Module 11 Example Set 2

1. A function has been written to service I/O requests from a certain device.
a) What determines the maximum rate at which the function will be called if interrupts are used in servicing the device?
The frequency at which the device generates interrupts would dictate the maximum rate at which the function must be called. Since interrupts occur at unpredictable time, the context of the running program must be saved and restored as well.

b) What determines the maximum rate at which the function will be called if polling is used in servicing the device?
The maximum rate would be determined by the duration of the polling loop.

c) If it takes 50 cycles to poll the device, could an I/O rate of fifty million requests per second be handled if the CPU clockrate is 2.5 GHz?
A clock rate of 2.5 GHz corresponds to a cycle time of 0.4 ns. Fifty cycles would be 50*0.4 = 20 ns. This corresponds to 50 million operations per second, however each request requires that the device be polled as well as serviced. Since the time to service the device will be greater than 0, 50 million requests could not be handled. The maximum rate of requests that can be handled would depend on the sum of the polling time plus the service time for the device.

2. The read access delay for an I/O system is defined as the time required for the device to acquire the requested data and prepare to start transmitting the data. The data transfer rate for an I/O device is defined as the number of bytes per second that it can transmit. Suppose that an I/O system has an access delay of 10 seconds and transfers data at the rate of 4096 bytes per second.
How long will the system require to complete a 3145728-byte I/O request?
The time required on the system is 10 + 3145728/4096 = 778 seconds.

3. The combined controller overhead and seek time for a certain disk system is 14 milli-seconds on average. It also takes an average of one half revolution of the disk to get to the beginning of a requested sector. The disk rotates at a rate of 7200 revolutions per minute. Each track contains 128 sectors, each of which is 512 bytes in size. The disk can transfer data as fast as it can be read. For this problem assume that there are no gaps between sectors.
How long will it take to read the contents of a file that is 50 kB in size if the file resides on a single track?
It takes on average 14 milli-seconds to move the access head to the track that contains the file. On average 0.5 revolutions will be required to get to the beginning of the file. One revolution takes 8.33 milli-seconds for one revolution, so one half would be 4.167 milli-seconds. The file contains 50*1024 = 51200 bytes of data which occupies 51200/512 = 100 sectors. It takes 100*8.33/128 = 6.51 milli-seconds to transfer the file contents. Therefore the total time = 14 + 4.167 + 6.51 = 24.677 milli-seconds to read the file contents.

4. Forty percent of the workload on a certain computer system corresponds to the execution of code not related to I/O. The remaining 60% is due to I/O operations. The workload requires 600 milli-seconds to complete.

a) What speedup would be achieved by making the I/O system 80% faster?

The original I/O systems consumes 0.6*600 = 360 milli-seconds and the code not related to I/O consumes 240 milli-seconds.

The improved I/O systems would take 360/1.8 = 200 seconds, so it provides a speedup of 600/(200+240) = 1.36

b) What speedup would be achieved by making the code not related to I/O 80% faster?

The improved code not related to I/O would consume 0.4*600/1.8 = 133.33 milli-seconds, so it provides a speedup of 600/(133.33+360) = 1.22