Roll No.: _

Amrita Vishwa Vidyapeetham

Amrita School of Computing, Coimbatore

B.Tech Mid-term Examinations – April 2024

Sixth Semester

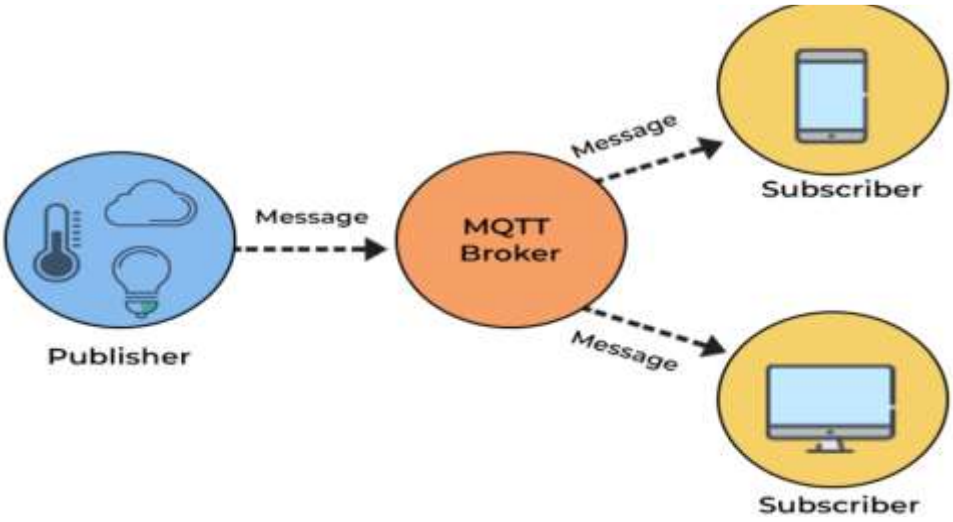
Computer Science and Engineering

19CSE312 Distributed Systems

Duration: Two hours Maximum: 50 Marks

CO	Course Outcomes
CO01	Understand the design principles in distributed systems and the architectures for distributed systems.
CO02	Apply various distributed algorithms related to clock synchronization, concurrency control, deadlock detection, load balancing, voting etc.
CO03	Analyze fault tolerance and recovery in distributed systems and algorithms for the same
CO04	Analyze the design and functioning of existing distributed systems and file systems
CO05	Design and implement a simple distributed system and implement different distributed algorithms over it.

1. a. MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol designed for constrained devices and low-bandwidth, high-latency, or unreliable networks. It is commonly used in various IoT to support both transient and persistent communication. Since neither the writers nor the customers communicate with each other immediately, their interactions are handled by third parties called brokers.



The figure shows a sample architecture of MQTT. Imagine a smart home system where various devices such as sensors, actuators, and controllers need to communicate with each other and

with a central hub or server for monitoring and control purposes. MQTT can facilitate communication between these devices efficiently and reliably. Explain the communication scenario where the temperature sensor publishes a reading and the light sensor needs to adjust the brightness based on the temperature reading, which will be more suitable for transient or persistent communication. [5 Marks] [CO01][BTL02]

b. Transparency in distributed systems refers to the ability to conceal the complexities of the system's implementation details from users, applications, and other components. It aims to provide a seamless and consistent interface, enabling users to interact with the system without being aware of the underlying complexities. Could you provide a detailed explanation of the different types of transparency exhibited within Netflix's distributed system architecture, highlighting how these elements contribute to a seamless user experience?

[5 Marks] [CO01][BTL02]

2. a. A snapshot algorithm attempts to capture a coherent global state of a distributed system. Run the Chandy Lamport algorithm on six different servers on the following conditions.

[8 marks][CO01][BTL03]

i. Server 2 Initiate Snapshot algorithm
ii. Show delayed marker messages on 4,1 and 5.
iii. With these delays how algorithm manages to take global state of the system.
iv. Show complete run till termination of algorithm.

b. i. Will the Global Snapshot algorithm for Global Sate Detection work if the channels are not FIFO? Why? [2 Marks][CO01][BTL03]

3. Answer the following question. [10 Marks][CO02] [BTL03]

a. What are the requirements a distributed Mutual Exclusion algorithm should satisfy and discuss the metrics used to measure the performance of such algorithms? [4 Marks]

b. Consider a toy distributed system with four systems each running Pa, Pb, Pc and Pd respectively, where Ricart-Agrawala algorithm is used to ensure mutual exclusion in the system as per the Lamports scalar time and is shown in the below process time diagram.

