PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Midterm Examination: Semester 2 **Academic Year**: 2003-2004

Date: 20th December 2003 **Time**: 9.00-12.00 (3 hours)

Subject Number: 240-572 **Room**: R300

Subject Title: Parallel and Distributed Simulation Systems

Exam Duration: 3 hours

This paper has 13 pages, 14 questions and 150 marks (50%).

Authorised Materials:

- Writing instruments (e.g. pens, pencils).
- Only a notebooks, handouts, and dictionaries are permitted.

Instructions to Students:

- Scan all the questions before answering so that you can manage your time better.
- Attempt all questions.
- Write your answers in the exam sheets.
- Write your name and ID on each page.
- Any unreadable parts will be considered wrong.

When drawing diagrams or coding, use good layout, and short comments;
marks will not be deducted for minor syntax errors.

Name_____Code_____

Question 1 (15 marks; 15 minutes)

1.1 Why are parallel and distributed simulations important? (5 marks)

1.2 Given a physical system,

1.2.1 Describe the fundamental concepts of Discrete Event Simulation. (3 marks)

1.2.2 Describe how to build a simulation model in terms of Discrete Event Simulation. (3 marks)

1.3 Tell the advantages and disadvantages of *publication and subscription* mechanisms in distributed environments. (4 marks)

Question 2 (6 marks; 6 minutes)

Amongst the given applications below (a-f),

2.1 Which are considered *system analysis?*

2.2 Which are considered *virtual environments*?

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a) war gaming simulations
b) simulation for training air traffic controllers
c) multi-user home entertainment
d) simulation of large networks such as millions of mobile subscribers
e) simulation of digital electronics circuits
f) simulations of adding a new runway to Bangkok airport

Question 3 (4 marks; 4 minutes)

If simulation time = W2S(W) = T0 + S*(W-W0), where W = wallclock time, S = scale factor, W0(T0) = wallclock (simulation time at start of simulation), assuming that simulation and wallclock time use the same time units,

a) what happen if the scale factor, S, is greater than 1? (2 marks)

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b) what happen if the scale factor, S, is smaller than 1? (2 marks)

Question 4 (10 marks; 10 minutes)

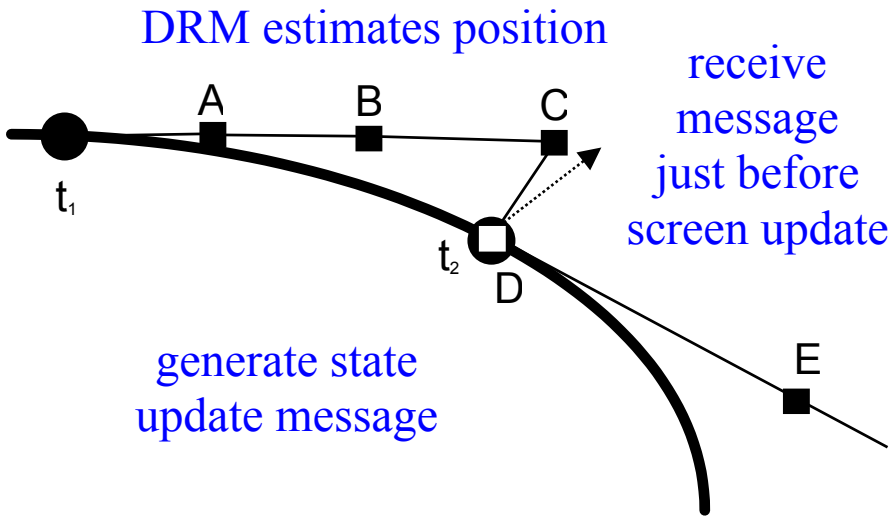
From the example *process-oriented* simulation of a network of airports, complete the following process by taking into account of the runway usage of the departure. Define new variables and constants if necessary.

```
/* simulate aircraft arrival, circling, and landing */
Integer: InTheAir;
Integer: OnTheGround;
Boolean: RunwayFree;

InTheAir := InTheAir + 1;
WaitUntil (RunwayFree);                    /* circle */
RunwayFree := FALSE;                       /* land */
AdvanceTime(R);
RunwayFree := TRUE;

/* simulate aircraft on the ground */
```

```
InTheAir := InTheAir - 1;
OnTheGround := OnTheGround + 1;
AdvanceTime(G);
/* simulate aircraft departure TO BE ADDED*/
 OnTheGround := OnTheGround - 1;
```

