Advanced Operating System (CSN-502)

End Term Examination 2019

Max. Time 3 Hrs. Max. Marks 100

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

1. [10 Marks] Attempt any TWO parts.

(a) Define Vertex coloring problem. Write a greedy algorithm for vertex coloring that never uses more than d + 1 colors where d is the maximum degree of a vertex in the given graph. Now draw a graph with at least 7 nodes and 12 edges and show its coloring based on your algorithm.

(b) State the problem of distributed task allocation. Explain consensus based bundle algorithm (CBBA).

(c) Write Bully algorithm for leader election. Explain its working with the help of a diagram.

(d) Consider clock synchronization problem in dynamic networks. Write fast and slow conditions of Dynamic-Weight algorithm. Explain each term of the conditions.

(e) Name five different sections (other than .data and .text sections) of an ELF file and give details about the type of information stored in these sections.

(f) Explain side channel attack using the algorithm for computing an RSA modulus.

(g) Explain malicious code filter (MCF) and PAYL tools.

(h) Compare static and dynamic malware analysis techniques.

(i) Explain (i) Trojan Horse (ii) Trap Door (iii) Logic Bomb and (iv) Virus

(j) Explain different types of DDoS attacks.

(k) Step 1 of Kerberos Client-Server authentication protocol is written below. In this step client C presents its ticket-granting ticket $tick_{TGS}$ to TGS to request a ticket for server S. C's knowledge of session key k is demonstrated using the authenticator $\{C, T1\}_k$ where T1 is the timestamp. Complete the protocol and explain each variable used.

Step 1: C → TGS | S, $tick_{TGS}$, $\{C, T1\}_k$

(l) Explain with the help of neat diagrams the difference between iterative and recursive name resolution.

(m) Explain write-invalidate and write-update coherence protocols with the help of diagrams. Discuss their advantages and disadvantages.

(n) Give a brief overview of different types of multiprocessor operating systems.

(o) Compare time sharing and space sharing scheduling used by multiprocessor operating systems.

(p) Draw a neat diagram of Android Stack Architecture and explain.

(q) Compare MACH and CHORUS operating systems based on the abstractions made by their developers.

(r) Consider real time OS. Generally what are the states in which a process can be during its life time? Explain Round Robin, Rate Monotonic and Earliest Deadline First (EDF) scheduling algorithms.

(s) Explain about "address ranges" proposed for Corey operating system.

(t) Draw a diagram and explain the architecture of HDFS.

(u) What is the role of quorum journal manager in HDFS? Explain.

(v) Write features of Coda distributed file system. Explain disconnected mode of Coda.

(w) Differentiate between MPI functions – MPI_Send, MPI_Ssend, MPI_Isend and MPI_Issend. Name two virtual topologies supported by MPI.

(x) What information is stored in a ".x" RPC file? What files will be generated on executing command "rpcgen somefile.x"? What information is stored in these files?

2. (a) [5 marks] Compare Byzantine agreement, Consensus and Interactive consistency problems based on the following:

(i) How many processes initiate the value and

(ii) Final agreement is on how many values?

(b) [12 marks] Write Lamport et al.'s OM (m) algorithm to solve Byzantine agreement problem. Let there be ten processors (p0, p1,..., p9) and m = 3. Write total number of rounds of message exchanges and number of separate executions of algorithms OM(0), OM(1) etc. in different rounds. If in the first round processor p0 sends a message to processor p1, how many messages p1 will send to other processors in next (second) round when it executes OM(2). Write these messages. To show a message send by the processor i to processor j in n^{th} round use notation m(n, i, j). How many TOTAL messages p1 will send in third round? Write these messages.

3. [15 marks] Consider Obermarck's distributed deadlock detection algorithm. Let there be three sites and 8 transactions as shown in Fig. 1. If in first iteration sites B and C have WFGs shown on the right side of Fig. 1, then write

(i) strings (cycles) sent by sites B and C to other sites. Also write the name of the site (A, B or C) to which string is sent.

(ii) draw modified WFGs of B and C for second iteration based on the strings received (site A does not send any string) in first iteration.

