Consider a distributed system consisting of 6 processes - P1, P2, P3, P4, P5 and P6. This system uses the Raynal-Schiper-Toueg algorithm for causal ordering of messages. P4 has sent 10 messages to P6. $DELIV_6$ = [8 9 0 8 5 0]. Which of the following is true?

Select one:
- No message from P4 has yet been delivered to P6
- All messages from P4 have been delivered to P6
- 2 messages from P4 is not yet delivered to P6
- 1 message from P4 is not yet delivered to P6

Total Messages sent from P4 to P6 is 10

DELIV6 ={8 9 0 **8** 5 0} -> $\{m_1^6\ m_2^6\ m_3^6\ \mathbf{m_4^6}\ m_5^6\ m_6^6\}$ => only 8 delivered

Answer :2 Messages from P4 is not yet delivered to P6

A distributed system consisting of 21 sites uses Maekawa's algorithm for implementing distributed mutual exclusion. Calculate the size of request set of each site.

Select one:
- 6
- 5
- 20
- 21

Size of Request set $|R_i|$=K= √N from N=K(K+1)+1

N=21

K= √21 -> Roundup(4.58) -> **5**

Just to check by applying K to find N

N=5(5-1)+1 -> 21 it is correct

Answer :5

For a distributed system, the synchronization delay is 4 seconds and the average critical section execution time is 12 seconds. What is the throughput of the system?

Select one:
- 0.0833
- 0.0625
- 0.125
- 0.25

Sync time (s) = 4

Min exec time (m) =12

Through put = 1/(s+m) => 1/(4+12) => 0.0625

Answer :0.0625

Which type of message is not used by Lamport's algorithm for implementing distributed mutual exclusion?

Select one:
- REQUEST
- QUERY
- REPLY
- RELEASE

Answer :QUERY

Which of the following message is used by Maekawa's algorithm for handling deadlocks?

Select one:
- INQUIRE
- DEFER
- TOKEN
- CAPTURE

Answer :INQUIRE

In a distributed system, the state of channel C_{23} is calculated as follows. (All symbols and notations have the usual meanings.)

Select one:

- $\{m_{23} \mid send(m_{23}) \in LS_2 \vee rec(m_{23}) \notin LS_3\}$
- $\{m_{32} \mid send(m_{32}) \in LS_3\}$
- $\{m_{32} \mid send(m_{32}) \in LS_3 \vee rec(m_{32}) \notin LS_2\}$
- $\{m_{23} \mid send(m_{23}) \in LS_2 \wedge rec(m_{23}) \notin LS_3\}$

•if a snapshot recording algorithm records the states of p_i and p_j as LS_i and LS_j , respectively, it must record the state of channel C_{ij} as transit(LS_i, LS_j)

•For C_{ij} , intransit messages are:

$$transit(LS_i, LS_j) = \{m_{ij} \mid send(m_{ij}) \in LS_i \wedge rec(m_{ij}) \notin LS_j\}$$

Answer :$\{m_{23} | send(m_{23}) \in LS_2 \wedge rec(m_{23}) \notin LS_3\}$

Suppose a distributed system contains 5 processes - P1, P2, P3, P4 and P5. Consider 2 events *a* and *b* occurring on this system. P2 sends a message to P4 corresponding to the event *a*. The event *a* has a vector timestamp of [3 2 4 1 3]. P2 sends another message to P4 corresponding to event *b*. The event *b* has a vector timestamp of [4 4 5 1 4]. After the occurrence of event *a* and before the occurrence of event *b*, P2 does not send any other message to P4. However, other events are occurring in the distributed system. Moreover, after the occurrence of event *a* and before the occurrence of event *b*, some message receive event has occurred at P2. You do not have to consider the vector timestamps of these other events. This system uses the Singhal-Kshemkalyani's Differential Technique for implementing vector clocks. Assume that initially, the vector clock of each process was [0 0 0 0 0] and d = 1. What will be the timestamp of the message sent corresponding to event *b*?

