

Name:..... UID:

Question 1 [5 marks] Understanding Limits and Having Expectations!

- (a) The Itanium 2 processor that forms part of the APAC Altix system is manufactured using 90nm technology. Approximately how many times the diameter of a neutral silicon atom is 90nm?

[1 mark]

- (b) Name any modern day microprocessor and state how many instructions it can issue in a single clock cycle.

[1 mark]

- (c) What latency would you expect to measure for an MPI communication on the APAC Altix system used in this course (i.e. on the AC)?

[1 mark]

- (d) Approximately how many floating point operations can be performed on the APAC AC system in the time required to synchronise 2 processes using a call to MPI_Barrier? Show how you derive your answer.

[2 marks]

Question 2 [5 marks] Parallel Hardware

- (a) Give one advantage of a hypercube topology over a 3-D torus topology for the network on a parallel computer.

[1 mark]

- (b) The graphics card on a modern home PC contains a SIMD parallel processor. What makes graphics operations particularly well suited to SIMD parallel processors?

[2 marks]

- (c) The APAC AC system has a fat-tree interconnect. Sketch a fat-tree interconnect and clearly identify what distinguishes it from a “normal” tree based interconnect, i.e. what makes it “fat”!

[2 marks]

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Question 3 [5 marks] Parallel Performance

(a) What does it mean to say that a parallel algorithm is “cost optimal”?

[1 mark]

(b) Your parallel code takes 40 minutes to execute on 2 processors of a parallel computer and 30 minutes to run the same problem on 4 processors of the same machine. Approximately how long do you estimate your code would take to run the same problem on 16 processors of the same machine?

[2 marks]

(c) Draw a diagram to illustrate how you would perform a broadcast operation on a ring of processors using a communication library that provides **cut-through routing** for point-to-point message passing.

[2 marks]

Question 4 [5 marks] Message Passing

- (a) MPI_Send is a blocking communication call. What does it mean to say that a communication call is blocking?

[1 mark]

- (b) Give **two** ways in which calling MPI_Barrier adds overhead to an MPI parallel program?

[2 marks]

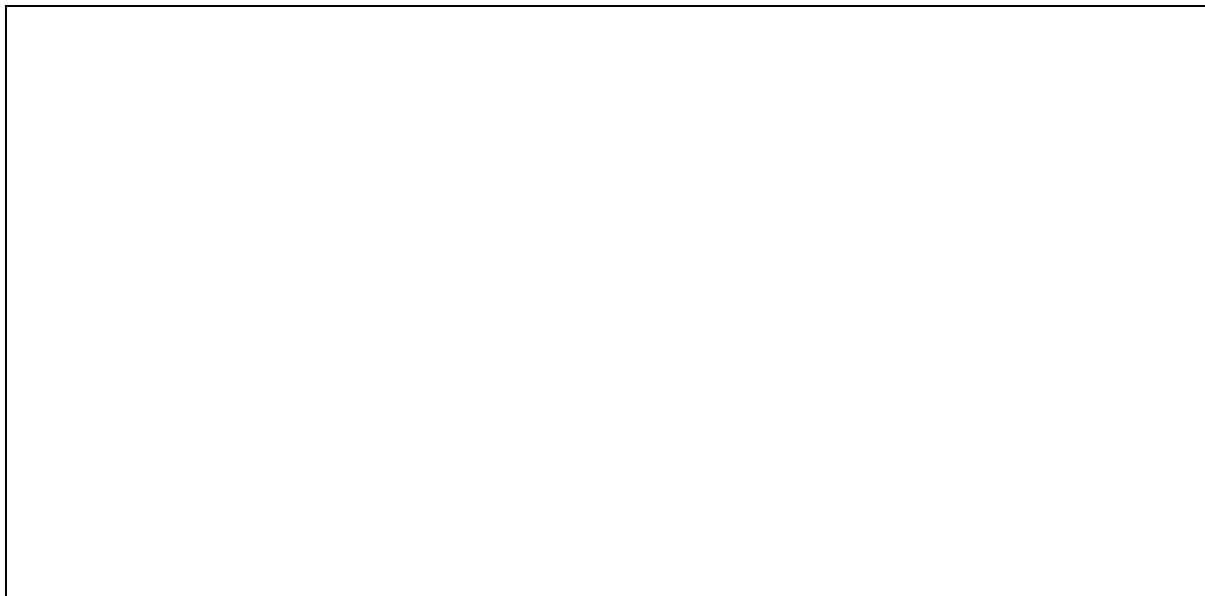
- (c) What are the five basic operations that you would expect to be provided by any message passing environment? (In this context “basic” means operations that cannot be constructed by using more primitive message passing operations, e.g. MPI_Broadcast is **not** a basic MPI operation.)

