

2018

COMPUTER AND INFORMATION SCIENCE

Paper : CISM-304

(Advanced Operating System)

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer **question nos. 1, 2** and **any four** from the remaining questions.

All answers should be precise

2×5

1. Answer **any five** out of the following :

- (a) Define the local and global states of system.
- (b) What is access transparency?
- (c) State at least two different motivations behind process migration.
- (d) Define user mobility in a distributed system.
- (e) What is forward intersection of a cut?
- (f) Why token-based algorithms are said to be inherently safe?
- (g) What would be the nature of a global state recording curve on the timeline of an event trace diagram?
- (h) What is the role of Interface Definition Language (IDL) in RPC?

2. Comment on the correctness of the following statements and justify your opinion. (Answer **any five**): 4×5

- (a) "A clock cannot be taken back for the sake of synchronization in a distributed system."
- (b) "Raymond's algorithm may grant access to processes out of turn."
- (c) "Migration of resources is a greater concern than address-space migration."
- (d) "Symmetric algorithms involve lower communication overhead in comparison with the diffusion computation approach."
- (e) "Vector clock provides only a partial order among time-stamps for different events in a distributed environment."
- (f) "Recording Global State for a distributed system is impossible."

Please Turn Over

(2)

3. (a) What is symmetric algorithm?
 (b) Define correctness of control algorithms for a distributed system.
 (c) What do you understand by fairness property in a distributed system?
 (d) Somebody suggested me that a greedy algorithm can be developed by modifying Ricart-Agrawala algorithm such that a process P_i wishing to enter its critical system does not send a "go ahead" reply to any other process till P_i itself has used its critical system. Give your views on the correctness of the revised algorithm.

2+2+2+4

4. (a) Describe a token-based algorithm to ensure mutual exclusion of processes run from multiple nodes in a distributed system connected using a hierarchical topology.
 (b) What would be the worst-case complexity for the above algorithm for a system with N processes running in that many nodes in the system?
 (c) Compare performances of symmetric algorithms vis-a-vis token-based algorithms for mutual exclusion.

6+1+3

5. (a) Define cut of a system.
 (b) What are forward and backward intersections?
 (c) The following events occur in a system of three processes :

process p1	process p2	process p3
event e1 ;	event e4;	event e6;
-----	-----	-----
send message to p2;	receive message from p3;	send message to p2;
event e2;	receive message from p1;	event e7;
-----	-----	-----
event e3;	event e5;	receive message from p2;
	send message to p3	event e8

- (i) Draw a timing diagram for the system.
 (ii) Show the event precedence in the system.
 (iii) List the concurrent events.

2+2+6

6. (a) State at least two different motivations behind process migration.
 (b) Describe the sender-initiated process migration approach.
 (c) What is stability? What is done to improve the stability of the system for sender-initiated process migration?
 (d) Define preemptive and non-preemptive process migrations.

2+4+2+2

7. (a) What are the drawbacks of the centralized deadlock detection algorithm?
 (b) Describe Mitchell-Merritt algorithm for deadlock detection in a distributed environment. Illustrate the same with an example. 3+7
8. (a) Explain the role of RPC run-time towards implementing RPC mechanism.
 (b) Name the IDL for SUN RPC environment. What compiler is used for IDL in SUN RPC? Which call semantic is followed for SUN RPC?
 (c) What are the different components in typical request message for RPC?
 (d) How the RPCs with large data arguments may be handled?
 (e) How an RPC of long duration may be handled? 2+3+2+1+2
9. (a) Derive the D^- , D^+ and D matrices for the following Petri Net :

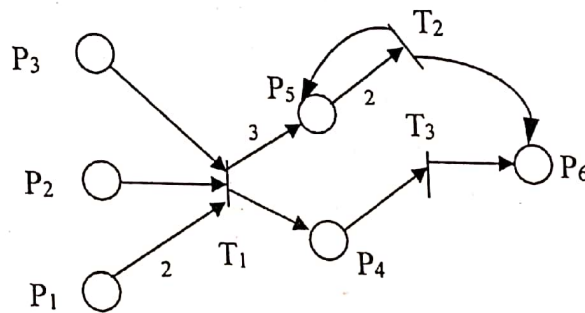


Fig. 1: A Petri Net Model

- (b) Given an initial marking of $\mu = [4, 3, 3, 0, 1, 0]$, draw the reachability tree for the Petri Net in Fig. 1.
 (c) Is it possible to reach a state with 4 tokens in P_6 for the above initial marking? Justify your opinion and list the firing sequence for the transitions accordingly. 4+3+3