Select one:

- {(1, 4), (3, 5), (5, 4)}
- {(1, 4), (2, 4), (3, 5), (5, 4)}
- {(1, 4), (2, 4), (3, 5), (4, 1)}
- {(1, 4), (2, 4), (3, 5), (4, 1), (5, 4)}

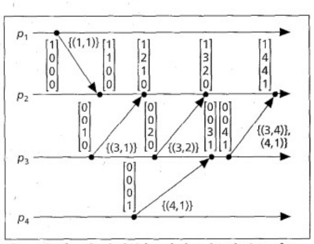


Figure 5. The Singhal-Kshemkalyani technique for vector clocks.

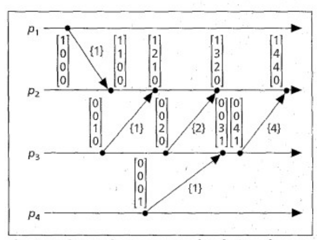


Figure 6. The Fowler-Zwaenepoel technique for vector clocks.

Ref : Fig 5

T1 T2 T3 T4 T5

P2 event 'a' timestamp -> { 3 2 4 1 3}

P2 event 'b' timestamp -> { 4 4 5 1 4}

As P2 receives messages after event 'a' & before event 'b' there is diff in time stamps of P1,P2,P3,P5 & seems no messages from P4 has occurred since it remains '1'.

So at event 'b', P2 has to sent differential timestamp values of P1,P2,P3,P5 -> {(1,4), (2,4), (3,5), (5,4)}

Answer :{(1,4), (2,4), (3,5), (5,4)}

Which of the following local variables is not used by the Synchronous Single-Initiator Spanning Tree algorithm using flooding?

Select one:

- visited
- parent
- color
- depth

Answer :color

A distributed system consisting of 11 processes uses the Schiper-Eggli-Sandoz protocol for causal ordering of messages. What is the size of the vector V_P maintained by each process?

Select one:

- 10
- 12
- 11
- 9

SES Algorithm

- SES: Schiper-Eggli-Sandoz Algorithm. No need for broadcast messages.
- Each process maintains a vector V_P of size N - 1, N the number of processes in the system.
- V_P is a vector of tuple (P',t): P' the destination process id and t, a vector timestamp.
- Tm: logical time of sending message m
- Tpi: present logical time at pi
- Initially, V_P is empty.

1

Size of V_P = N-1 -> 11-1 = 10

Answer :10

Which of the following is false for Lamport's algorithm for implementing distributed mutual exclusion?

Select one:

- Each site maintains a request_queue
- Communication channels are not required to be FIFO
- CS requests are executed in increasing order of timestamps
- request_queue of each site contains mutual exclusion requests ordered by their timestamps

- every site S_i keeps a queue, $request\_queue_i$
- $request\_queue_i$ contains mutual exclusion requests ordered by their timestamps
- FIFO
- CS requests are executed in increasing order of timestamps

Answer :Communication channels are not required to be FIFO

Consider a node P of a graph. P has 7 neighbors - Q, R, S, T, U, V and W. You do not have to worry about the remaining nodes of the graph. The Synchronous Single-Initiator Spanning Tree algorithm using flooding is executed on this graph. In round x, P receives QUERY messages from T and U. P will send out QUERY messages in round x + 1. How many QUERY messages will P send out in round x + 1?

Select one:

- 5
- 7
- 6
- 4

Synchronous Single-Initiator Spanning Tree Algorithm using Flooding

Algorithm for P_i

Round r > 1 and r <= *diameter*

if P_i planned to send in previous round **then**

  P_i sends QUERY to *Neighbors*

if *visited* = 0 **then**

  if P_i receives QUERY messages **then**

    visited = 1

    depth = r

    parent = any randomly selected node from which QUERY was received

    plan to send QUERY to *Neighbors* \ {senders of QUERYs received in r}

'P' has 7 neighbor nodes

- 'P' receives query from 'T' & 'U' at round 'X'.
- So 'P' will send query to other neighbors Q,R,S,V & W excluding T & U

Answer :5

A distributed system consisting of 20 sites uses the Ricart-Agrawala algorithm for implementing distributed mutual exclusion. How many messages are required per CS execution?