Question 5 (10 marks; 10 minutes)

About *dead reckoning*, show how to solve the following potential problems by modifying the following picture and giving some explanation:



5.1 Discontinuity may occur when position update arrives; may produce "jumps" in display (5 marks)

5.2 Message latency (5 marks)

Question 6 (10 marks; 10 minutes)

Suppose that A, B and C are logical processes (LPs) that connect to each other as below.

Qa is a message queue received from logical process A.

Qb is a message queue received from logical process B.

Qc is a message queue received from logical process C.

At LP A, Qb has two messages with time stamp 5 and 7.

At LP B, Qc has two messages with time stamp 6 and 8.

At LP C, Qa has one message with time stamp 9.

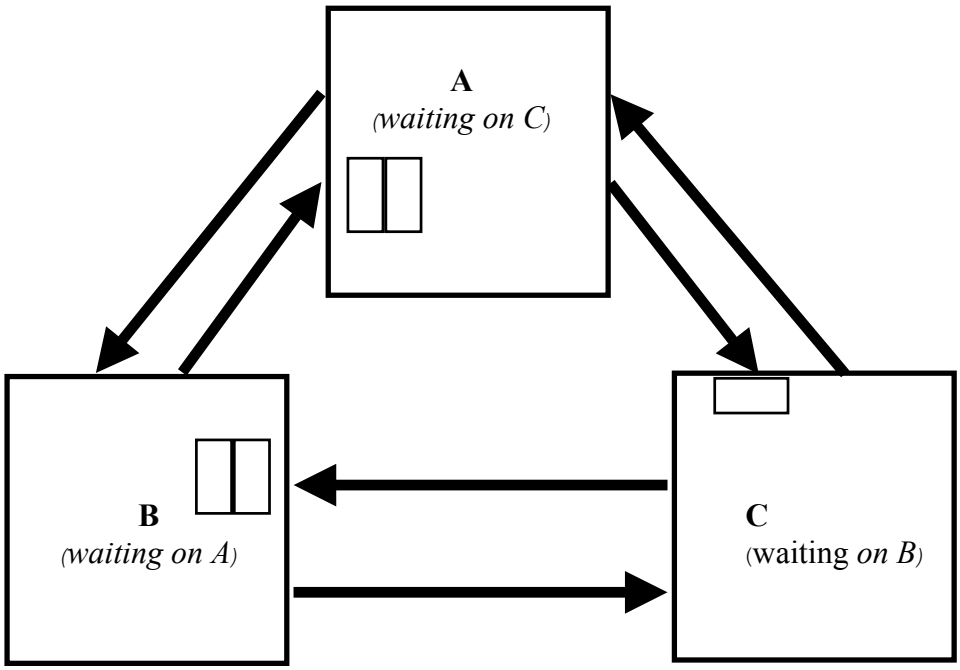
LP A is waiting on LP C (Qc has no messages)

LP B is waiting on LP A (Qa has no messages)

LP C is waiting on LP B (Qb has no messages)

If the *lookahead* for all processes is 2 and the current simulation time at all processes is 3,

6.1 Calculate the number of null messages needed in order to avoid *deadlock*. Start from LP A sending a null message to LP B. (5 marks)



Number of null messages required _____

6.2 After using null messages which events are **safe** to process? Explain why?

(5 marks)

_____

_____

_____

_____

Question 7 (10 marks; 10 minutes)

According to *Diffusing computation* for deadlock detection by Dijkstra and Scholten, draw diagrams show how a deadlock can be detected if the total number of logical processes is 5.

Question 8 (10 marks; 10 minutes)

In a simulation system, the current simulation time is 4. Show how to change the *lookahead* by drawing graphs.

