CSE 221 Winter 2003 Final Examination

There are five questions in this examination, each worth 20 points. Please answer all five questions. You have three hours to complete this examination.

Problem 1

What a system designer leaves out of an architecture is often as important as what is included. Choose one of the operating systems that we discussed in class for which some feature normally considered an integral part of an operating system was *not* included. Explain the reasons why the designer (or designers) decided to leave this feature out of their design.

Problem 2

Dave Clark's paper on upcalls discusses an architecture that is a radial departure from the one that Edsgar W. Dijkstra chose for T.H.E.

a) In what way does Clark's upcall architecture conflict with the design of T.H.E.?

b) What issues or problems did Dijkstra avoid by not having an architecture like Clark's?

c) Despite these issues and problems, why did Clark decide to use his kind of architecture? How did Clark address these issues and problems?

Problem 3

A *reliability-induced synchronous write* is a synchronous write that is issued by the file system to ensure that the file system's state (as represented by the system's metadata) is not in a bad state should the system crash at an embarrassing time.

a) Consider a file *f* being created in Unix. Assume that the directory in which *f* is created is called *d*. An inode *i* will be allocated to *f* and *d* will be updated. Thus, there are two disk operations that the file system will issue: one will mark inode *i* as being allocated (the file type in *i* will be set to some value that is not *empty*) and the pair [*f*, *i*] will be written into *d*.

   In Unix FFS, one of these writes will be done synchronously (that it, it will be a reliability-induced synchronous write). Which write is it? Explain why.

b) Consider the same operation in LFS. Does LFS generate a reliability-induced synchronous write? Explain.

c) Consider the same operation with the Rio file cache. Does this file system generate a reliability-induced synchronous write? Explain.

Problem 4

The VAX-11/780 memory-management architecture supported paging, but it did not provide a *page-referenced* bit.

a) Why is it important to have a page-referenced bit when implementing demand paging?

b) How did the authors of the paper *Converting a Swap-Based System to do Paging in an Architecture Lacking Page-Referenced Bits* surmount the problem of the VAX-11/780 not providing page-referenced bits?

c) Briefly explain how a similar technique can be used to provide *copy-on-write* semantics on shared read/write data spaces.

Problem 5

Choose one of the papers we covered in class that described a specific system. Give two design decisions from that paper, where each example illustrates one of Butler Lampson's design hints (as covered in his paper *Hints for Computer Systems Design*). Explain how each design decision is an example of the hint.