

COSC 6360--Operating Systems
MIDTERM EXAMINATION
Monday, March 27, 2000

THIS EXAM IS **CLOSED BOOK**. YOU CAN HAVE **TWO SHEETS** OF NOTES.

1. In UNIX, what is a *special file*? (5 points) What is the major advantage of having them? (5 points)
A special file is not a file but a device that has a name obeying UNIX pathname conventions for files, like "/dev/tty," and can be accessed through normal file operations. The major advantage of the feature is that it allows UNIX programs to access these devices as if they were regular files.
2. What is the advantage of having a clock page replacement policy with *two hands* and what are the functions of each of them? (10 points)
Clock policies with two hands expel stale pages faster without incurring any additional context switch overhead. The first hand marks all pages invalid, the second hand expels all pages that have not been accessed since they were marked by the first hand.
3. What are *mapped files*? (5 points) What is their main advantage? (5 points) Why would they be hard to implement on a conventional virtual memory system? (5 points) Which feature of the Mach VM make their implementation feasible and **why**? (5 points)
Mapped files are files that have been mapped in the virtual address space of the processes that are accessing them. Hence read and writes can be implemented as library procedure calls rather than system calls, which results in a savings of two context switches per call.
Mapped files are hard to implement on a conventional virtual memory system because missing pages need to be read from the file system and dirty pages need to be written back to the file itself
Mach implements mapped files through external pagers.
4. What are the main advantage and disadvantage of structuring a recoverable virtual memory as a set of library functions instead of a set of separate processes? (2x5 points)
This question refers to a paper by Satyanarayanan et al. on LRVM.
5. What is an upcall? (5 points)
A upcall is a call made by the kernel to some user process.
6. What is the function of the *libOS* in the *Xok* system? (5 points)
The libOS provides a traditional kernel interface to processes that do not need to use the advanced features of the Xok system. It emulates traditional system calls by library calls to libOS functions accessing the exokernel.

7. What is partial subblocking? (5 points) What is its major advantage? (5 points) Describe in some detail page table organization that would support partial subblocking with a blocking factor of 8? (10 points: you will lose five points if your answer does not include a diagram)

Partial subblocking associates multiple physical page numbers (PPN's) with each TLB tag and requires these pages to be placed in a single, aligned block of main memory. As a result, each TLB entry contains one single virtual page number (VPN) and one single PPN. A valid bit vector specifies which of the mapped pages are in main memory. This valid bit vector is normally stored in the unused bits of the VPN and PPN entries.

A page table organization supporting partial subblocking with a blocking factor of 8 would have a clustering factor of 8. Each cluster would contain:

- a) the VPN of the first page in the cluster (ending with three zeroes),
- b) the PPN of the first frame in the cluster (ending with three zeroes),
- c) a valid bit vector containing 8 entries, and
- d) a pointer to the next entry in the bucket.

8. What is *false sharing* in a distributed shared memory system? (5 points) What does Munin do to reduce it? (5 points)

False sharing occurs when processes on different nodes access at the same time distinct shared variables that happen to be in the same page. Since Munin always transfer entire pages of distributed shared memory between its nodes, the effect is the same as if the processes were accessing the same variable.

To reduce its impact on the system performance, Munin allows the programmer to declare some variable write-shared. Write-shared variables can be updated concurrently without intervening synchronization because the programmer knows that different portions of the data are accessed.

9. Which problem did Hoare solve by introducing *guarded commands* and *alternative commands* in CSP? (5 points) How are other programming languages solving—or avoiding—that problem? (5 points)

Guarded commands and alternative commands allow CSP processes to wait for messages coming from several possible senders. Without them, CSP processes could only wait for messages coming from a specific sender. Other programming languages avoid the issue by implementing indirect naming, which allows processes to wait for messages received on a specific port.