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 33

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. Your colleague at work, Bill, who always comes to you for help, comes for your aid today again. He is a nice guy, he always means well. But sometimes things just does not turn out as intended, alright, most of the times. This time, however, he with an actual problem.

"Sorry to bother you again", he says, "I was thinking about threads and processes." As we know from earlier, Bill maintains an operating system in his spare time. "I know I have talked to you about this previously too, but I've forgotten some of what you said, and I have some new ideas", he says.

"OK, shoot", you say.

"Well, I'm working on handling processes and threads. I've looked at how UNIX-like systems does this, but I'm not quite sure I understand it completely. Can you explain it to me?"

Help Bill by explaining how to approach process and thread handling. More specifically, tell Bill about:

(3p) (a) The advantages of the Linux implementation of the fork(2) system call.

(3p) (b) How the copy-on-write technique works, and why it is good.

(3p) (c) The different ways to handle threads and their advantages.

(3p) 2. By the end of the day your telephone rings, it is your not-so-tech-savy friend. He is by the way a rather enthusiastic fellow, some would even go for the word excentric. It is your friend Steve, and you are going out with Steve and Bill to catch the latest film in the cinema right after work, you do this every now and then.

"How're you doing", he says, "are you and Bill on your way?"

"Yes, we'll leave in a few minutes, Linus might also join us", you say.

"Great! You know I was thinking about what you said about deadlocks a few months ago. I'll tell you when you get here."

You and Bill leave the office and arrive at the cinema to meet Steve by the registers to get your tickets.

"Linus couldn't join us, he was busy hacking on some features in Linux," you say.

"I've never understood why he publishes his code for free on the net", Steve says. "He should do like Bill and start to charge people money for it."

"Well, I think it's quite good", Bill says, "this way I can copy some of his features and incorporate it into my Wall-Hole operating system. I've done that from the Berkely Software Distribution."

"About that deadlock-thingy, I was thinking about that on my way from work the other day. I was in my car, heading for a round-about. I was thinking, this could turn into a deadlock situation. Don't you think?"

Discuss with Steve whether this is a deadlock or not.

3. After the film has ended you pose the question about threads and processes to Steve.

"Steve, Bill is thinking about whether to choose threads or processes in his browser, what are your thoughts?"

"Certainly he should choose the one easiest for developers. Getting developers to your platform is the key to success", Steve replies.

"Sure, but shouldn't I think first about my users", Bill asks.

"Developers, developers, developers", Steve starts to chant like obsessed, shortly continuing to shouting, "DEVELOPERS, DEVELOPERS, DEVELOPERS! I love that word; some day, if I am to hold a presentation I will start it with those very words."

"We know that for sure, and so does the rest of the cinema. I solved the networking stuff by copying the the code from BSD, but I do not know how to solve the interface to the hardware. I have heard of monolithic kernels, loadable kernel modules and drivers; I do not really know what that means though."

You on the other hand, know perfectly well the different approaches to interface the hardware. Explain to Bill

(3p) (a) the different types of kernels there are (how they work), and

(3p) (b) what advantages there are of each type.

(3p) 4. Back in your office trying to work, your boss comes by your desk. "I've got a wee bit o'problem, laddie," he says, "it concerns the efficiency of page replacement algorithms."

"Mhm, go on," you say.

"Well, it's like this, I've got this page-reference string", he shows you a paper containing a string of numbers:

1, 2, 3, 4, 1, 1, 2, 4, 5, 5, 6, 8, 7, 8, 8, 9, 9, 9, 9, 1

He continues, "a memory access takes 100 ns if the page is in memory, with a page-fault it takes 10 ms to load the page into memory and another 100 ns to complete the access."

You nod and say, "and you want me to tell you the efficiency of some algorithms compared to the optimal page-replacement?"

His eyes are shining, "exactly, laddie!" he says enthusiastically. "It's the second-chance algorithm, there is only a concern of reading, no writing done to memory. How does this algorithm perform compared to the optimal page-replacement algorithm? We've got only five wee frames to work with, lad."

Do the following calculations and explain them thoroughly:

(3p) (a) What is the average access time for the optimal page-replacement algorithm for this reference string?

(3p) (b) What is the average access time for the second-chance page-replacement algorithm for this reference string?

(3p) 5. You are back in your office, it is Friday afternoon. Another one of your co-workers comes by. He says to you "I hope you haven't forgotten about our meeting. You promised me you'd give me some feedback on my ideas for Freax", and he smiles. He knows just as well as you do that you did forget about it, it was not in your calendar and you have been so distracted this week you remember only fragments.

"Well," he continues, "we are supposed to discuss some aspects of scheduling for my free-time project." It is your friend Linus, who didn't join you for cinema, and he is actually an intern from the University of Helsinki. "What I'd like to do is to have a nice general scheduling algorithm for processes. Interactive processes should have priority over I/O-bound processes". The two of you enter the meeting room.

Give Linus an overview of how to implement his scheduler.

Finally Thursday evening, now it is time 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.