

**THE BCS PROFESSIONAL EXAMINATION
Professional Graduate Diploma**

April 2005

EXAMINERS' REPORT

Distributed & Parallel Systems

Question One

1. a) What are the advantages of distributing objects in a client-server environment? Explain the basic concepts that govern a distributed object model. You may use a diagram to illustrate aspects of the model. **(7 marks)**
- b) Consider an application in which a set of results are available from a client program for a file object located in a remote database server in a three-tier client server architecture. Explain with the help of a functional diagram how a static remote method invocation (RMI) is implemented for this application. For the purpose of discussion you may assume a single-language RMI system. **(12 marks)**
- c) How does a typical middleware architecture implement the RMI for the above application? **(6 marks)**

Answer Pointers

Referring to the main text: Distributed Systems – Concepts & Design by George Coulouris, Jean Dollimore and Tim Kindbery (Third Edition)

- a) Pages 171-173 of the above text

Advantages

- Objects can be migrated to enhance performance, availability and fault tolerance
- Objects provide encapsulation for processes which aid secure accesses as methods are used.
- Different data formats can be used at different servers

(3 marks)

Basic Concepts

- Remote object references: use of Java etc
- Remote interfaces: methods in Java, CORBA IDL
- Distributed dynamic objects and named objects
- Model diagram of server and client machines showing object references etc

(4 marks)

- b) Pages 177-178 of the above text

The functional diagram should clearly show a three-tier RMI architecture with client and a server with remote objects in the server and corresponding proxies in client as well as clear requests and replies for client and server respectively. The role of proxies should be clearly explained. The protocol for RMI invocation starting with call from the client program to server method with details such as parameter marshalling etc should be clearly explained.

(12 marks)

Pages 678-679 of the above text

- c) A CORBA model would illustrate this better.
Concepts of ORB, clients, servers, stubs, skeletons, IDLs etc
The client program containing the RMI call communicates with the stub and this in turn communicates with the ORB of the middleware which identifies with the remote objects to be communicated with (as they are registered with the ORB). Here stubs and skeletons act as proxies.

(6 marks)

Examiner's Comments

Question 1 a) is concerned with distributed objects and distributed object model which underpin application software and systems software in modern distributed systems. Not many students answered this question, and those who answered, the number who got it completely right was small. However, there were some good answers for part of the question, particularly aspects of RMI. A few others tried to reinterpret the question and hence the answers were not convincing. Question 1b) encouraged different responses; a few of them were of reasonably good quality. Question 1c) attracted discussion on OMG CORBA architecture, which is good. However, in these cases there were only very brief explanations.

Question Two

2. a) List and explain the security requirements for a typical on-line application running in a distributed system environment. (7 marks)
- b) Discuss the features of the secure socket layer technology (SSL). Explain clearly how a protocol based on SSL helps to transfer data securely from a client process to a process in a remote server for the application in a) above. (11 marks)
- c) Explain in what ways middleware can ensure secure RMI. (7 marks)

Answer Pointers

- a) The list should consist of the following:
- confidentiality
 - authentication
 - integrity
 - non-repudiation
 - access control
 - availability

(7 marks)

- b) Page 299 of the above text

SSL protocol stack explanation.

SSL function should include SSL client authentication, SSL server authentication and SSL encryption.

(6 marks)

Use of the above stacks and functions and description of the transfer process with clear stages of the handshake protocol. Use of a flowchart or line diagram showing the process flow would be very informative.

(5 marks)

c) Page 693-694 of the above text

Use to reference CORBA secure services;

- Authentication of principals, generating credentials etc.
- Access rights checking
- Facilities for non-repudiation

(3 marks)

Checking of credentials by the server sent by the client and validation of access rights etc before the invocation can go ahead.

(4 marks)

Examiner's Comments

Question 2 a) solicited good response. However, the majority of answers were concerned with a mix of security mechanisms and security requirements. It was expected that a distinction would have been made between these two, and answers expected were to be about security requirements. Some got it right and others did not. Question 2b) and 2c) attracted very few good answers, partly because many did not get the Secure Socket Layer discussion right. There was minimal critical discussion of security through middleware.

Question Three

3. a) How is a "cluster" of computers distinct from:

- a distributed system
- a parallel system
- a network of workstations

(15 marks)

b) Given that a single system image creates the illusion that a collection of computer elements is a single resource, discuss how well the concept of "cluster" fits the notion of a single system image. Make reference to application and sub-system levels as appropriate.

