Score:_____ Name:_____

ECE 3055 Quiz 10 - April 6, 2011

1. A new Seagate hybrid disk drive (i.e., hybrid means both a small built-in flash SSD and a regular disk drive) contains an internal RAM cache of 32M, a 4G SSD Flash drive, and a 500G magnetic disk drive. They claim it has performance 80% faster than a traditional drive and only 25% slower than a full SSD drive at ¼ of the cost of an SSD drive.
   For this new drive, what is the average time to read a 64KB block of file data from the magnetic disk drive assuming that has an average seek time of 8 ms. (i.e. assume a 32M cache miss and an SSD miss). 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 .1 ms controller overhead per 64KB 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!)

   $8/4\text{ ms} + .5/(7200/60)\text{ sec} + \frac{128 \times 8 \times 512}{3 \times 10^9}\text{ sec} + .1\text{ ms} = 6.44\text{ ms}$

   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

   2 pts. 6.44 (in ms. – *Note: use average seek time adjusted by the book's suggested ¼ correction factor for observed (i.e., typical) seek time for this calculation*)

   With this time for a 64KB data transfer, the disk I/O transfer bandwidth is 10.2 MB/sec

   Part 2: Assuming that the data needed was all in the disk's 32M RAM cache, compute the maximum transfer bandwidth for a 64KB transfer. Assume the SATA bandwidth is the limiting factor here.

   1 pt. $65536/(.175 + .1)\text{ ms}$ (3?4 if .1 left out)

   Maximum transfer bandwidth assuming internal cache hit is 242 MB/sec

   Part 3: For this new Seagate Hybrid drive, assume the SSD transfer rates are quoted as 18MB/sec for random 64KB reads and 12 MB/sec for writes. So if the data was all available in the SSD drive,

   1 pt.

   the disk read transfer rates could be 1.76 times faster and writes could be 1.18 times faster with all SSD hits (assuming 64KB blocks as computed in Part 1 for the hard disk)

   Part 4: Ignoring the effects of the disk's 32M RAM cache, what SSD hit rate would be required on reads so that the drive is only 25% slower and a full SSD drive as claimed in the product's ads.

   2 pts. than $1.76x + (1-x) = .75 \times 1.76$ $\downarrow$ Also ok (53.8)

   SSD hit rate 42.1 %

2. An application is being ported to a new multicore computer system with 8 processor cores. Assuming 75% of the sequential execution time is numerical computations that can be evenly divided among 8 processors and the remaining 25% is I/O that must be performed sequentially on one processor, what is the maximum speedup that could be obtained on the new multicore computer?

   2 pts. $1/(.75/8 + .25) = 2.91$

   Maximum Speedup = 2.91

3. List in order of CPU efficiency (*from highest to lowest*) the three basic techniques that are commonly used to transfer I/O data. List any additional hardware requirements needed for each technique.

   2 pts.

I/O Transfer Technique	Additional Hardware Required
1. DMA	DMA Controller + Interrupt Hardware
2. Interrupts	Interrupt Hardware
3. Polling	none