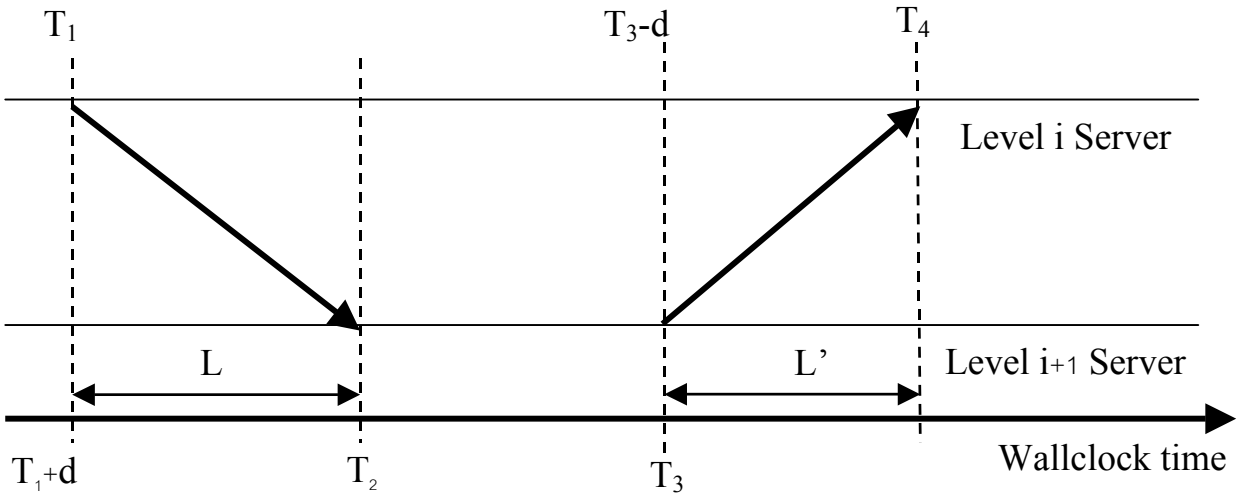
8.1 From 3 to 5 (5 marks)

8.2 From 5 to 2 . (5 marks)

Question 9 **(**10 marks; 10 minutes)

From the given data, estimate the NTP latency and offset.

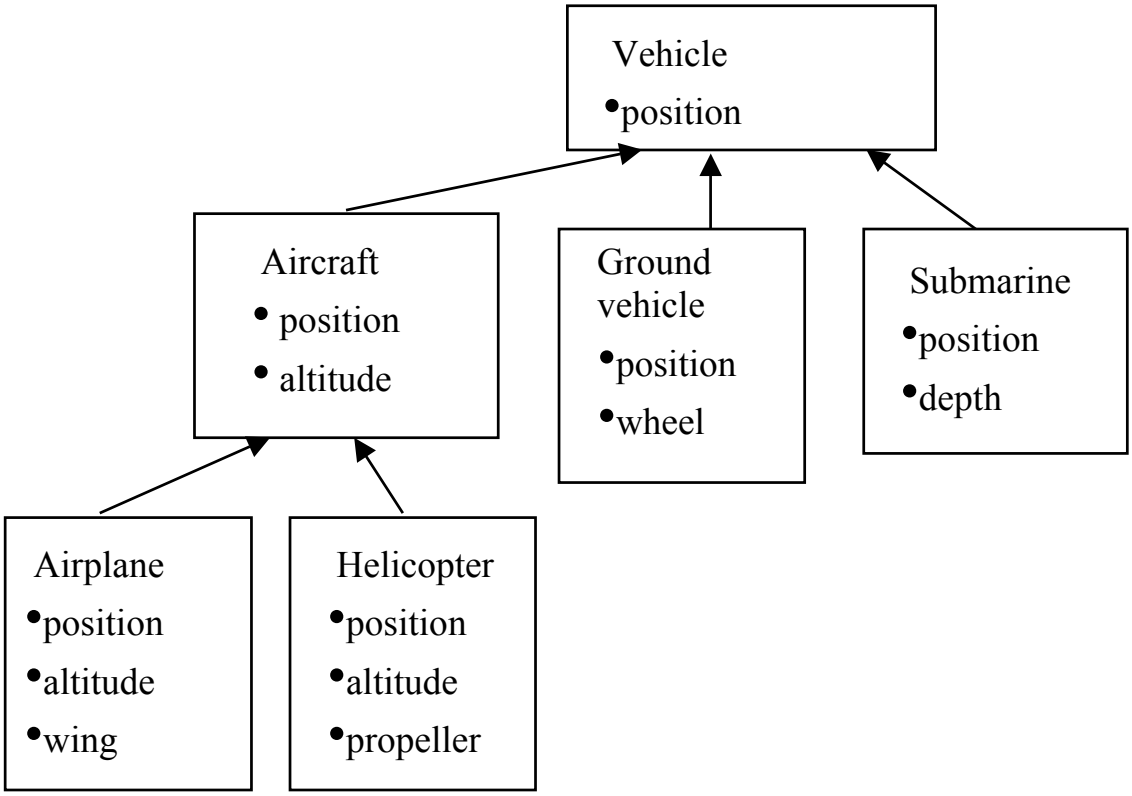
$T_1 = 10.1$, $T_2 = 12.2$, $T_3 = 14.4$, $T_4 = 16.5$