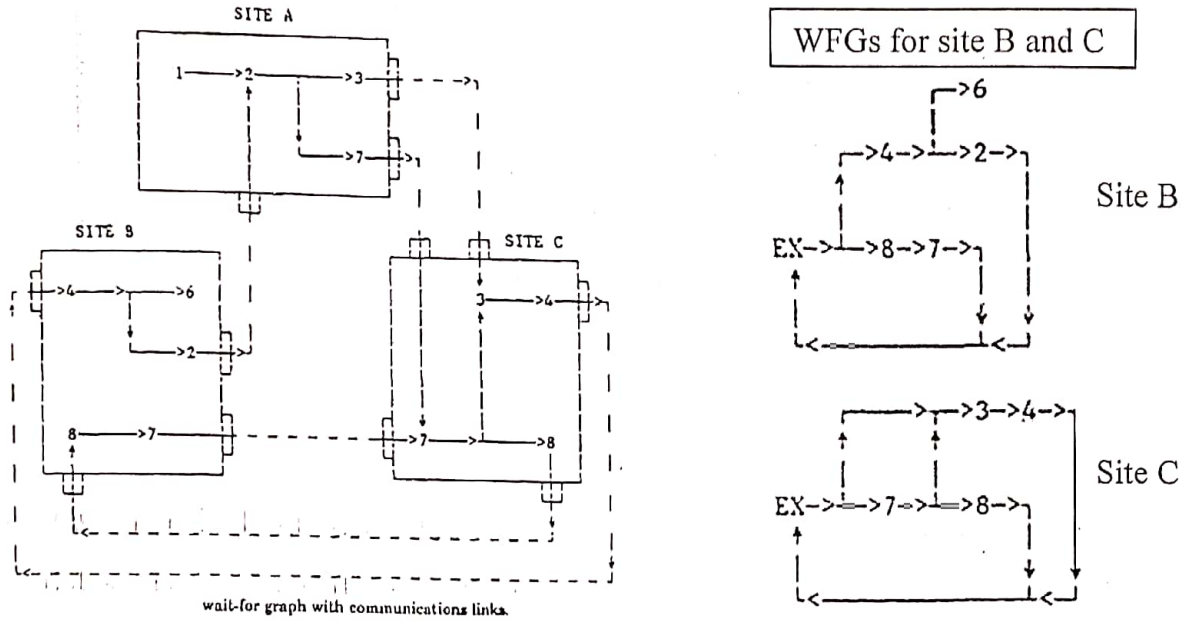

Fig. 1

A. [15 marks] Draw Finite state automata of three-phase commit protocol discussed in class for coordinator and cohorts. Now assume a system with one coordinator (i = 1) and one cohort (i = 2)

(i) Define concurrency set (C(s)) and sender set (S(s)) of state s.

(ii) Write concurrency set of the non-final states (q1, w1 and p1) of the coordinator and non-final states (q2, w2 and p2) of the cohort.

5. (a) [10 marks] Explain the technique proposed by Singhal and Kshemkalyani for efficient implementation of Vector Clocks. Clearly define all data structures maintained by each process and the information carried by the messages exchanged between processes. For Fig. 2 write the compressed timestamp carried by each message. (events – message sent, receive and cut event)

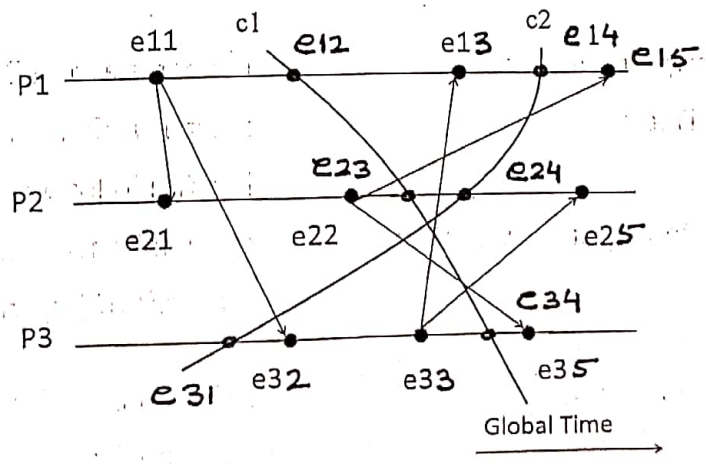

Fig. 2

(b) [5 marks] Define vector time of a cut of a distributed computation where each event of the distributed computation has a vector timestamp. What are the vector times of the cuts c1 and c2 shown in Fig. 2?

6. (a) [2 Marks] Let ρ be the maximum clock drift rate. If application requires that clock skew should be less than δ then what should be the resynchronization period?

(b) [10 Marks] Write Huang's termination detection algorithm and outline its proof of correctness.

(c) [6 Marks] Consider the mode where a pair of NTP servers exchange messages bearing timing information for synchronizing clocks. An NTP server B receives server A's message at 16:34:23 bearing a timestamp 16:34:13 and replies to it. A receives the message at 16:34:18, bearing B's timestamp 16:34:26. Estimate the offset between A and B and the accuracy of estimate. Show calculations.

7. [10 Marks] Five replicas of a file are stored at sites A, B, C, D and E. Majority based dynamic voting protocol proposed by Jajodia and Mutchler is in use for updating replicas. Each site can access all other sites (one partition) at time t. Following table shows the state of system at time t.

	A	B	C	D	E
VN	9	9	9	9	9
RU	5	5	5	5	5
DS	-	-	-	-	-

What will be version number (VN), number of replicas updated (RU) and distinguished site list (DS) after each event if following sequence of events happen.

(i) A receives an update and can communicate only with B and C
(ii) A receives an update and can communicate only with C
(iii) D receives an update and can communicate with B, C and E
(iv) E receives an update and can communicate only with B