Systems Comprehensive Exam, Fall 2004

Tuesday, August 17, 2004

1 Instructions

This is a closed-book, closed-notes exam with a total of 100 points. You may not use any external source for answering these questions. Please direct any questions about this exam to Professor Bridges or Professor Martin. Professor Bridges may be reached either in person in his office in 345G Farris, by phone at 277-3032, or by email at `bridges@cs.unm.edu`. From 9:00am to 1:00pm, Professor Bridges will be available only by email or cell phone at 363-8798. Professor Martin may be reached either in person in his office in 340 Farris, by phone at 277-8926, or by email at `cris@cs.unm.edu`. Turn your exam in to Professor Bridges or the front office by 5:00 PM MDT on Tuesday, August 17, 2004. Exams *will not* be accepted after this time except by prior arrangement with Professor Bridges.

Type or write your answers to the stated number of questions in each of the following three sections. Make any *reasonable* assumptions necessary to answer the question, but be sure to state any assumptions that you make.

2 Short Answer - Answer 3 of 4 (30 points)

Briefly answer 3 of the following 4 questions. Your answer should be no longer than *one* paragraph.

1. **Caching.** Briefly describe the three types of cache misses.
2. **TCP/IP.** Describe how the slow start mechanism of TCP is used to increase the congestion window.
3. **TLB Management.** TLB faults can be handled by hardware or software. Discuss the relative benefits of each approach.
4. **Deadlock.** Explain the difference between deadlock avoidance and deadlock prevention.

3 Medium Answer - Answer 2 of 4 (40 points)

Provide detailed answers to two of the following four questions. Be sure to state any assumptions you make and to fully justify your answers. Limit your answers to approximately one to two pages in length.

1. **Out of order completion.** Using pseudo assembly language for a RISC (load-store) architecture, present a concrete example illustrating a potential benefit of out of order instruction completion. Describe the general circumstances under which instructions can be completed out of order.
2. **Process migration.** Describe the issues that must be addressed when implementing process migration within the network for the CS department. How do theses issues change when you consider migration across the UNM campus network? How do they change when you consider process migration across the Internet?

3. **Distributed transactions.** Describe the 2-phase commit protocol for distributed transactions. Carefully describe the point at which the transaction becomes permanent (aka committed).

4. **OS Design.** In the context of micro-kernels, what is an "up-call"? What is a "scheduler activation"? Describe in detail how scheduler activations and up-calls are related.

4 Design - Answer 1 of 2 (30 points)

Provide a *full* and *detailed* answer to one of the following two questions. Be sure to state any assumptions you make and to fully justify your answer.

4.1 Page pre-fetching

Consider the possibility of using page pre-fetching to avoid the delay associated with a page fault and subsequent time needed to load the page from backing store.

1. Discuss the potential benefits and costs associated with page pre-fetching in general terms.

2. Consider the following four levels: language implementation, runtime/libraries, operating systems, and architecture. For each of these levels, describe the relevant information that could be obtained to support page pre-fetching and how this could be used to implement page pre-fetching.

3. Describe one instance of how you could integrate information provided by multiple levels to improve the benefits of page pre-fetching.

4. Suppose that you have to choose one of the four levels to instrument. Which do you believe will yield the best benefit/cost ratio and why?

4.2 Ubiquitous computing

Consider a time in the not-too-distant future, when every automobile is equipped with a GPS sensor, a wireless networking transmitter/receiver, and several sensors for recording environmental information, like temperature, moisture content, ambient light, RADAR emissions, etc. Given this context, it is natural to assume that our automobiles will start to carry on conversations with one another. In particular, your car might provide information to on-coming cars about the conditions where you were a short time ago.

To make this scenario plausible, there are at least two research areas that must be explored:

1. Communication infrastructure services are needed that take into account speed and direction of travel.

2. Coherence and consistency of the information exchanged in these conversations must be addressed.

Choose one of these areas and provide a fairly detailed description of the important issues. Provide a brief description of the important issues in the other area.