Advanced Operating System (CSN-502)
Mid Term Test 2019

Max. Time 1.5 Hr. Max. Marks 40

Note: If any data is missing, make suitable assumptions and state them clearly.

1. [6 Marks] Assign clock values to each send and receive event in the Fig. 1 using
   (i) Lamport's clock
   (ii) Vector clocks.

   Assume that initially clock values are all zero.

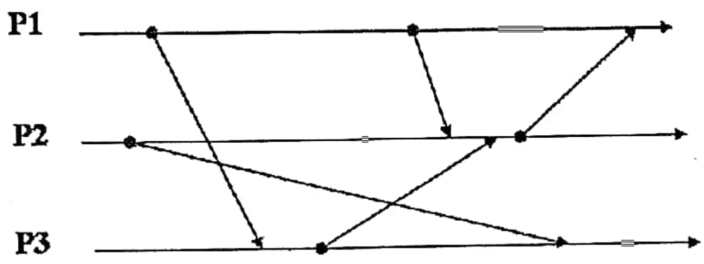

Fig. 1

2. [8 Marks] Consider a distributed system having four processes. Vector clocks are used to assign timestamp to the events. Timestamps assigned to 6 different events are given below. Write all pairs of concurrent events? Justify.

   (3, 1, 5, 7), (3, 2, 6, 7), (2, 1, 6, 8), (2, 1, 3, 4), (2, 2, 3, 3), (3, 3, 2, 5)

   - Define partial order. For events a and b with vector timestamps t_a and t_b, show with the help of an example that relation $t_a \parallel t_b$ is not a partial order

3. [8 Marks] Consider a scenario where machines on a LAN use Cristian's algorithm for the clock synchronization. There are many methods that can be used to estimate RTT and the time.

   Method 1: A process requests the time server for time and receives time value t in reply. It then estimates round trip delay (RTT) and estimates the actual time as t + RTT/2 to set its clock. What is the accuracy of this estimate and why?

   Method 2: Cristian also suggested that variability in the RTT can be handled up to some extent by making several request (say n requests) to time server and choosing the minimum value of RTT. Show with the help of an example that choosing the minimum RTT may not always give the best estimate of time out of the all possible n choices of RTT.

   Can you suggest a method better than the second one for estimating RTT?

4. [10 Marks] Write Agarwal-El Abbadi algorithm for constructing a tree-structured quorum. Let there be 15 sites that are logically organized into a complete binary tree as shown in Fig. 2. Write all quorums when:

(a) node 3 fails

(b) node 1 and 2 fail

Show a scenario where majority algorithm will form a quorum but Agarwal-El Abbadi algorithm cannot form a quorum due to node failures.

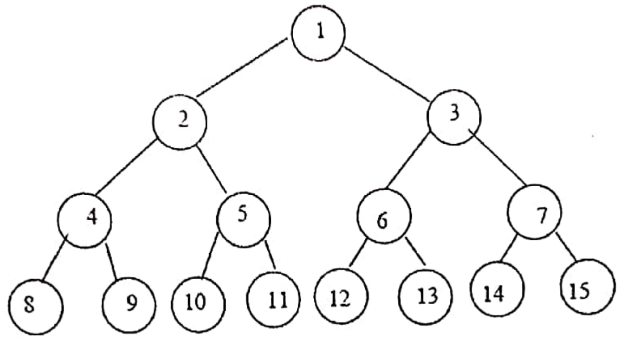

Fig. 2

5. [8 Marks] Consider Raymond's tree based algorithm. What is the

(a) Worst-case message complexity per Critical Section entry

(b) Average number of messages needed per critical section entry

Justify your answers.

Consider the spanning tree shown in Fig. 3. Assume initially the privilege is at site 3. Sites request for Critical Section (CS) entry in the sequence 1, 5, 2, 9 and 10. They get the PRIVILEGE and execute the CS also in the order 1 5 2 9 and 10. How many REQUEST and PRIVILEGE messages will be exchanged between sites to satisfy all these requests? Justify your answer by writing a possible sequence in which these messages will be transmitted. To show a REQUEST (PRIVILEGE) message from node A to B, write REQUEST_{AB} (PRIVILEGE_{AB}).

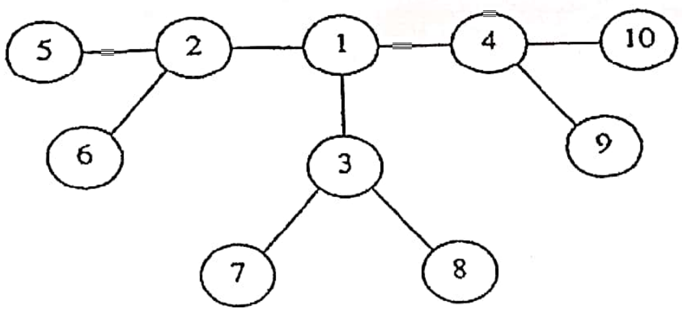

Fig. 3

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