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UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
Academic Session 2004/2005

March 2005

**CST315 – Principles of Parallel & Distributed Programming**

Duration : 2 hours

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**INSTRUCTION TO CANDIDATE:**

- Please ensure that this examination paper contains **FOUR** questions in **THREE** printed pages before you start the examination.
  - Answer **ALL** questions.
  - You can choose to answer either in Bahasa Malaysia or in English.
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ENGLISH VERSION OF THE QUESTION PAPER

1. (a) Designate the following problems as either potentially distributed or parallel applications. Explain briefly your answers.
  - (i) Internet banking where you can execute transaction from computer at home. Different transactions are being processed on different servers.
  - (ii) Interactive war simulation which involves movements of a huge number of entities (thousands of vehicles and armies). Users are from different cities.
  - (iii) The processing and the rendering of image for data received from Hubble telescope.

(10/100)
- (b)
  - (i) What is parallel computing? In your opinion, does this technology have a bright future? Explain your answer.
  - (ii) Give **one (1)** example trend in the area of parallel computing (you can relate with your Assignment 2).
  - (iii) Name **two (2)** common issues that may arise in both distributed and parallel computation?

(15/100)
2. (a)
  - (i) A Bioinformatics Center is planning to purchase a new parallel machine. What advice would you give them (please discuss in terms of the type of machine, price and maintenance, application, suitability and architecture)?
  - (ii) Compare and contrast static and dynamic interconnection network and give **two (2)** examples for each.

(10/100)
- (b) Assuming that you were given a task to parallelise the generation of the prime numbers using the Sieve of Erathosthenes.
  - (i) Is the algorithm suitable for parallelisation?
  - (ii) Identify the type of parallelism that may be applicable for this algorithm.
  - (iii) Describe the design stages that you may use prior to the code development.

(15/100)

3. (a) Estimate the total execution time for a particle simulation problem with 1000 particles on a 4-node PC cluster. The most expensive computation occurs in the main loop which involves distance calculation ( $t_d$ ), velocities ( $t_v$ ) and accumulation of forces ( $t_f$ ). Hence  $T_{comp}$  is the total computation time of all these three values.

Each processor makes two communications; that is sending of data during the configuration set up and also gathering of the final force results. Total communication time ( $T_{comm}$ ) includes these total collective communications time. Provide the parallel cost model,  $T_{par}$  for the above application.

Below is the general algorithm. Note: You ought to assume that the workload at each processor is the same.

```
Begin
  Broadcast data to processors (MPI_Bcast)
  Loop (Total Particles/Processors) times
    Calculate distances
    Calculate interaction
    Accumulate forces
  End Loop
  Merge Forces From All Processors (MPI_Allreduce)
End
```

(15/100)

- (b) Assuming that there exists a large discrepancy between the time obtained from the above cost model compared to the actual time measured when running the actual codes. Suggest the possible causes of discrepancies?  
(10/100)
4. (a) If you were requested to parallelise an existing sequential program, what would be the steps that you would use? When will you apply the following three loop conversion mechanisms: FAN, PAR and PIPE?  
(10/100)
- (b) (i) Compare and contrast static with dynamic scheduling. Give **one (1)** example application of each.
- (ii) Apply a Dimension Exchange load balancing algorithm on an 8-processor hypercube with initial load of 12 units at P0. Work out the whole process of load distribution step by step.  
(15/100)