(10 marks)

Answer Pointers

(Taken from Recommended texts: Colouris page 217, Wilkinson, page 28, Pfister page 87).

Please note: Pfister is now no longer on the reading list and has been replaced by Wilkinson & Allen's book for April 06.

In summary a cluster consists of a collection of interconnected "whole" computer and is used as a single unified computing resource distinct from a distributed system by its internal anonymity and peer relations and distinct from a parallel system by its high availability, scaling and system management. Clusters are not much different but more akin to a subparadigm of distributed or parallel systems.

Nowadays the term "network of workstations" has now given way to a cluster of computers. Here the communication method is commonly Ethernet in type, the addressing adopts TCP/IP standards and configurations are found that use all (or a portion) of an existing network or a dedicated set (within a laboratory). The Beowolf cluster of commodity components is worth mentioning.

(15 marks)

Given that every SSI can be viewed as having boundaries with support at different levels, discussion of some of these boundaries (possibly using application, subsystem, OS kernel and hardware boundaries) and corresponding levels of abstraction (such as cluster) would be appropriate.

(10 marks)

Examiner's Comments

This question was reasonably well done. Questions 3 averaged 15.7 marks. Questions 3 and 5 were the most popular two questions and question 4 the second least popular. Although it is an obvious remark, it is where students fail to answer the question that they receive no reward. Students often fail to answer the question by choosing to answer another question instead.

In the Professional Graduate Diploma there is an expectation that candidates might be able to draw higher level perceptions and insights. To do this usually requires a good standard of English plus the confidence to venture an opinion based upon critically evaluation.

In question 3 part (a) many offered definitions but failed to point out how each system was distinct from a 'cluster'. Although not explicitly mentioned in the question, those who were able to produce a diagram or diagrams in part (b) of question 3, did offer more than those who resorted to text alone.

Question Four

4. a) Three desirable attributes of parallel algorithms and software are:

- concurrency
- locality
- modularity

What is meant by these terms?

(8 marks)

b) Summarise three forms of basic model used to describe parallel algorithms and indicate current trends.

(8 marks)

c) Give an example of any parallel algorithm (such as finite difference, pairwise interactions, sorting or 2D grid) or any other of your choice, using both text and a diagram to aid in its description

(9 marks)

Answer Pointers

a) Concurrency refers to the ability to perform many actions many actions simultaneously, locality means a high ratio of local:remote memory accesses and modularity indicates that complex entities may be decomposed in to simpler components.

(8 marks)

b) Parallel algorithms may be modelled through the use of state machines and process algebras (as in CSP), though the trend is away from static task and channel structure and toward a notation that facilitates a (java) thread-like object-oriented implementation. Other Answers include message-passing, data parallelism and shared memory models.

[Magee & Kramer, page 32]

(8 marks)

c) If the candidate chooses on of the three problems quoted, it is likely that the explanation will be found in Quinn (for finite difference, pairwise interactions or sorting) or in Pfister (for 2D grid). However, Quinn covers other case studies (sieve of eratosthenes, matrix-vector multiplication, monte carlo methods, linear systems, fast fourier transforms [Quinn, Pfister].

(9 marks)

[Quinn is no longer on the reading list].

Examiner's Comments

This question was reasonably well done and averaged 17.0 marks. In question 4, as might be expected, students tended to do well in each of the three parts where they were prepared.

Question Five

5. You have agreed to talk for 30 minutes at the next meeting of your local branch. The title of your talk is "System Performance: how it is measured and improved".

Sketch out approximately eight presentation slides, with associated notes, that you would use for your talk.

(25 marks)

Answer Pointers

The question defines the audience so the candidate should bear this in mind when answering.

The number of slides indicate to the candidate that they should spend approximately 5 minutes on each slide and the candidate should remember only a note (not an essay) is required.

The approaches to be discussed are diverse. A good answer may favour a particular approach but should reflect the diversity.

(5 marks for overview/context, 5 for structure/layout, 5 for first four slides, 5 for second four slides, 5 for approach/style)

Examiner's Comments

This question was reasonably well done and averaged 13.6 marks. The format of question 5 is anticipated and it is a popular choice of question but this year not particularly well answered.

Students should remember that in future examiners will look for correctness, clarity, completeness, relevance and depth in their answer to this type of question.