2017

COMPUTER AND INFORMATION SCIENCE

Paper — CISM – 304

(Advanced Operating System)

Full Marks – 70

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Candidates are required to give their answers in their own words as far as practicable

Answer **Question Nos. 1 and 2**, and **any four** from the rest

1. Answer **any five** out of the following : 2×5
- ✓ (a) What is global state of a system ?
 - ✓ (b) Define Name transparency.
 - ✓ (c) State at least two different motivations behind process migration.
 - ✓ (d) Why token based algorithms are said to be inherently safe ?
 - ✓ (e) What would be the nature of a global state recording curve on the time line of an event trace diagram ?
 - ✓ (f) State the condition for Happens Before relation between events.
 - ✓ (g) What are the two different types of long RPC ?
2. Comment on the correctness of the following statements and justify your opinion — answer **any five** : 4×5
- ✓ (a) "It may not be wise to use vector clock for time-stamping in solutions such as Ricart-Agrawala's symmetric algorithm for mutual exclusion in distributed systems".
 - ✓ (b) "Raymond's algorithm may grant access to processes out of turn".
 - ✓ (c) "Failure of liveness is not a major concern for deadlock detection algorithms".
 - ✓ (d) "Lamport's Clock model generates unique time stamp for each and every event in a distributed system".
 - ✓ (e) "In a distributed system, resource migration is more challenging than migration of codes for a process".
 - ✓ (f) "Call by reference is not a suitable option for parameter passing in RPC".
3. (a) Describe a token based algorithm for mutual exclusion on ring topology in distributed system.
- ✓ (b) What would be the best and worst-case control message complexity for the above algorithm for a system with N processes in the ring ? Justify your assessment. *best case: 1 worst case: (n-1)*
- ✓ (c) Compare symmetric algorithms vis-a-vis token based algorithms for mutual exclusion. 4+3+3

[Turn Over]

4. (a) Define condition of consistency in terms of processes and channels in a distributed system.

(b) Two unrelated events X and Y occurs in two different nodes. The logical clock time-stamp values for the two events are $TS(X)$, and $TS(Y)$ respectively such that $TS(X) > TS(Y)$. It cannot be inferred from these statements that physically Y has occurred before X" — give your opinion on the validity of the statements above and justify the same.

(c) Compare the performance of Vector clock with Lamport's logical clock model.

3+4+3

5. (a) Describe the Ho-Ramamurthy's deadlock detection algorithm for distributed environment. Illustrate the same with an example.

(b) Comment on the safety and liveness properties of Ho-Ramamurthy's deadlock detection algorithm.

6+4

6. (a) Define pre-emptive and non pre-emptive process migration.

(b) Name two alternate metrics that may be used to measure load in a node.

(c) State two different motivations for process migration other than load balancing.

(d) State the merits and demerits of sender initiated versus receiver initiated process migration approaches.

2+2+2+4

7. (a) Explain the roles of client stub towards implementing RPC mechanism.

(b) What is Orphan call ? Why is it important to detect ?

(c) What is binding for RPC ?

(d) Suggest the appropriate call semantics to be used (among may-be, last-of-many, at-least-once or exactly-once) for the following application:

(i) To request a time server to get the current time;

(ii) To request a booking server to reserve a seat.

