Mittuniversitetet

MID SWEDEN UNIVERSITY

Final exam

DT011G Introduction to Operating Systems

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Instructions

Carefully read the questions before you start answering them. Note the time limit of the exam and plan your answers accordingly. Only answer the question, do not write about subjects remotely related to the question.

Write your answers on separate sheets, not on the exam paper. Only write on one side of the sheets. Start each question on a new sheet.

Make sure you write your answers clearly, if I cannot read an answer the answer will be awarded no points – even if the answer is correct. The questions are *not* sorted by difficulty.

Note that your answers for this exam does *not* have to include references to relevant literature.

Time 5 hours.

Aids Dictionary, course literature [SGG09, SGG13a, SGG13b], graded assignments, personal notes, and a calculator. The student may use the following e-book reader: TrekStor eBook-reader 3.0.

Maximum points 18

Questions 5

Preliminary grades

To pass this exam you need to have at least an average of one (1) point per question, and no question may be awarded zero points. The averages for the grades can be summarised as follows: $E \geq 1$, $D \geq 1.5$, $C \geq 2$, $B \geq 2.5$, $A \geq 3$, with no question awarded zero points.

Aim

The aim of the exam is to examine that you have fulfilled the requirements specified in the course syllabus.

An operating systems oriented computer science fiction, or: The exam questions

(3p) 1. A colleague at your work-place is setting up a web-server. He is working with the Apache web-server. The Apache web-server is modular by design, meaning it has loadable modules to get different behaviour on different systems. For instance, it has one module which spawns a child process for each client to handle its requests. Another of Apache's modules creates a thread for each client to handle its requests.

Your colleague asks you: "What are the advantages and disadvantages of each approach? Which one should I pick?"

(3p) 2. After work you are visiting a friend, this friend of yours is not very tech-savy (although he himself thinks that he is). When you arrive he says to you: "You know what, I managed to deadlock a ssh and tar pipe the other day." You look strangely at him as he continues, "well, I ran `tar -zcf - <files> | ssh user@server tar -zxf -`," a trick you taught him, "and then I accidentaly disconnected my access point. The program was deadlocked for several minutes before it finally quit."

Explain to your friend what a deadlock really is and why this is not a deadlock.

(3p) 3. A little embaressed for his misunderstanding of what a deadlock is (remember, he considers himself as tech-savy) he quickly changes the conversation. "Oh, I have to tell you, I just upgraded my legacy 32-bit hardware for my in-closet server to a bit more modern 64-bit hardware." Whereby you reply: "Nice, did you know something cool, the 64-bit address space is so large that hierarchical paging systems are in general too ineffective to use, one has to resolve to hashed or inverted page tables instead." Your friend looks at you in disbelief and says: "And why is that? How can it be effective for 32-bit systems but not for 64-bit systems? That makes no sense."

How do you answer him? (A tip is to give a convincing example and calculating the effective access time for that particular example, there is no arguing against that as long as it is a valid example and your calculations are correct.)

4. Back at work in the morning, you are trying to focus on your work. However, one of your colleagues comes to you with Silberschatz in hand.

"We add paging to primary memory to remove problems of (external) fragmentation," she says. "In the same manner we divide the secondary memory into blocks (and clusters). Then why do we talk about fragmentation in file systems when it's not an issue in RAM?"

You're thinking to yourself, "well, that's not true of all file systems, but fine, we're not on that level yet."

(3p) (a) Explain what is meant by "fragmentation" when we talk about files in secondary memory.

(3p) (b) Explain why this can be an issue in secondary memory but not in primary despite us using the same methods in both places.

(3p) 5. You are finally approaching the end of your day. Thinking back on a day full of interruptions, you start thinking "oh, how I wish I could just turn off preemption sometimes." That reminds you that OSes sometimes turns off interrupts in kernel mode to avoid race conditions, "why couldn't Mother Nature make the world more like an x86-architecture?"

That the kernel must protect its data structures by locks in a multiprocessor environment is obvious, but why must the kernel do that in a single processor environment too?

Finally you are done, go through your answers thoroughly again(!) and then go for a treat after all this hard work.

The end.

References

[SGG09]   Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne. *Operating System Concepts*. John Wiley & Sons Inc, Hoboken, N.J., 8 edition, 2009. International Student Version.

[SGG13a] Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne. *Operating System Concepts.* John
          Wiley & Sons Inc, Hoboken, N.J., 9 edition, 2013.

[SGG13b] Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne. *Operating System Concepts.* John
          Wiley & Sons Inc, Hoboken, N.J., 9 edition, 2013. International Student Version.