CMU 18–746 **Storage Systems** **27 Feb 2008**

Spring 2008 **Exam 1**

Name: _____

Instructions

There are four (4) questions on the exam. You may find questions that could have several answers and require an explanation or a justification. As we've said, many answers in storage systems are "It depends!". In these cases, we are more interested in your justification, so make sure you're clear. Good luck!

If you have several calculations leading to a single answer, please place a box around your answer.

Problem 1 : Short answer. [48 points]

(a) Consider a 10 GB file accessed by a workload of random 2 KB reads. Is there a significant benefit to placing this file in the outermost zone of the disk? Explain why or why not.

(b) What value would you have been unable to determine for your disk in the "(a) Write-based SKIPPY" experiments of Lab 1, if the head switch time and the cylinder switch time values were identical? Explain why.

(c) In looking at the files on his 100 GB disk, Dr. Jones noticed 10 files for which the length value stored in the inode was 100 GB. Explain how all of those files could fit on the same 100 GB disk.

(d) Most disks' firmware prefetches physically sequential sectors from the media into the on-board buffer/cache memory. Explain (briefly) how file system data placement decisions can arrange to maximize the value of such prefetching despite having no direct knowledge of physical disk parameters (e.g., sectors-per-track or number of heads).

(e) Imagine a file named /home/ganger/foo and a "symbolic link" file named /home/garth/foo that refers to it. If /home/ganger/foo is renamed to /home/ganger/bar, what will happen when someone tries to access /home/garth/foo?

(f) Some modern disks perform write-back caching, wherein write requests are reported complete once the corresponding data is transferred from the host into the on-board RAM. What problem for file systems can arise if the disk firmware's disk scheduler reorders the media writes in order to improve efficiency? Explain (briefly).

Problem 2 : Disk details. [28 points]

Consider the following disks.

	Seagate Cheetah4LP		IBM Ultrastar18ES	
Year	1996		1998	
Form factor	3.5” half-height		3.5” half-height	
Capacity	4.5 GB		9 GB	
Cylinders	6582		11474	
Surfaces	8		5	
Spindle speed	10033		7200	
Zone Information				
	firstcyl–lastcyl	*sectors per track*		
Zone 1	0–1343	195	0–377	390
Zone 2	1345–2448	187	378–1263	374
Zone 3	2450–3541	176	1264–2247	364
Zone 4	3543–4406	166	2248–3466	351
Zone 5	4408–5223	155	3467–4504	338
Zone 6	5225–5956	145	4505–5526	325
Zone 7	5958–6580	131	5527–7044	312
Zone 8			7045–8761	286
Zone 9			8762–9815	273
Zone 10			9816–10682	260
Zone 11			10683–11473	247

Table 1: *Specifications for the Seagate Cheetah 4LP and IBM Ultrastar 18ES.*

(a) Compute the cylinder and surface number for LBN 1,874,600 on the Seagate Cheetah 4LP.

(b) Compute the cylinder and surface number for LBN 1,874,600 on the IBM Ultrastar 18ES.

(c) What would be the expected average rotational latency for a 30000 RPM disk drive?

(d) Assuming an average seek time of 5 ms, what would be the average service time for random 1KB requests to a Seagate Cheetah4LP disk? (It is okay to approximate, but state any assumptions in doing so.)

Problem 3 : More short answer. [24 points]

(a) Most file systems use the cylinder group (a.k.a. allocation group) concept to improve on-disk locality of related data and metadata blocks. If doing so reduces the average seek distance by a factor of two, why should one not expect a 50% reduction in average service time?

(b) Is any update ordering still required for correctness when using write-ahead logging to provide metadata integrity? Explain.

(c) Imagine an inode structure that uses 10 direct blocks, 2 indirect blocks, and one double indirect block. With an 8 KB block size and 32-bit unsigned integers for block pointers, what is the largest file size?

Problem 4 : Instructor trivia. [up to 2 bonus points]

(a) What company does our first guest lecturer work for?

(b) What should Brandon do for six weeks after completing his Ph.D.?

(c) Garth (Prof. Gibson) founded a company called PANASAS. What did the acronym ”PANASAS” stand for? (Hint: the first ’A’ is Advanced, and the last two letters are Application Software.)

(d) Where should Greg (Prof. Ganger) take his family for a few days of active vacation this summer?