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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION   SUMMER SEMESTER, 2021-2022
DURATION: 3 HOURS   FULL MARKS: 150

CSE 4641: Distributed Operating Systems

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer **all 6 (six)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

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1. a) Define distributed operating system. What are the advantages and disadvantages of distributed operating system? Discuss major design issues of distributed system.

    2 +6+5
    (CO1)
    (PO1)

    b) Explain the role of middleware in Remote Procedure Call (RPC) systems and discuss the advantages and disadvantages of using middleware for distributed communication.

    8
    (CO1)
    (PO1)

    c) What are the desirable features that a good global scheduling algorithm for distributed systems should have?

    4
    (CO2)
    (PO1)

2. a) Define a process and a thread. Discuss the differences between user-level threads and kernel-level threads.

    4+6
    (CO1)
    (PO1)

    b) In Figure 1, a multithreaded Web server is shown.
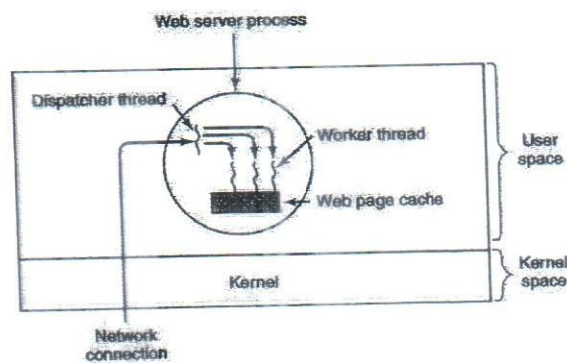
    5+5+5
    (CO1,
    CO2)
    (PO1)

Figure 1: A multithreaded web server for Question 2.b)

   i. Discuss the functionalities of each component on Figure.

   ii. If the only way to read from a file is the normal blocking read system call, do you think user-level threads or kernel-level threads are being used for the Web server? Justify.

   iii. Are there any circumstances in which a single-threaded server might be better? Give an example.

3. a) Write short notes on the following:

    4 × 3
    (CO1)
    (PO1)

    i. Atomic Transactions.
    ii. Real time distributed systems.
    iii. The need for consistency and how it is achieved in distributed systems.

b) In Figure 2, sequences of events at processes P1, P2, and P3 are given. Answer the questions that follow:

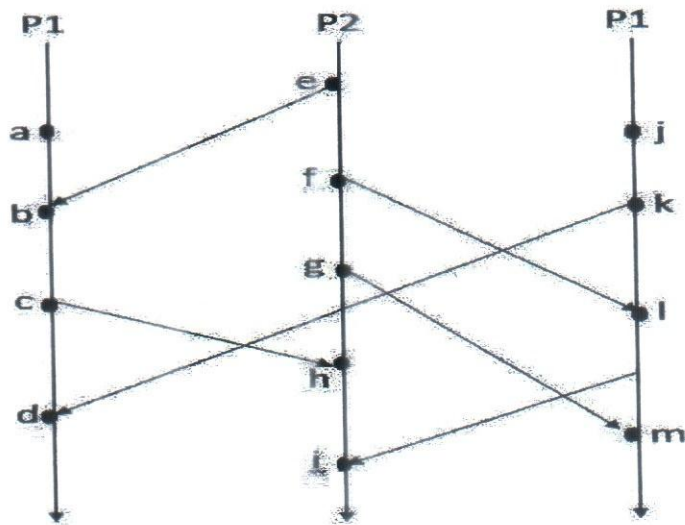
Figure 2: Sequences of events in the processes P1, P2 and P3 for Question 3.b)

   i. Determine the Lamport timestamps of each event.
   ii. Write down the Vector timestamps of each event.

4. a) What is a leap second? Discuss the effects of leap seconds on various systems that rely on accurate timekeeping, including navigation systems, telecommunications networks, and financial systems.

      2+4
      (CO1)
      (PO1)

  b) Explain the potential security concerns associated with Distributed Shared Memory, including the risk of unauthorized access to shared memory regions, and describe how these concerns can be addressed using authentication and encryption mechanisms.

      6
      (CO2)
      (PO1)

  c) Define and give examples of Strict Consistency, Sequential Consistency and Causal Consistency in distributed shared memory.

      7
      (CO1)
      (PO1)

  d) What is false sharing? Why does false sharing degrade performance?

      2 + 4
      (CO1)
      (PO1)

5. a) In distributed systems where messages are asynchronous and failures can be Byzantine, we have to use at least $n = 3f + 1$ replicas in total to tolerate f faulty replicas. Show that this bound is tight, i.e., that $n \geq 3f + 1$ must hold for the client to always be able to identify the correct result. Mention your assumptions for this proof.
(Hint: Use a diagram and prove that if n is less than $3f + 1$, we cannot get the correct results.)

      10
      (CO2)
      (PO2)

  b) In Figure 3, four replicas in a distributed system are presented. These replicas are used for fault tolerance. Replica 3 is faulty (byzantine fault). For each round of communications, write the messages received at each of the replicas. Also show the majority vote to detect the faulty replica.
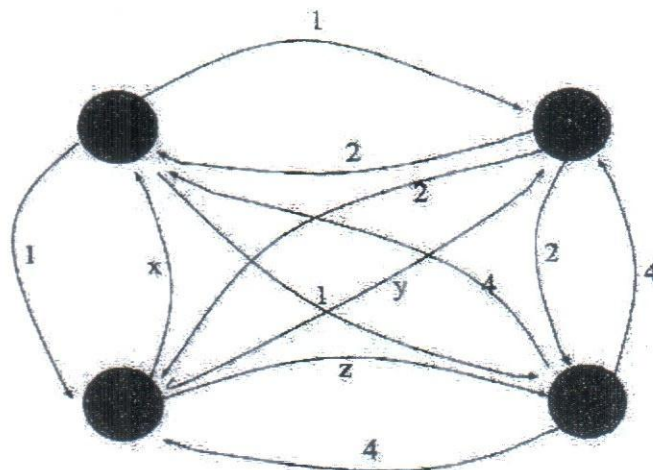
      8
      (CO3)
      (PO2)

Figure 3: Four replicas in a distributed system. For Question 5.b)

c) Compare and contrast between Page-Based and Object-based distributed shared memory.

4
(CO1)
(PO1)

d) Discuss trends in distributed file system and how they affect the design issues of distributed file system.

3
(CO1)
(PO1)

6. a) Define semaphore and explain how it is used to control access to shared memory in a concurrent programming environment.

6
(CO1)
(PO1)

b) Explain the concept of location transparency and location independence in a distributed file system design.

5
(CO1)
(PO1)

c) With the help of a high-level architecture diagram, explain Andrew File System (AFS) implementation. Discuss the differences between AFS and Network File System (NFS).

10 + 4
(CO1)
(PO1)