EXAM 2

CS 450 – Spring 2009

ANSWER KEY

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This is a closed book test. No notes or other resources are allowed. Read each question carefully and pace yourself. Put all answers on the exam paper, in the space provided.

1. (20 points: 2 each)

TRUE OR FALSE

a) Two memory management problems that cannot be solved without hardware assistance are protection and dynamic relocation. *TRUE*

b) The memory allocation strategy most likely to require blocks to be chained in order by size is the best fit strategy. *TRUE*

c) Most OSs maintain the current date as a count of the total days that have elapsed since the beginning of the year zero. *FALSE*

d) Software caching relies on the principle of locality to speed up input and output. *TRUE*

e) In general, programming a parallel port is more complex than programming a serial port. *FALSE*

f) A blocked-indexed file system cannot support random access to files. *FALSE*

g) The best location on a file volume for the directory is the highest-numbered tracks of the disk. *FALSE*

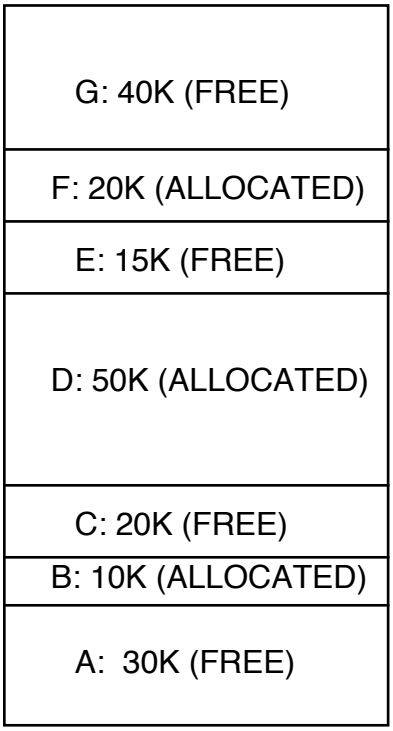
h) Most file systems keep the entries in each directory in sorted order. *FALSE*

i) The use of a cache for page descriptors allows a virtual memory system to run faster than one with no mapping at all. *FALSE*

j) Dynamic relocation is not possible without hardware support. *TRUE*

2. (10 points)

The diagram below shows the memory map for a heap with some blocks allocated and some blocks free. Block A is at the lowest addresses. Assume that the last block to be allocated was block B. A request arrives to allocate a block of size 12K. Name the four allocation strategies studied, and identify the block that would be selected using each strategy.



First fit: This strategy would select block A, the first block from the beginning that is large enough.

Next fit: This strategy would select block C, the first block after the previous allocation that is large enough.

Best fit: This strategy would select block E, the smalles block that is large enough.

Worst fit: This strategy would select block G, the largest block of all.

3. (15 points: 5 each)

A memory management strategy must solve three basic problems. Identify each problem and explain how it is solved by the use of paging hardware.

*The problems to be solved are **allocation, relocation**, and **protection.***

Allocation is the problem of meeting arbitrary requests for blocks to be allocated and freed while avoiding fragmentation. In a paged memory system, all blocks are of fixed size, and a contiguous region in the virtual space can be constructed from any available blocks in the physical space. All pages are interchangeable, and fragmentation does not occur.

Relocation is the problem of making a process run correctly at the location it is loaded into, even if that location is not known until load time. A paged memory system allows the location of a process in virtual space to be predetermined, even if its location in physical space is not.

Protection is the problem of restricting memory access by a process to specific regions of memory and perhaps to limited operations such as read only. The hardware-based translation inherent in paging can include and enforce protection checks.

4. (10 points: 5 each)

a) Why is there a need for a real-time clock separate from the system clock?

The system clock "ticks" much too rapidly (hundreds of times per microsecond). The real-time clock only needs or can use a resolution on the scale of milliseconds or so. The real time must be maintained in a register which has a limited number of bits.

b) Since the real-time clock is a register that can be updated by hardware, what is the purpose of a clock interrupt?

The clock interrupt gives the OS an opportunity to check the timer queue for actions to be performed at a particular time.

5. (10 points)

Explain the purpose of the I/O interface (or controller) that connects devices to the processor. Why does this simplify the design of both the processor and the device?

The I/O interface acts as an arbiter between the processor and the device. As a result, the processor does not need to know the details of the device, and the device does not need to know the details of the processor. Each can view the other using a very simple model.

6. (10 points)

A straightforward blocked-chained file organization is very inefficient for general file access, since the links in a whole sequence of blocks must be read to find a specific part of the file. Explain how the File Allocation Table of the DOS/Windows FAT file systems is organized to overcome this problem.

The FAT implements a blocked-chained organization in which all of the links to successive blocks are stored in a central table. In addition, all or most of this table is normally cached in main memory. This greatly reduces the disk accesses needed to follow these links.

7. (10 points)

When a process is waiting for I/O, it may wait in two distinct queues before returning to the ready state. Explain.

A process requesting an I/O transfer often must wait for the requested device to become available. When the device is available the transfer is initiated, and the process must then wait for the transfer to be complete. These two waits become subdivisions of the BLOCKED state. In our text they are called IO_WAIT and IO_ACTIVE, respectively.

8. (15 points)

We have studied three special techniques for buffer management: ring buffers, double buffering, and software caching. Select **one** of these techniques and fully explain it.

*For full credit, you should describe **exactly one** of these techniques.*

If you discuss the ring buffer, your answer should address its purpose (to hold input that occurs before a process is ready) and its usual implementation (as a circular array). You should also mention the handling of overflow.

If you discuss double buffering, you should describe the basic mechanism (two buffers alternating between input and output) and the purpose (to speed up a stream of block processing, usually involving disk transfers). You should also note why more buffers would not be as beneficial.

If you explain software caching, you should discuss the mechanism (maintaining a number of buffers to hold disk blocks in current use) and how it is implemented (save the blocks most recently accessed, discard those that have not been used recently). Your answer should briefly explain the principle of locality.