Comprehensive Exam: Software Systems (60 points) Autumn 1990

1. (12 points total) *Potpourri*

   (a) (4 points)
   The shortest time to completion first scheduling algorithm yields the minimum average response time for a set of jobs in a uniprocessor system. Why is it not used in all computer systems ?

   (b) (4 points)
   Access lists and capabilities are two mechanisms for protection. Explain briefly how each of these mechanisms works.

   (c) (4 points)
   How can the virtual memory address mapping mechanism be used to improve the performance of sending large messages in an operating system which uses message passing ?

2. (16 points total) *Virtual Memory*

Many machines have a translation lookaside buffer (TLB). A TLB is a cache of page table information. It stores the most recently used virtual to physical page mappings. When translating a virtual address, the address translation hardware looks up the TLB for the required mapping. If the mapping is in the TLB, no access to the page table is necessary. This improves performance because access to the TLB is faster than access to the page table.

   (a) (4 points) Give two examples where the existence of the TLB requires operating system code which would be unnecessary on the same machine without a TLB.

   (b) (4 points)
   What is the benefit of including an address space identifier (as well as a virtual address) for each entry in the TLB ?

   (c) (8 points)
   Some machines (for example the VAX) do not have a reference bit. It is possible however, to simulate a reference bit using software and the valid bit. Describe how this can be done.

3. (12 points total) *File Systems*

   (a) (6 points)
   Two file systems are identical except in the way that they allocate disk blocks to files. System 1 uses a linked list for block allocation. A block is allocated from the head of the list. When it is released, it is added to the end of the list. System 2 uses

4. (6 points) Consider the following schedule of operations, where Rlock is read lock and Wlock is write lock.

T1	T2	T3
Rlock X		
read X		
	Rlock X	
	read X	
		Rlock Z
		read Z
		Unlock Z
Wlock Y		
read Y		
write Y		
Unlock X		
Unlock Y		
		Rlock Y
		read Y
		Unlock Y
	Rlock Y	
	read Y	
	Wlock Z	
	read Z	
	write Z	
	Unlock X	
	Unlock Y	
	Unlock Z	
		Wlock X
		read X
		write X
		Unlock X

(a) (4 points) Is this a serializable schedule? Give an equivalent serial schedule or show why there is not one.

(b) (2 points) Indicate whether each of the transactions T1, T2, and T3 use two-phase locking (2PL).

5. (5 points) Consider a distributed database with N nodes. Each node has the power to grant a lock on any item. If a node wishes to read an item, then it must obtain locks from R nodes, if it wishes to write an item, then it must obtain W locks. Note that $R + W > N$ ensures serializability. For the following cases, give conditions involving R, W, and N so as to minimize network traffic: