen one at the cost of some performance.

3. Scalability and Growth: Performance of the system can be increased by simply adding another processor to the system. As stated earlier, there may be limitations to this as we approach higher numbers of processors.

Stallings, W. (2018). Operating Systems: Internals and Design Principles. Pearson Education Inc.

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