NTP latency = _____

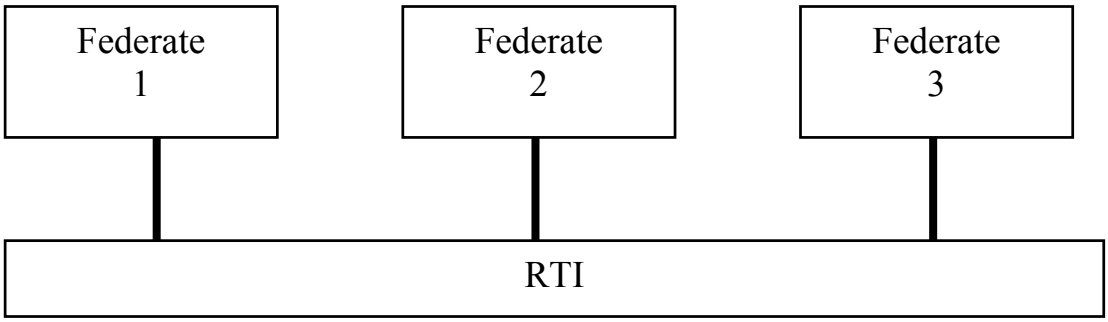
offset = _____

Question 10 (15 marks; 15 minutes)



Class hierarchy diagram

10.1 Modify the above class hierarchy diagram and the below federation diagram to show that adding a new sub class (i.e. boat, pick-up, truck) can be done at a federate without class modification at the other federates (10 marks)



Federation diagram

10.2 Give examples of using *interest expressions* and *description expressions* from the given class hierarchy diagram. Include class-based and value-based expressions. (5 marks)

interest expressions (3 different examples)

_____

_____

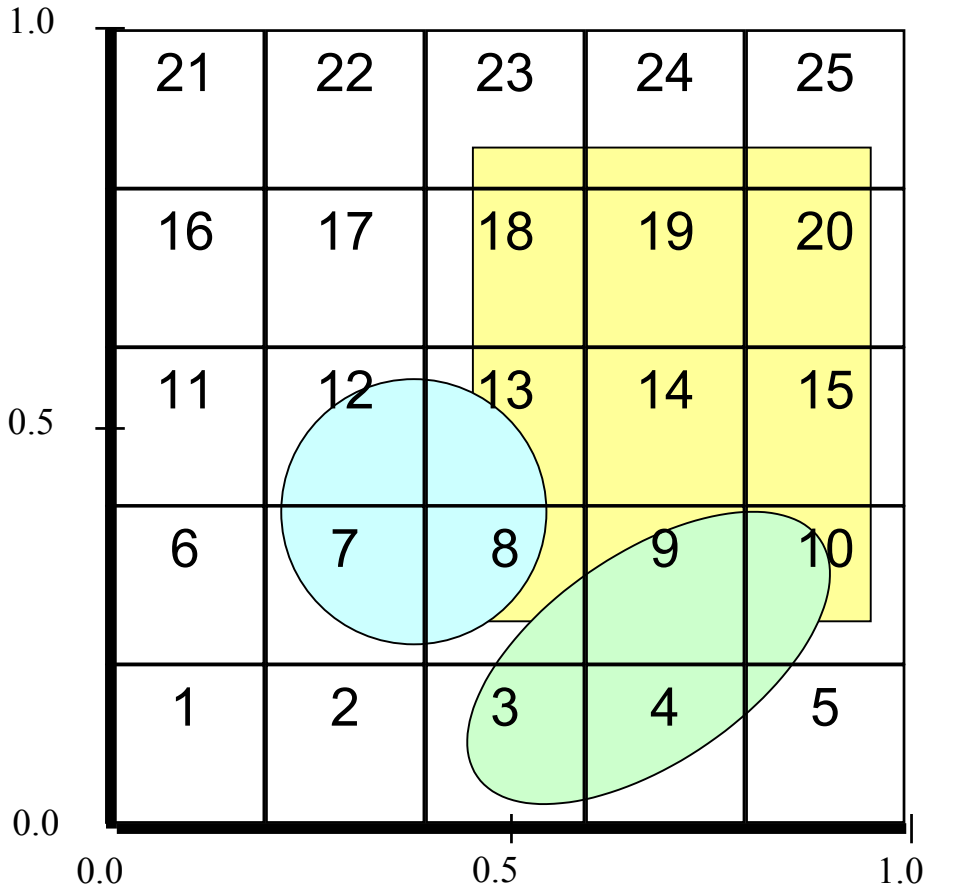
description expressions (2 different examples)