2+3+1+4

8. (a) Derive the D-, D+ and D matrices for the following Petri Net :

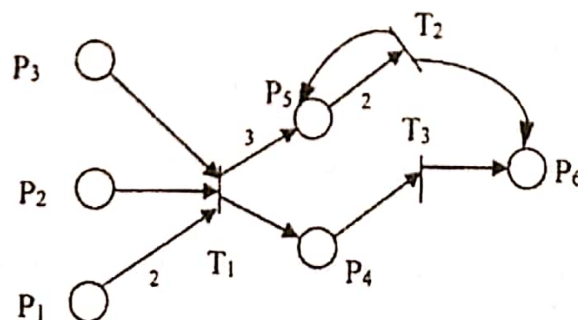


Fig. 1 : A Petri Net Model

(b) Given an initial marking of $\mu = [2, 3, 3, 0, 1, 0]$, draw the reachability tree for the Petri Net in Fig.1.

(c) Is it possible to reach a state with 4 tokens in P_6 for the above initial marking ? Justify your opinion and list the firing sequence for the transitions accordingly.

4+3+3

2016

COMPUTER AND INFORMATION SCIENCE

Paper — CISM – 304

(Advanced Operating System)

Full Marks – 70

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Candidates are required to give their answers in their own words as far as practicable

Answer Question No. 1 and any four from the rest

1. Answer *any seven* questions of the following :

2×7

- (a) Define the local and global states of system.
- (b) What is location transparency ?
- (c) Define liveness of an algorithm in a distributed system.
- (d) What would be the nature of a Cut if it represents the global state recording in an event trace diagram ?
- (e) What is the maximum number of hops that a Token request message may require for Ring topology with N number of nodes forming the Ring in a distributed system ?
- (f) What is an engaging query in diffusion computation ?
- (g) What is Orphan call in the context of Remote Procedure Call (RPC) ?
- (h) State the condition of concurrency for two or more events in a distributed system.
- (i) What is preemptive process migration ?
- (j) Define Stub in the context of RPC.

2. (a) What is a consistent state ? State the condition of consistency among processes in a distributed system.

(b) "It's not practically possible to synchronize the local clocks in a distributed environment so that the clock values are identical in all the participating nodes" – give your opinion on the correctness of the statement and justify the same.

(c) What is an event ?

(d) The following events occur in a system of three processes :

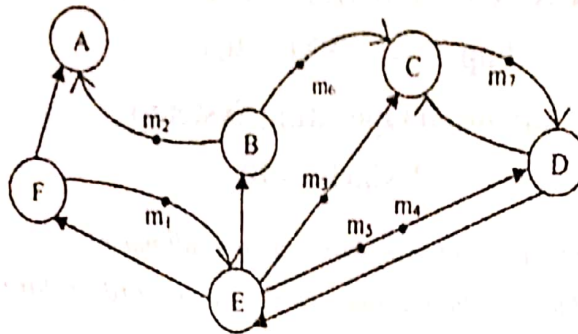
<u>process p1</u>	<u>process p2</u>	<u>process p3</u>
event e1; -----	event e4; -----	event e6; -----
send message to p2; event e2; -----	receive message from p3; receive message from p1; -----	send message to p2; event e7; receive message from p2; -----
event e3;	event e5; send message to p3;	event e8;

- (i) Draw a timing diagram for the system.
- (ii) Show the event precedence in the system.
- (iii) List the concurrent events.

3+4+3+4

[Turn Over]

3. Consider the distributed system in figure 1 with six processes in as many sites and answer the following questions with respect to the same :



(Figure 1 : A Distributed System)

(a) Identify which of the following is not a valid order in which the nodes may actually record their states following Chandy-Lamport's state recording algorithm.

- F, E, B, A, C, D
- F, A, B, C, D, E
- F, A, E, C, D, B
- F, A, E, B, C, D

Explain why.

(b) "Following Chandy-Lamport's algorithm, even if we choose an initiator node whose out-degree is greater than zero, it may not be possible to complete the state recording for all the nodes and channels in a system built on connected graph topology with all its nodes in the same partition" — do you agree with this comment ? Justify your opinion.

(c) If node C becomes the initiator then answer the following :

(i) Can node F record its state before node E does so ? Explain.

(ii) Mark recording for all the states and channels following Chandy-Lamport's algorithm assuming node A receives its first marker from node B and not from node F.

