Date:_____

Quiz for Chapter 6 Storage and Other I/O Topics

Not all questions are of equal difficulty. Please review the entire quiz first and then budget your time carefully.

Name:_____

Course:_____

1. [6 points] Give a concise answer to each of the following questions. Limit your answers to 20-30 words.

(a) What is memory mapped I/O?

(b) Why is DMA an improvement over CPU programmed I/O?

(c) When would DMA transfer be a poor choice?

Name:_____

2. [6 points] Mention two advantages and disadvantages for using a single bus as a shared communication link between memory, processor and I/O devices.

Name:_____

3. [6 points] Disk Technology. Suppose we have a magnetic disk (resembling an IBM Microdrive) with the following parameters:

Average seek time	12 ms
Rotation rate	3600 RPM
Transfer rate	3.5 MB/second
# sectors per track	64
Sector size	512 bytes
Controller overhead	5.5 ms

Answer the following questions. (Note: you may leave any answer as a fraction.)

(a) What is the average time to read a single sector?

(b) What is the average time to read 8 KB in 16 consecutive sectors in the same cylinder?

(c) Now suppose we have an array of 4 of these disks. They are all synchronized such that the arms on all the disks are always on the same sector within the track. The data is striped across the 4 disks so that 4 logically consecutive sectors can be read in parallel. What is the average time to read 32 consecutive KB from the disk array?

Name:_____

4. [6 points] Answer the following questions:

(a) What is the average time to read or write a 512-byte sector for a typical disk rotating at 7200 RPM? The advertised average seek time is 8ms, the transfer rate is 20MB/sec, and the controller overhead is 2ms. Assume that the disk is idle so that there is no waiting time.

(b) A program repeatedly performs a three-step process: It reads in a 4-KB block of data from disk, does some processing on that data, and then writes out the result as another 4-KB block elsewhere on the disk. Each block is contiguous and randomly located on a single track on the disk. The disk drive rotates at 7200RPM, has an average seek time of 8ms, and has a transfer rate of 20MB/sec. The controller overhead is 2ms. No other program is using the disk or processor, and there is no overlapping of disk operation with processing. The processing step takes 20 million clock cycles, and the clock rate is 400MHz. What is the overall speed of the system in blocks processed per second assuming no other overhead?

Name:_____

5. [6 points] What is the bottleneck in the following system setup, the CPU, memory bus, or the disk set?

- The user program continuously performs reads of 64KB blocks, and requires 2 million cycles to process each block.
- The operating system requires 1 million cycles of overhead for each I/O operation.
- The clock rate is 3GHz.
- The maximum sustained transfer rate of the memory bus is 640MB/sec
- The read/write bandwidth of the disk controller and the disk drives is 64MB/sec, disk average seek plus rotational latency is 9ms.
- There are 20 disks attached to the bus each with its own controller. (Assume that each disk can be controlled independently and ignore disk conflicts.)

Name:_____

6. [6 points] Discuss why RAID 3 is not suited for transaction processing applications. What kind of applications is it suitable for and why?

Name:_____

7. [7 points] Suppose we have two different I/O system A and B. A has data transfer rate: 5KB/s and has access delay: 5 sec. While B has data transfer rate: 3 KB/s and has access delay: 4 sec. Now we have a 3M I/O request, taking performance into consideration, which I/O system will you use? What about for a 3KB request?

Name:_____

8. [7 points] If a system contains 1,000 disk drives, and each of them has a 800,000 hour MTBF, how often a drive failure will occur in that disk system? Could you give some idea to improve that? And why will your idea work?

Name:_____

9. [6 points] What is the average time to read a 512 byte sector for Seagate ST31000340NS in Figure 6.5? What is the minimum time? Assume that the controller overhead is 0.2 ms, and the disk is idle so that there is no waiting time.

Name:_____

10. [4 points] How many times can you store a 4MB song at your 1GB NOR flash memory in Figure 6.7 before the first wear out if wear leveling working ideally?

Name:_____

11. [6 points] In Figure 6.8 which fields are correlated with each other? Why do these correlations exist?

Name:_____

12. [6 points] In Figure 6.9, PCI-E connections are available from both the north bridge and the south bridge. What are the advantages and disadvantages to attaching devices to the PCI-E connections on the north and south bridges?

Name:_____

13. [6 points] Section 6.7 focuses on transactional processing as an example of a disk IO intensive application. Give another example of a disk IO intensive application compare and contrast the performance requirements and consider how different disk implementations (magnetic media, flash memory, or MEMS device) can be more or less appropriate for different applications.

Name:_____

14. [6 points] Imagine that you are proposing a new disk IO benchmark for transaction processing, what sort of experiments would you perform to show that your benchmark's results are meaningful. Imagine that you are reviewing a paper introducing a new disk IO benchmark for transaction processing. What sort of subtle flaws would you search for?

Name:_____

15. [6 points] Which of the following would be an acceptable transport medium for real-time transmission of human voice data? Which would be "overkill"?

- 56.5Kbps modem
- 100 Base-T Ethernet connection
- 802.11b wireless connection.

Name:_____

16. [10 points] A given computer system includes a hard disk with direct memory access (DMA).

(a) Suppose a user application needs to change a single byte within a disk block. Sketch, in order, all communications that must take place between the processor and the hard drive to complete this operation.

(b) Assume the total time required to perform a read of n blocks from a hard disk is T(n) = 250ms + 100ms * n. Further, assume that for any read or write to a hard disk block a, there is a probability p = 0.75 that hard disk block a+1 will be read soon afterwards. Given that an application has requested a read of a single disk block, the OS can expect the application to read subsequent blocks later. If the OS will pursue a strategy of reading n blocks at a time, analyze how the OS can choose this n in order to minimize the expected read time.