_____

_____

Question 11 (10 marks; 10 minutes)

From the *Grid-based* implementation in *Data Distribution*, find out *unwanted* and *duplicate* messages and their receivers and explain why they are unwanted and duplicated.



Update region Subscriber 1 Subscriber 2

Unwanted messages _____

Why unwanted? _____

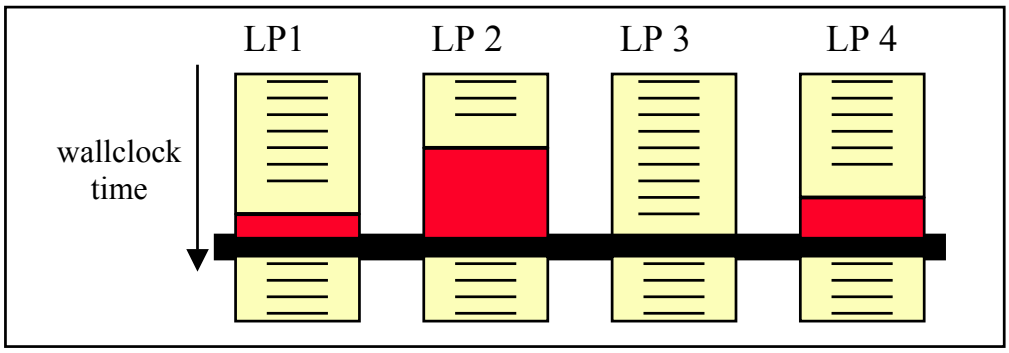
Duplicated messages

_____

Why duplicated? _____

Question 12 (5 marks; 5 minutes)

Use the following diagram to explain the barrier mechanism.