(iii) How does the state recording change if a message m_8 is sent over channel Ch_{DE} after the state for node D is recorded ?

$$2+5+(1+5+1)$$

4. (a) Describe Ricart-Agrawala's symmetric algorithm for mutual exclusion.

(b) Derive the control message complexity for the above algorithm for a system with M out of N processes requesting to enter CS.

(c) Describe the logical clock model introduced by Lamport.

(d) "Two unrelated events X and Y occurs in two different nodes. The logical clock time-stamp values for the two events are $TS(X)$, and $TS(Y)$ respectively such that $TS(X) > TS(Y)$. It cannot be inferred from these statements that physically Y has occurred before X" — give your opinion on the validity of the statements above and justify the same.

(e) State a major deficiency of Raymond's algorithm for mutual exclusion.

$$6+2+1+4+1$$

- (a) What do you mean by edge-chasing algorithms ?
- (b) Describe Mitchell-Merritt's algorithm for deadlock detection with a simple illustrative example.
- (c) Write a diffusion-computation based algorithm to find total number of messages sent in a distributed system. 2+6+6
6. (a) Describe the receiver-initiated process migration approach. ✓
- (b) What is the comparative impact on stability for sender-initiated versus receiver-initiated process migration approaches ? ✓
- (c) What is preemptive process migration ?
- (d) "In a distributed system, resource migration is more challenging than migration of codes for a process" — give your opinion on the statement and justify the same. 4+3+2+5
7. (a) "Call by reference is not a suitable option for parameter passing in RPC" — do you agree with this comment ? Justify your opinion.
- (b) Describe the role of RPC Runtime towards implementing RPC.
- (c) What are the relative advantages of using multiple binding agents vis-à-vis broadcasting for binding of RPC calls in case of a distributed system with large number of nodes ?
- (d) Explain how RR communication protocol may support Exactly Once call semantic. 4+3+4+3

2015

COMPUTER AND INFORMATION SCIENCE

Paper – CISM – 304

(Advanced Operating System)

Full Marks – 70

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Candidates are required to give their answers in their own words as far as practicable

Answer **Question No. 1** and **any four** from the remaining questions

All answers should be precise

1. Answer **any seven** out of the following : 2×7

- (a) What is global state of a system ?
- (b) Define Name transparency.
- (c) State at least two different motivations behind process migration.
- (d) Why token based algorithms are said to be inherently safe ?
- (e) What is an event ? How is it related to a process ?
- (f) Define diffusion computation.
- (g) What would be the nature of a global state recording curve on the time line of an event trace diagram ?
- (h) State the condition for Happens Before relation between events.
- (i) What is the condition of idem-potency ?
- (j) Define stateless and stateful servers.

2. (a) Define condition of consistency in terms of processes and channels in a distributed system.

(b) Explain the vector clock mechanism with a suitable example. What is its major advantage over Lamport's logical clock model ?

(c) "It may not be wise to use vector clock for time-stamping in solutions such as Ricart-Agrawala's symmetric algorithm for mutual exclusion in distributed systems" — Give your opinion on the correctness of the statement and justify the same.

3+(4+2)+5

[Turn Over]

3. (a) How do you compare progress condition versus liveness of a system ?
- (b) Describe Raymond's algorithm for mutual exclusion.
- (c) Comment on the correctness of Raymond's algorithm for mutual exclusion.
- (d) "Raymond's algorithm may grant access to processes out of turn"
— Give your opinion on the correctness of the statement and justify the same. 2+6+2+4
4. (a) Why deadlock avoidance is tough to achieve as a deadlock handling mechanism for distributed environment ?
- (b) Describe the centralized deadlock detection algorithm for distributed environment. Illustrate the same with an example.
- (c) "Failure of liveness is not a major concern for deadlock detection algorithms" — Give your opinion on the statement and justify the same. 3+7+4
5. (a) State the three major components of process migration. Which of these are required towards implementing preemptive process migration ? Why ?
- (b) State and explain different levels of resource-machine binding that needs to be considered for resource migration.
- (c) Describe the hybrid approach for process migration. Comment on the performance of this approach. 5+3+6
6. (a) State the roles of client stub and server stub in implementing RPC mechanism.
- (b) What are the different approaches for generating stubs ? Compare the relative advantages and disadvantages.
- (c) What is Orphan call? Why is it important to detect ?
- (d) Describe the role of binding agent for RPC. 6+3+2+3
7. (a) What is call-back RPC ?
- (b) Explain with a suitable illustration, how the executable at client and server sides are built for SUN RPC.
- (c) Suggest the appropriate call semantics to be used (among may-be, last-of-many, at-least-once or exactly-once) for the following applications:
- To request a time server to get the current time ;
 - To request a booking server to reserve a seat. 2+8+4

