Score:_____ Name:_____

ECE 3055 Quiz 8 - October 27, 2010

1. What is the average time to read a 4KB block of file data on a typical PC notebook disk drive that has an average seek time of 8 ms. The drive rotates at 7,200 RPM, has an SATA transfer rate of 3Gb/s per second, and 512 byte sectors (i.e. Lower case "b" is bits). Assume the disk is idle and there is a .2 ms controller overhead per 4KB transfer. Ignore the impacts of caching in the drive. (*Note*: In I/O device transfer rates, MB is always 10^6 bytes – not 2^{20} bytes!)

$8/4\,ms + .5/(7200/60)\,sec + \frac{8\times8\times512}{3\times10^9\,sec} + .2\,ms =$ $2 + 4.17 + .011 + .2 =$ 6.38 ms

Part 1: Assuming the sectors are located in a contiguous block on a single track and the computer can read or write them all in one pass under the read head, the average observed transfer time would be

6.38 (in ms. – *Note: use average seek time with the book's suggested ¼ correction factor for observed seek time for this calculation*)

5 pts. With this time for a 4KB data transfer, the disk I/O transfer bandwidth is .642 MB/sec

$4096/6.38\times10^{-3}$

Part 2: For a new Western Digital Solid State drive, the transfer rates are quoted as 20MB/sec for random 4KB reads and 15 MB/sec for writes. So if a solid state drive was used in the PC instead,

the disk read transfer rates could be 31.2 times faster and writes could be 23.4 times faster with a SSD (assuming 4KB blocks as computed in Part 1 for the hard disk)

2. A PCI bus has a 67 MHz clock and can transfer 32-bit data packets from successive memory locations every two clock cycles after using an initial clock cycle to send out the starting address. Assuming the typical PCI burst transfer size is four 32-bit data packets in 9 clocks (i.e. one address followed by four data values from sequential addresses for 3-2-2-2 timing), compute the maximum I/O bandwidth of the bus in megabytes per second.

2 pts. $4\times4\times67\times10^6/9$

Maximum I/O bandwidth = 119.1 (in megabytes per second)

3. An application is being ported to a parallel computer system with 32 processors. Assuming 90% of the sequential execution time is numerical computations that can be evenly divided among 32 processors and the remaining 10% is I/O that must be performed sequentially on one processor, what is the maximum speedup that could be obtained on the parallel computer?

2 pts. $1/(.9/32+.1)$

Maximum Speedup = 7.805

4. Rank the three techniques that are commonly used to transfer I/O data in terms of the processor time requirements per data transfer (*from highest to lowest*).

1 pt.
1. Polling
2. Interrupts
3. DMA