_____

_____

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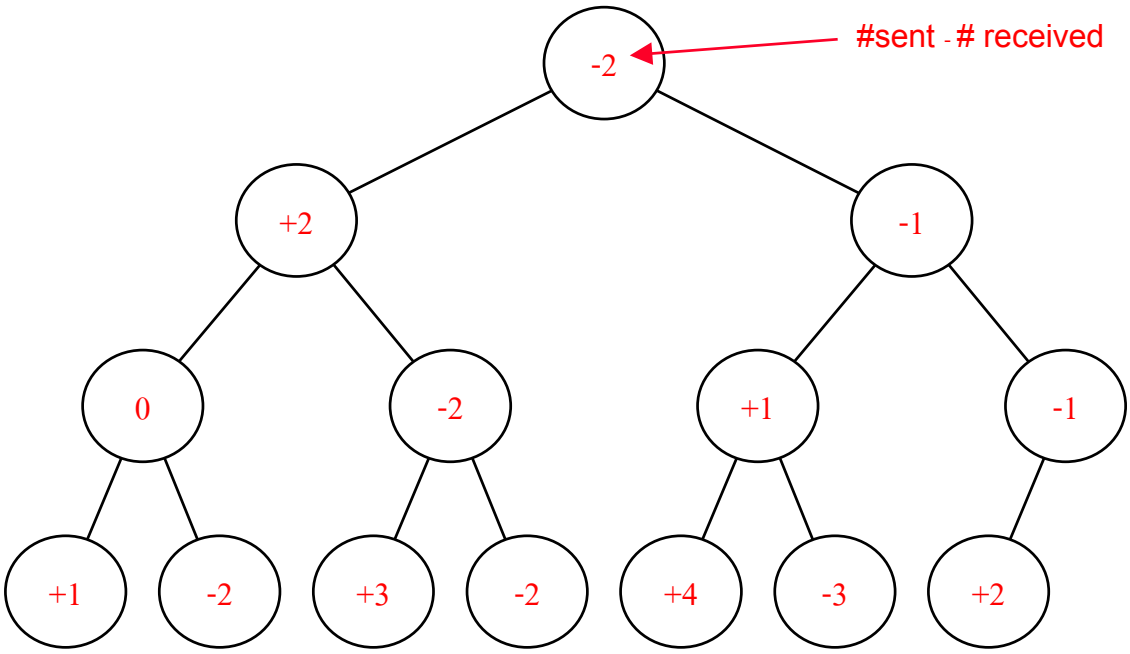
Question 13 (10 marks; 10 minutes)

13.1 From the following Tree in *Flush Barrier*, check if there are still *transient messages* or not. (5 marks)



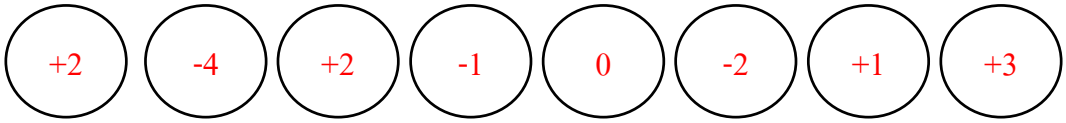
Number of transient messages _____

13.2 From the following diagram, check with *Butterfly Flush Barrier* if there are still *transient messages* or not. Also, show the computing steps. (5 marks)

Step 3

Step 2

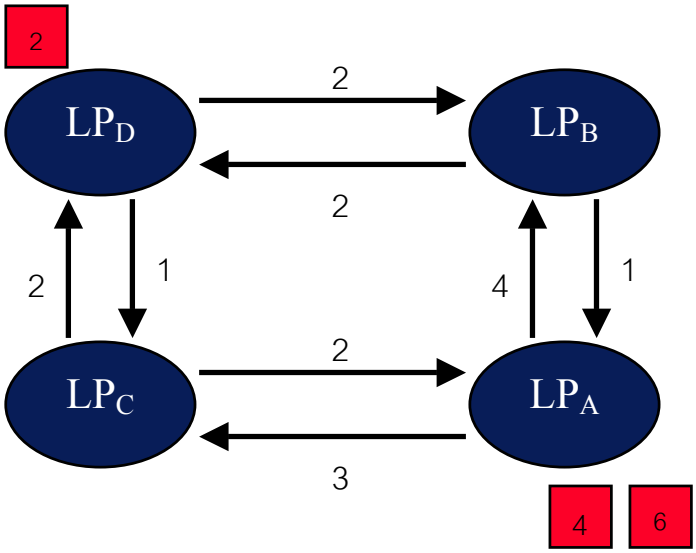
Step 1



Number of transient messages _____

Question 14 (20 marks; 20 minutes)

From the following diagram,



14.1 Calculate the distance matrix (10 marks)

	LP A	LP B	LP C	LP D
LP A				
LP B				
LP C				
LP D				

14.2 Calculate the Lower Bound on the Time Stamp (LBST) of each logical process.
(8 marks)

LBST A
_____

LBST B_____

LBST C_____

LBST D_____

14.3 Is the event with the time stamp 4 safe to process? _____(1 marks)

14.4 Is the event with the time stamp 6 safe to process? _____(1 marks)

---End of Examination---

Happy New Year

Pichaya Tandayya
December 2003