2014

COMPUTER AND INFORMATION SCIENCE

Paper – CISM – 304

(Advanced Operating Systems)

Full Marks – 70

The figures in the margin indicate full marks

Candidates are required to give their answers in their own words as far as practicable

Answer Question No. 1 and any four from the remaining questions.

All answers should be precise.

1. Answer *any seven* out of the following :

2×7

- (a) Define the local and global states of system.
- (b) What is access transparency ?
- (c) Define user mobility in a distributed system.
- (d) What is forward intersection of a cut ?
- (e) What is the control message complexity for Ricart-Agrawal's symmetric mutual exclusion algorithm ?
- (f) What is an engaging query in diffusion computation ?
- (g) Define Remote Procedure Call (RPC).
- (h) State the conditions of event precedence.
- (i) Explain how process migration can help to reduce communication load on the network.
- (j) What is the role of Interface Definition Language (IDL) in RPC ?

2. (a) What is a consistent state ? State the condition of consistency among processes in a distributed system.

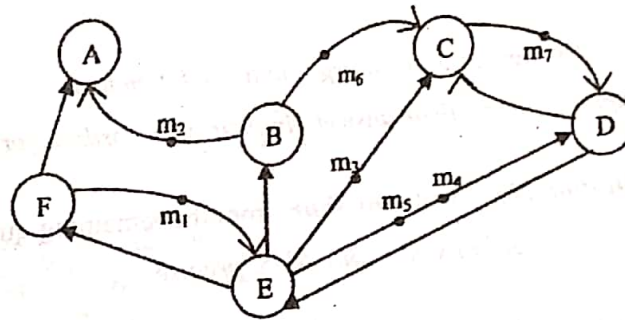
(b) "A local clock cannot be taken back to make it consistent with the local clock of another node" — Give your opinion on the correctness of the statement and justify the same.

[Turn Over]

(c) What is a cut ? Draw a cut for an ideal snapshot recording. State the condition of consistency in terms of the cut of system.

(d) Describe Naïve State recording algorithm for a distributed system. Does it ensure consistent state recording? Justify your opinion. 3+2+3+(4+2)

3. Consider the distributed system in figure 1 with six processes in as many sites and answer the following questions with respect to the same.



(Figure 1: A Distributed System)

(a) Identify which of the following is not a valid order in which the nodes may actually record their states following Chandy-Lamport's state recording algorithm.

- (i) F, E, B, A, C, D
- (ii) F, A, B, C, D, E
- (iii) F, A, E, C, D, B
- (iv) F, A, E, B, C, D

Explain why ?

(b) "Following Chandy-Lamport's algorithm, even if we choose an initiator node whose out-degree is greater than zero, it may not be possible to complete the state recording for all the nodes and channels in a system built on connected graph topology with all its nodes in the same partition" — Do you agree with this comment ? Justify your opinion.

(c) If node C becomes the initiator then answer the following :

(i) Can node F record its state before node E does so ? Explain.

(ii) Mark recording for all the states and channels following Chandy-Lamport's algorithm assuming node A receives its first marker from node B and not from node F.

(iii) How does the state recording change if a message m_8 is sent over channel Ch_{DE} after the state for node D is recorded ? 2+5+(1+5+1)

4. (a) Define correctness of an algorithm.

(b) How do you prove correctness of a token based algorithm? Describe a token based algorithm for mutual exclusion on a directed ring topology.

(c) Using the above algorithm for a ring with n nodes, what could be the maximum number of hops that a token request may have to traverse before it reaches the process holding the token? Explain your answer.

