

# CS140 Operating Systems and Systems Programming Final Exam

December 10<sup>th</sup>, 2001

(Total time = 165 minutes, Total Points = 165)

Name: (please print) \_\_\_\_\_

In recognition of and in the spirit of the Stanford University Honor Code, I certify that I will neither give nor receive unpermitted aid on this exam.

Signature: \_\_\_\_\_

This examination is closed notes and closed book. You may not collaborate in any manner on this exam. You have 165 minutes (2 hours and 45 minutes) to complete the exam. Before starting, please check to make sure that you have all 13 pages.

1	
2	
3	
<b>Total</b>	

Name: \_\_\_\_\_

**1. Protection and Security (68 points)**

(a) (8 points) In a public key cryptosystem, a person can encrypt a file with his or her own public key. What might be the purpose, if any, of a person doing this operation?

(b) (8 points) In a public key cryptosystem, a person can compute a message digest of a file and then encrypt the message digest with his or her own private key. The encrypted message digest could be appended to the file when it is distributed over the Internet. What might be the purpose, if any, of a person doing this operation?

(c)(10points)DescribehowMicrosoft'sWindows2000operatingsystemattemptstobattlepasswordstealingTrojanHorses.

(d)(6points)Whatisa *nonce*andwhatistheproblemitisintendedtosolve?

(e)(8points)Explainwhysomeonemightwanttopublishdetailsoftheirsecuritymechanism?

(f)(10 points) Some systems have deployed a protection system that uses both capabilities and access control lists to protect files. Describe the problem with capabilities that adding an access control list can help with. Describe how it helps.

(g)(6 points) Describe what is meant by the confinement problem?

(h)(12points)Liststhethreecorecomponentsofaprotectionsystem.Foreach componentgiveanexampleofatechniqueusedtoimplementit.

## 2. Filesystems (72 points)

(a) (8 points) A file system designer claims that an aggressive prefetching algorithm in his file system can turn a latency problem into a bandwidth problem. What does he mean by this?

(b) (6 points) The original Unix file system's consistency check program (fsck) had an option to sort the free list into increasing disk block number order. Why would someone want to do this to a file system?

(c)(6points)Underwhatconditionswouldafreelistbeabetterdatastructurethana  
bitmapfortrackingfreeblocksinafilesy stem?

(d)(6points)ExplainwhymovingadiskformattedwithaBSDfastfilesystemfroma  
fastertoslowerCPUmachinecanresultinthemaximumtransferspeedforlargefiles  
droppingtoavalueequaltothefilesystem'sblocksizetimestherevolutio nrateofthe  
diskdrive.

(e)(5points)Describe the mechanisms used by the BSD fast file system to get disk locality for files in the same directory.

(f)(8points)Given that CPUs are much faster than disks, some people have suggested doing disk scheduling by trying all possible orderings of the requests using a disk simulator and choosing the ordering that the simulator predicts the disk could process the fastest. Assuming that CPUs are fast enough to do this, what would be the problem of deploying something like this in a real system?



(g)(8points)Describe the factors that go into deciding how large of a log area is needed for a file system that does write-ahead logging of metadata.

(h)(12points)Listoneadvantageandonedisadvantageofeachof thefollowingfile  
descriptortechniques(a)contiguousallocation(b)linkedfiles(c)multilevelindex.

(i)(7 points) Given the BSD fast file system, which would be a better way for a disk designer to increase the capacity of a disk (a) add more cylinders or (b) make each cylinder bigger?

(j)(6 points) Your partner has an idea at 11:45 PM on the day the file system project is due and quickly modifies the file system to allow files to share the same disk block if they have the same contents. He does this by detecting if a block being written already exists on the disk and updates the file descriptor to point at that block rather than allocating a new one. The idea would be to use less disk space for workloads that have many copies of the same files. What other changes would you need to make to the file system to get this work correct?

**3. Virtual Memory (25 points)**

(a) (10 points) You decide to implement a working set algorithm for your Nachos' virtual memory system. Your partner decides that he is going to play with you a bit by setting  $\tau$ , the working set parameter, to bogus values. What would be the symptoms if he set it way too large? How about if he set it way too small?

(b)(7points) Given a machine with a 32bit virtual address and a 36bit physical address (fully populated with memory), would it be possible to make the machine thrash assuming that you have a reasonable virtual memory system?

(c)(8points) Would it ever make sense to use a LRU replacement algorithm with a local page replacement policy? Justify your answer.