TDIU25 Exam

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Admitted material

Dictionary from English to your chosen language.

Jour

Ahmed Rezine (013-281938) visiting after about one hour.

Instructions

- Fill in the exam wrapper and read the instructions on it before you start.
  Read instructions and all assignments carefully and completely before you begin.
- You may answer in either English or Swedish.
- State your interpretation of the question and all assumptions you make.
- Write clearly. **Unreadable text will be ignored.**
- Be precise in your statements. **Prove your point when possible.**
  Ambiguous formulations will lead to reduction of points.
- **Motivate clearly and in depth all statements and reasoning.**
  Explain calculations and solution procedures.
- The exam is 40 points and graded U, 3, 4, 5 (**preliminary** limits: 20p, 30p, 35p).
  Points are given for motivations, explanations, and reasoning.

Definitions

Unless you are more specific, the correcting team will interpret the following terms as follow:

memory Volatile random access memory (DRAM), about 100ns access time.

disk Permanent storage, about 10ms access time.

page A fix size region of virtual memory, possibly on disk.

frame A fix size region of physical memory (DRAM).

block A data block located on disk.

Problem 1 (10pt)

The current state of a system:

- The system is idle. Ready queue is empty.
- Process P1 is waiting for keyboard input. It's next CPU burst is expected to be 2 ticks.
- Process P2 is waiting for disk data. It's next CPU burst is expected to be 6 ticks.
- Process P3 is waiting for network data. It's next CPU burst is expected to be 2 ticks.
- If a process is created, its initial CPU burst will be estimated to be 4 ticks.

The following list of events will take place starting at time 0:

Tick	Event
0	Disk data is delivered.
1	Process P4 is created.
2	Network data is delivered.
5	Executing process asks to sleep for one tick (i.e., until tick 6).
6	Process from tick 5 wakes up from sleep.
7	Keyboard input is delivered.

Table 1: Events in the system.

(a) What is the difference between a "ready queue" and a "waiting queue"? (2pt)

(b) Use preemptive shortest job first and show, from tick 0 to tick 14, which process is running (if any) and the contents of ready- and wait-queues (6pt)

(c) At tick 6, some process is executing. How will the kernel (wich is not running at that time) get the chance to wake up the process from tick 5? (2pt)

Problem 2 (12pt)

Assume an architecture with 32 bits physical and logical addresses. The architecture can be configured to use either 4 KiB or 1 MiB page sizes. Assume each page entry takes up 4 bytes.

1. Suppose we adopt 4KiB pages.
   a) How many page table levels are needed? Explain. (2pt)
   b) Given your answer to the previous question, what is the smallest size taken by the page tables for a process that has at least one valid page from which it can read and write data. (2pt)
   c) What information is cached in the TLB (translation look-aside buffer) for this system? (1pt)
2. Suppose we adopt 1MiB pages.
   a) How many page table levels are needed? Explain. (2pt)
   b) Given your answer to the previous question (with 1MiB pages), what is the smallest size taken by the page tables for a process that has at least one valid page from which it can read and write data. (2pt)

c) What information is cached in the TLB (translation look-aside buffer) for this system? (1pt)

3. Draw a diagram that describes how a TLB can be combined with one of the above designs in order to speed up the translation of a logical address to a physical address. (2pt)

Problem 3 (4pt)

For each of the following items, state and motivate (in less than 3 sentences) if it is a representative of a capability-based approach or of an ACL-based approach to protection:

1. Each meeting has a list of personally invited guests.
2. Access to some buildings in Campus Valla after 17.00 requires using a personal access card that is presented each time a building is accessed. The card content is compared against the list of students and employees at LiU that may access to the given building.
3. Cars have to have visible parking tickets. The parking tickets can be obtained by using cash to pay the parking fee without entering a registration number or any other identifier.
4. Physical individual room keys can be used to open a student dormitory or a corridor.

Problem 4 (10pt)

Consider a filesystem on a disk that has physical block sizes of 512 KiB and logical blocks that are concatenations of n physical blocks. Assume indexed allocation with 10 direct pointers to data blocks, one indirect pointer and one double indirect pointer.

1. Assume block pointers are 2 Bytes (16 bits) long. How large should the size of the logical blocks be in order for the inodes to be able to point to any portion of a 1 GiB (2^{30} bits) disk? what about a 1 TiB (2^{40} bits) disk? (2pt)
2. Discuss advantages and disadvantages of the two logical block sizes. Give at least two different aspects. (2pt)
3. Assume block pointers are 4 Bytes long and $n = 2$. What is the maximum size of a file given the adopted indexed allocation scheme? (2pt)
4. Suppose whole blocks are read and written, that operations on blocks are carried in memory, that only direct pointers are used for indexed allocation, that needed inodes are already in main memory, that you do not need to account for writing inodes back to disk, and that free blocks are available with known disk positions in memory (no I/O needed to find them). We would like to add one full block of data between the 4^{th} and the 5^{th} data blocks of a file that takes up 8 logical blocks. How many I/O operations on logical blocks are required for each of: (a) contiguous allocation, (b) indexed allocation, and (c) linked allocation. (3pt)

Problem 5 (4pt)

A replay attack consists in an attacker listening and repeating valid data (e.g., passwords) in order to gain access to secret data. One mechanism to resist replay attacks in password authentication is to use one-time passwords. For this, a list of n passwords is prepared and shared between the system and the user in a secure way. Passwords can only be used once.

Instead of sharing a big list of n passwords, a system and a user program can instead share a single "main password" pw. They can change pw after each n authentications (the mechanism for changing passwords in a secure manner is not relevant for this problem).
Describe a mechanism that allows a user program and a system to have the same list of n passwords while sharing only one single "main password" pw. Explain how your mechanism can derive the i^{th} password from the current "main password" pw. (hint: one way hash functions)