(d) Prove the correctness of Ricart-Agrawala's symmetric algorithm for mutual exclusion.

$$2 + (1+5) + 3 + 3$$

5. (a) What do you mean by edge-chasing algorithms?

(b) Describe Mitchell-Merritt's algorithm for deadlock detection with a suitable illustrative example.

(c) Write a diffusion-computation based algorithm that computes the total number of messages sent across the system.

6. (a) State the difference between pre-emptive and non pre-emptive process migration.

$$2 + 6 + 6$$

(b) Name two alternate metrics that may be used to measure load in a node.

(c) State the merits and demerits of sender initiated versus receiver initiated process migration approaches.

(d) Describe the hybrid approach for process migration. Comment on the performance of this approach.

7. (a) "Call by reference is not a suitable option for parameter passing in RPC" — Do you agree with this comment? Justify your opinion.

$$3 + 1 + 4 + 6$$

(b) State the *Last One* call semantic for RPC. Explain how it may fail in presence of Orphan calls.

(c) How can you handle RPCs that take long time to execute to make sure that the call is in process?

(d) Explain how RR communication protocol may support Exactly Once call semantic.

$$2 + 5 + 3 + 4$$

2013

COMPUTER AND INFORMATION SCIENCE

Paper CISM – 304

(Advanced Operating System)

Full Marks – 70

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Candidates are required to give their answers in their own words as far as practicable

Answer Question No. 1 and any four from the rest

1. Answer any seven of the following :

2×7

- (a) What is global state?
- (b) What is distribution transparency?
- (c) State at least two different motivations behind process migration.
- (d) What is the primary limitation of symmetric algorithms for a distributed system?
- (e) What is an event? How is it related to a process?
- (f) Define diffusion computation.
- (g) What is Remote Procedure Call (RPC)?
- (h) Define termination detection for a distributed system.
- (i) State at least two different motivations behind process migration.
- (j) What is binding for RPC?

2. (a) Do you consider client-server architecture to be an example of a distributed system? Justify your opinion.

- (b) Define access transparency and migration transparency.
- (c) "Recording Global State for a distributed system is impossible"—give your opinion on the correctness of the statement and justify the same.
- (d) Define Cut of a system with a small illustrative example.

3+4+5+2

[Turn Over]

3. (a) How do you define the condition of precedence between two events?
 (b) Discuss the condition of consistency involving two processes and a unidirectional channel between the two processes.
 (c) Describe the logical clock model introduced by Lamport.
 (d) "Two unrelated events X and Y occurs in two different nodes. The logical clock time-stamp values for the two events are TS(X), and TS(Y) respectively such that $TS(X) > TS(Y)$. It cannot be inferred from these statements that physically Y has occurred before X" — give your opinion on the validity of the statements above and justify the same. 2+3+4+5
4. (a) How do you interpret liveness and safety when you are designing an algorithm to ensure mutual exclusion of processes using critical section?
 (b) Describe Raymond's algorithm for mutual exclusion with suitable illustrative example.
 (c) "Raymond's algorithm may grant access to processes out of turn" — give your opinion on the correctness of the statement and justify the same. 2+7+5
5. (a) Describe the receiver-initiated process migration approach.
 (b) What is the comparative impact on stability for sender-initiated versus receiver-initiated process migration approaches?
 (c) What is preemptive process migration?
 (d) "It is possible to migrate a process without migration of corresponding address space" — give your opinion on the statement and justify the same. 4+3+2+5
6. (a) Why deadlock avoidance is tough to achieve as a deadlock handling mechanism for distributed environment?
 (b) Describe centralized deadlock detection algorithm for distributed system with an example.
 (c) "Failure of liveness is not a major concern for deadlock detection algorithms" — give your opinion on the statement and justify the same. 3+7+4
7. (a) Illustrate and briefly state the architecture of RPC.
 (b) What is IDL? Name the IDL for SUN RPC. Which call semantic is followed for SUN RPC?
 (c) How the RPCs with large data arguments may be handled?
 (d) What is orphan call? How this may be handled in RPC? 4+3+4+3