[2 marks]

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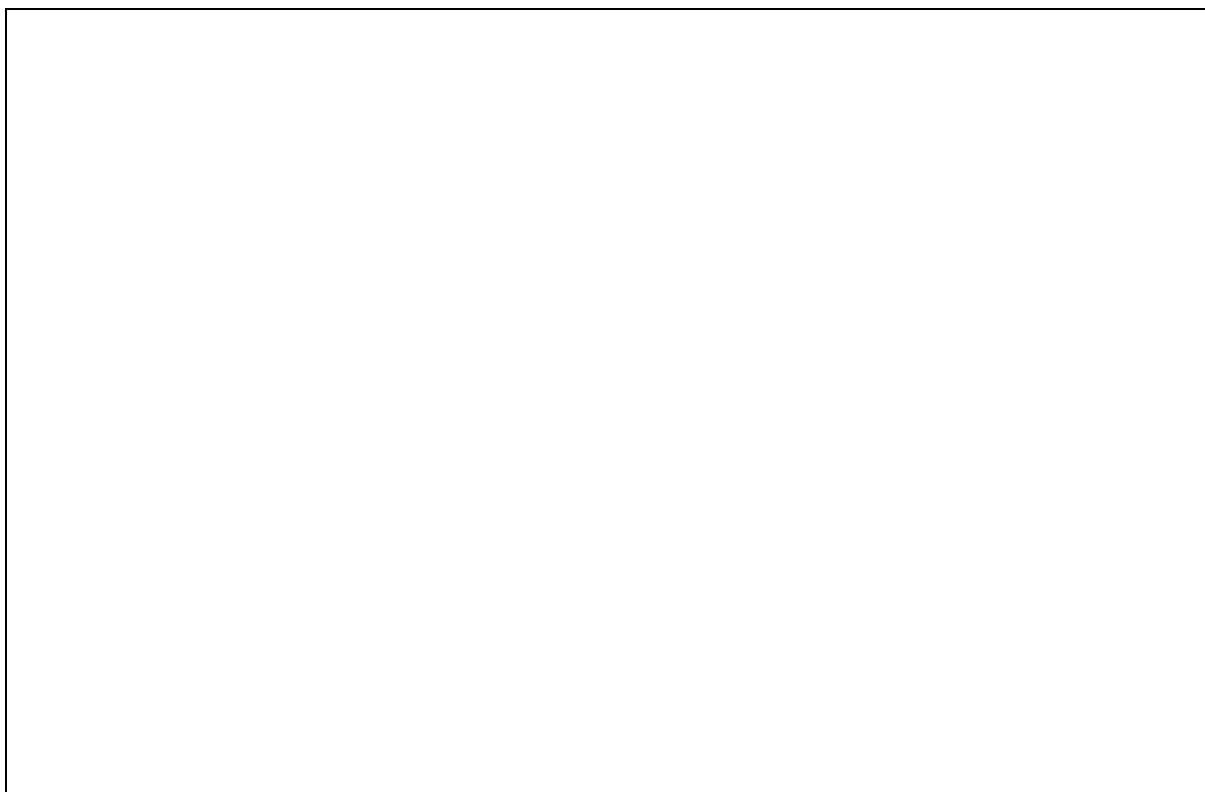
Question 5 [10 marks] Developing Parallel Algorithms

- (a) Draw **two** 2-dimensional domains, one that is partitioned over 6 processors using a block partitioning approach, and the other that is partitioned over 6 processors using a strip partitioning approach.