Select one:

- 40
- 38
- 42
- 36

Performance - requires 2(N − 1) messages per CS execution
So # of messages = 2(20-1) = **38** where N is 20 sites

Answer : 38

Which type of message is used by the Chandy-Lamport algorithm for global snapshot recording?

Select one:

- marker
- request
- reply
- release

Answer :Marker

Suppose a spanning tree contains 20 nodes. How many messages are required to conduct a broadcast on this spanning tree?

Select one:

- 21
- 20
- 19
- 10

each broadcast and each convergecast requires $n - 1$ message

⇨ 20-1 = 19

Answer :19

Which of the following is not a problem associated with global snapshot recording of distributed systems?

Select one:

- large number of processes
- asynchronous message transmission
- lack of a globally shared memory
- lack of a common global clock

- problems in recording global state
  - lack of a globally shared memory
  - lack of a global clock
  - message transmission is asynchronous
  - message transfer delays are finite but unpredictable

Answer : Large number of processes

Suppose a distributed system contains 50 processes. This system uses the Raynal-Schiper-Toueg algorithm for causal ordering of messages. The number of elements that are present in the SENT array of each process is

Select one:
- 100
- 50
- 2500
- 1000

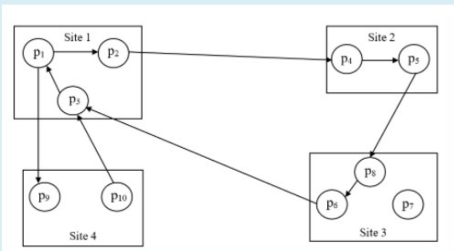
Raynal–Schiper–Toueg Algorithm

Complexity:
- space requirement at each process: $O(n^2)$ integers
- space overhead per message: n^2 integers
- time complexity at each process for each send and deliver event: $O(n^2)$

where n=50, n^2=2500

Answer :2500

Identify all the locally dependent processes for the WFG shown below. You don't have to consider any transitive dependencies.



Select one:
- p_1 dependent on p_2, p_3 dependent on p_1, p_4 dependent on p_5, p_8 dependent on p_6
- p_3 dependent on p_1, p_4 dependent on p_5
- p_3 dependent on p_1, p_4 dependent on p_5, p_8 dependent on p_6
- p_1 dependent on p_9, p_3 dependent on p_1, p_5 dependent on p_8, p_8 dependent on p_6

P1->P9 is wrong as P9 has no dependencies. It'll execute independently and release the resources to P1.

Answer :P1->P2,P3->P1,P4->P5,P8->P6

What type of communication is used by the Birman-Schiper-Stephenson protocol for causal ordering of messages?

Select one:
- broadcast
- convergecast
- unicast
- multicast

Answer : Broadcast

Suppose a distributed system contains 6 processes - P1, P2, P3, P4, P5 and P6. Consider 2 events *x* and *y* occurring on this system. P3 sends a message to P6 corresponding to the event *x*. The event *x* has a vector timestamp of [1 2 5 2 4 4]. P3 sends another message to P6 corresponding to event *y*. The event *y* has a vector timestamp of [2 3 7 3 5 6]. Other events are occurring in the distributed system. Also, after the occurrence of *x* and before the occurrence of *y*, a message receive event has occurred at P3. You do not have to consider the vector timestamps of these other events. This system uses the Fowler-Zwaenepoel's Direct Dependency Technique for implementing vector clocks. Assume that initially, the vector clock of each process was [0 0 0 0 0 0] and d = 1. What will be the timestamp of the message sent corresponding to event *y*?

Select one:

- {(1, 2), (2, 3), (3, 7), (4, 3)}
- {(3, 7)}
- {(1, 2), (2, 3), (3, 7), (4, 3), (5, 5), (6, 6)}
- {7}

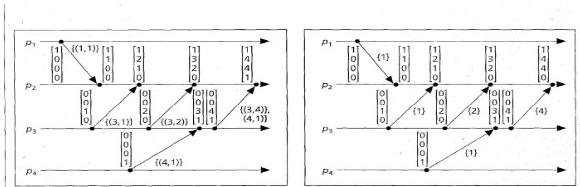


Figure 5. The Singhal-Kshemkalyani technique for vector clocks. **Figure 6. The Fowler-Zwaenepoel technique for vector clocks.**

Ref : Fig 6

Irrespective of any received messages P3 will send only it's own current vector clock value alone.

