資訊網路與多媒體研究所

102. 9. 26

資格考試科目：高等作業系統

Instructions: There are **five** questions which count 100 points in total. Each question may have several sub-questions. Please read the questions carefully before answering.

1. (24 pts) A virtual memory system can be structured on fixed-size pages and variable-size segments.
   A. (4 pts) Compare the two approaches; describe one scenario the paging approach work better than the segment approach.
   B. (4 pts) Following the previous question, describe one scenario the segment-based approach works better than the paging approach.
   C. (4 pts) Please explain the different between internal fragmentation and external fragmentation.
   D. (4 pts) Which one of the above two fragmentations occurs in paging systems? Please explain your answer.
   E. (8 pts) Describe two tradeoffs involved in having a design of smaller pages versus larger pages?

2. (18 pts) Two common approaches to structure an operating system kernel: Monolithic kernel vs. microkernel. A monolith approach puts all operating system into one executable while a microkernel approach puts only allows bare essential functions to run in privileged mode.
   A. (6 pts) which approach provides better flexibility and why?
   B. (6 pts) which approach provides better scalability and why? (Scalability refers to the ability of supporting large number of processors/cores in the system.)
   C. (6 pts) which approach provides better security and why?

3. (16 pts) In a multi-processor/core systems, shared memory can reduce the inter-process/core communication overhead. To assure data consistence for shared memory, consistency models are used to describe what level of data consistency are provided in the system.
   A. (8 pts) Sequential consistency model requires that all the processes on the system see the same order of memory access. Please describe the rationale for not preserving the memory access order in consistent with actual memory access order.
   B. (8 pts) Weak consistency model requires that all the write operations must be guarded by synchronization variables. Please describe the challenges for implementing this model on loosely coupled distributed systems?

4. (24 pts) Input/Output are widely used operations in applications and has great impact to the application performance. There are several manners to improve IO efficiency and performance. Please answer the following questions
   A. (8 pts) For unbuffered IO library, the size of data to be accessed on each read/write function has great impact to IO efficiency. Suppose that the size of data blocks on the storage device is 4KB and the size of the file to be accessed is 100MB. An application reads the content of a file and processes its content. Please compute the total size of data transmission between (1) user process and kernel, and (2) kernel and storage devices for two cases.
      a. Each read() function requests for 1B.
      b. Each read() function requests for 8KB.
   B. (8 pts) Please describe the impact to IO efficiency on read()/write() with/without O_NONBLOCK option.
   C. (8 pts) Please describe the impact to IO efficiency on read()/write with/without O_SYNC option.

5. (18 pts) In distributed systems, it is very often that a coordinator is needed to synchronize the work among the processes in the systems. Election algorithms such as bully and ring-based algorithms are designed to determine which process is the coordinator process. Assume that there are *n* processes in the system and each process has a unique label. Please answer the following questions:
   A. In the conventional ring-based election algorithm, a unidirectional ring is used. What is the number of messages needed in worst case and in average to elect a new coordinator when only the coordinator process fails? (10 pts)
   B. In order to shorten the time to elect the new coordinator for ring-based election algorithm, Bob suggests to use a bidirectional ring. Can the election algorithm be made more efficient? If no, explain why. If yes, suggest such an algorithm and compare the number of messages needed for electing a coordinator in the two algorithms. (8 pts)