UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2004/2005

March 2005

CST315 – Principles of Parallel & Distributed Programming

Duration : 2 hours

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.

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)