[2 marks]

- (b) Monte Carlo methods are said to be well suited to parallelisation. Briefly outline one problem that uses a Monte Carlo approach and state why Monte Carlo is well suited to running in parallel.



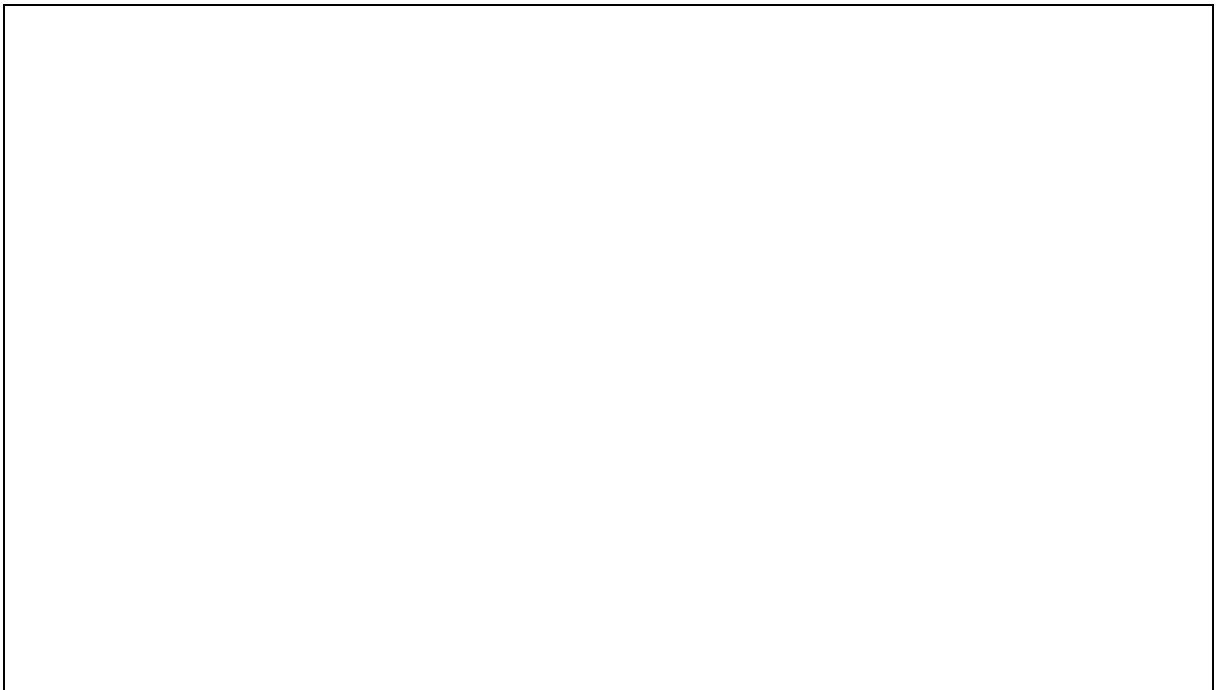
[2 marks]

- (c) Give pseudo-code that illustrates how you would sum together a vector of N integers using a divide and conquer approach.



[3 marks]

- (d) Given a list of N numbers ($x_i, i = 1, 2, 3 \dots N$) and a parallel machine with 4 processors show how you might compute x_i^{32} using a pipeline approach, i.e. each number in the list enters the pipeline at one end and emerges as that number raised to the power of 32.



[3 marks]