Exam: TDIU11

Operating Systems

2023-06-07 kl: 14-18

On-call (jour): Ahmed Rezine, (Tel. 1938).

- You may answer in either English or Swedish. You can use a dictionary between English and another language.
- Use the exam wrappers distributed at the exam room. Do not forget to fill each wrapper with your anonymous ID.
- Read the instructions and all the assignments before you begin answering.
- Be **precise and clearly motivate** all statements and reasoning. If in doubt about a question, write down your interpretation and assumptions.
- Write clearly. Unreadable text will be ignored!
- The exam is graded U, 3, 4, 5 (preliminary limits: 20pts, 30pts and 35pts).

Problem 1 (scheduling, 12pts)

Assume a system that is idle in the beginning. Consider the following set of jobs, their arrivals and their execution times:

Job	Arrival time	Execution time
J1	1	9
J2	4	7
J3	6	3
J4	10	2
J5	12	1

Table 1. Job arrivals

Questions:

1. Assume preemptive shortest remaining time first algorithm is used for scheduling:
    a. Give a Gantt diagram showing which process is running from tick 1 (inclusive) to tick 23 (exclusive). (2pts).
    b. What is the average waiting time? (2pts)
    c. What is the average turnaround time. (2pts)
2. Assume a multi-level feedback queue with a Round Robin level and a First-In First-Out (FIFO) level. The Round Robin level has higher priority. Running Jobs in the FIFO level are preempted if Round-Robin jobs are available to run. Each job is initially inserted at the end of the ready queue of the Round Robin level. After executing for 5 ticks in the Round Robin level, a process is preempted and inserted at the end of the ready queue of the FIFO level.
    a. Give a Gantt diagram showing which process is running from tick 1 (inclusive) to 23 (exclusive). (2pts).
    b. What is the average waiting time. (2pts)
    c. What is the average turnaround time. (2pts)

Problem 2 (Processes, 4pts)

Suppose the following programs are launched by an unprivileged user. For each case, do you see negative effects? What typical Operating System mechanisms (e.g., dual-mode, preemption, context-switch, etc) are used to limit these negative effects? explain in 4-5 sentences for each case.

1.
```
int main()
{
        …
        //disable interrupts
        …
}
```
2.
```
int main()
{
        …
        //execute an infinite loop
        …
}
```

Problem 3 (Filesystem, 12pt)

The following operations all take place within the same directory on the same partition on the same disk. Assume removing a file (i) automatically opens it, (ii) erases it from the directory immediately and (iii) marks it for later deallocation in the system-wide open file table. Assume this deallocation happens when all processes that have opened the file close it. The operations take place in the following order:

1. process A opens the file data_1 as fd A1
2. process B removes the file data_1
3. process B creates the file data_1
4. process B opens the file data_1 as fd B1
5. process B writes "hej" to fd B1
6. process C writes "Hi" to fd B1
7. process B closes fd B1
8. process A write "heureka" to fd A1
9. process A close fd A1

a) The first step identifies the inode of data_1 in the directory, checks that the user has the required privileges, and adds an entry for the file in the system-wide table if such an entry did not already exist, where it records that a new process opened the file. This step also adds an entry to the open file table that is local to process A. It returns a file descriptor to be used by process A. For each one of the remaining operations (i.e. operations 2-9), describe at a similar level of details how the directory, the local open file tables and the system-wide open file table change. (8pt).

b) What data content will be in data_1 after the operations? (2pt)

c) Will all operations succeed? If not, why? (2pt)

Problem 4 (Memory management, 12pts)

Assume an architecture with 32 bits addresses (both physical and logical addresses are 32 bits). The architecture can be configured to use page sizes of either 4KiB (2^{12}bytes) or 1 MiB (2^{20} bytes). Assume each page entry is 4 bytes.

1) Assume pages are 1MiB large with one level paging.

    a. How many entries would the single page table have? (2pts)

    b. What is the minimum information that has to be stored in an entry? Explain, by proposing possible values to the corresponding page entry, how logical address 0xabcd1020 may be translated to a different physical address. (2pts)

    c. Suppose access to main memory takes 200 nanoseconds ($200 \times 10^{-9} seconds¿$. What should the TLB hit ratio be (given as a percentage between hits and total queries) for the time taken to access a virtual address to be 202 nanoseconds in average. You can neglect TLB access time. (3pts).

2) Assume pages are 4KiB large. Assume two levels paging.

    a. How large (in bytes) would a page table take at each level? (2pts)

    b. What is the maximum number of page tables a process might use? What is the maximum accumulated size of all page tables? Observe the question is about the page tables, not the pages. (3pts).