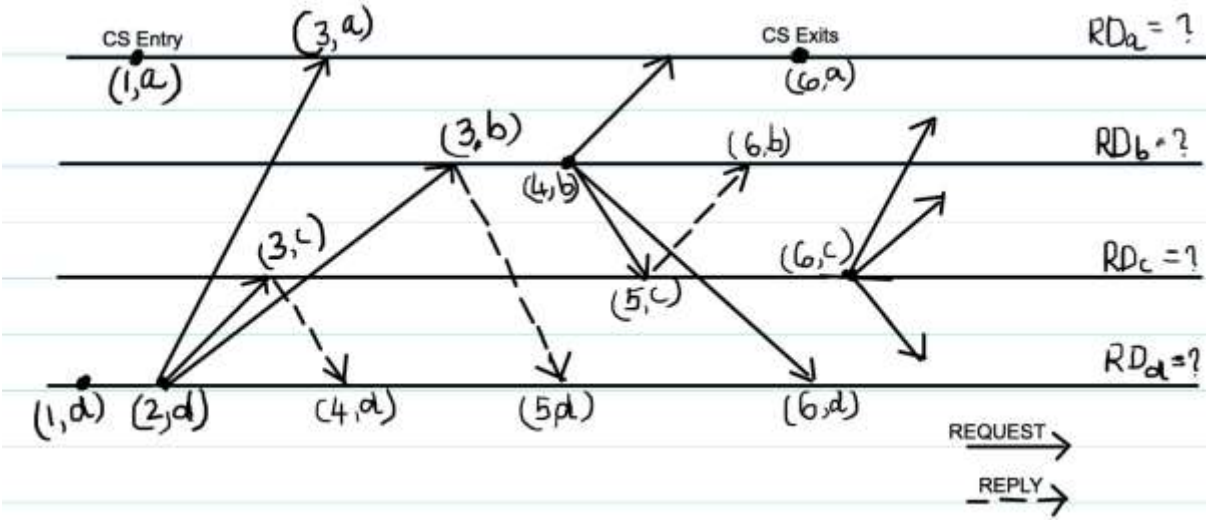
Scenario I: Refer the process time diagram and answer the following question.

a. Pa enters the Critical Section (CS) at (1,a) and exits at (6,a). Meanwhile Pd and Pb are making requests to enter the CS at timestamps (2,d) and(4,b) respectively. Show the updates happening in Request Deferred Array (RD).

b. Which Process will be entering the CS when Pa exits at (6,a). Show the updates in RD when Pa exits

c. Complete the process time diagram followed by the exit of CS by Pa [4 Marks]

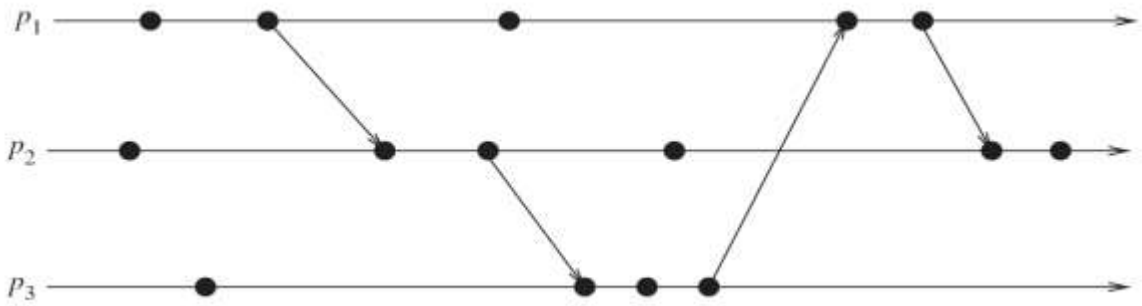
Scenario II: After Scenario I completes, Pc is placing a request to enter the CS at timestamp (6,c). Draw the Process time diagram and the order in which the processes are entering the CS, RD array updates. [2 Marks]



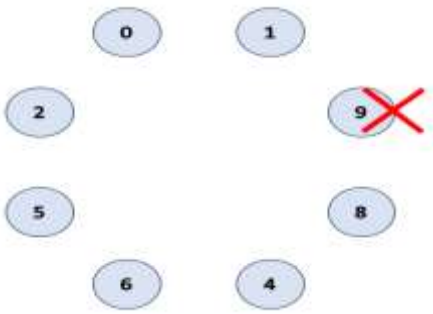
.

4. a. What are the two rules of updating vector clocks and how you compare two vector timestamps. Draw the vector clocks progress with an increment value of 1 to Figure.

[5 marks] [CO01] [BTL02]



b. Explain the leader election process using the Bully algorithm of a distributed system. Assume that the system has 8 nodes (processes) and the 5th node initiates the election process after confirming that the leader node 9 has crashed/down, as shown in Figure. What happens if node 9 active after the election process selected a leader? [5 marks][CO02] [BTL02]



5. a. Draw a timing diagram to explain Synchronous RPC communication. (Your timing diagram should contain a timeline for both the client and the server as well as all the messages exchanged between them.) [4 marks][CO4][BTL02]

b. Draw the state transition diagram for coordinator and participant in two phase commit(2PC) protocol. Apply 2PC protocol for the following scenario: When a customer makes a reservation for a hotel room the reservation system needs to update availability and allocate resources accordingly. The 2PC protocol ensures that all necessary updates are made consistently across distributed systems, avoiding double bookings or overcommitment of resources.

[6 Marks] [CO4][BTL2]

Consider the following cases:

(i) Case 1: When the coordinator fails in phase 1.

(ii) Case 2: When the coordinator fails in phase 2. Following subcases

a. One participant who knows about the decision made by the coordinator.

b. One participant who knows the decision also fails.

****

Course Outcome /Bloom's Taxonomy Level (BTL) Mark Distribution Table

CO	Marks	BTL	Marks
CO01	25	BTL 1	
CO02	15	BTL 2	30
CO03		BTL 3	20
CO04	10	BTL 4	