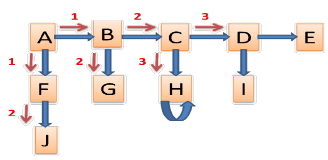
As per event 'y' timestamp of P3 is {2 3 7 3 5 6}. So it'll send only 7

Answer : {7}

A spanning tree contains 10 nodes - A, B, C, D, E, F, G, H, I and J. The HOLDER variable values of the nodes are as follows - $HOLDER_A$ = B, $HOLDER_B$ = C, $HOLDER_C$ = H, $HOLDER_D$ = C, $HOLDER_E$ = D, $HOLDER_F$ = A, $HOLDER_G$ = B, $HOLDER_H$ = self, $HOLDER_I$ = D, $HOLDER_J$ = F. Calculate the size of REQUEST_Q of node C.

Select one:

- 4
- 2
- 3
- 1



Answer : 3

Request-deferred array is used by which of the following algorithm for implementing distributed mutual exclusion?

Select one:

- Lamport's algorithm
- Ricart-Agrawala algorithm
- Maekawa's algorithm
- Raymond's Tree based algorithm

Answer : Ricart-Agrawala Algorithm

Consider a distributed system containing 5 processes - P1, P2, P3, P4 and P5. Consider the channel C_{45} in this system. P4 has sent messages m_1, m_2, m_3, m_4 and m_5 along C_{45}. P5 has received messages m_2 and m_5 along C_{45}. Each of m_1, m_2, m_3, m_4 and m_5 is a white message. This distributed system uses the Lai-Yang algorithm for global snapshot recording. What will be the state of channel C_{45}?

Select one:

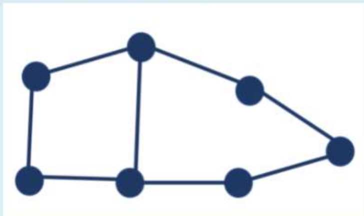
- $\{m_1, m_3, m_4\}$
- $\{m_3, m_4, m_5\}$
- $\{m_3, m_4\}$
- $\{m_1, m_4\}$

SC_{ij} = {white messages sent by p_i on C_{ij}} − {white messages received by p_j on C_{ij}}

$= \{m_{ij} \mid send(m_{ij}) \in LS_i\} - \{m_{ij} \mid rec(m_{ij}) \in LS_j\}$

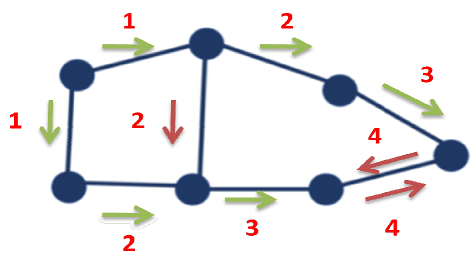
Answer : {m1,m3,m4}

What is the diameter of the given graph?



Select one:

- 4
- 5
- 2
- 3



Answer : 3

Suppose a distributed system contains 5 processes - p1, p2, p3, p4 and p5. Consider a probe message of the form (2, 1, 4) that is being used in an execution of the Chandy-Misra-Haas algorithm for the AND model. From the format of the probe message, determine the initiator of the algorithm.

Select one:

- p4
- p2
- p1
- cannot be determined due to insufficient information

Probe message format -> (initiator, Sender, receiver)

Our probe message is -> (2,1,4)

Answer : P2

Which of the following is false for the Lai-Yang algorithm for global snapshot recording?

Select one:

- each process is initially white
- marker messages cannot be used
- every message sent by a red process is a red message
- a red process is a process who has not yet recorded its local state

- when a process turns red, it sends these histories along with its snapshot to the initiator process that collects the global snapshot

Answer : A red process is a process who has not yet recorded its local state