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EXAMINATION - CANDIDATES MAY
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MATERIAL DURING THE SITTING

No calculator

THE UNIVERSITY OF BIRMINGHAM

Sample Exam Paper

06 06798

Distributed Systems

2 hours

[Answer ALL Questions]

Part A (Short Questions)

1. Define *network transparency*. [4%]

2. Define the *asynchronous* model of interprocess communication. [4%]

3. Define a *socket* and how it is used. [4%]

4. What is *data marshalling?* How can data be marshalled in the Java programming language? [4%]

5. Describe *at least once* RMI semantics. [4%]

6. Briefly describe the *thread-per-request* multi-threaded server architecture. [4%]

7. Describe the *write through* method of server caching in the NFS file server. [4%]

8. Suppose the multicast navigation method is used to resolve a name in a name service. What problems may arise? [4%]

9. What is meant by *symmetric cryptography?* [4%]

10. Briefly describe how the *gossip* architecture works. [4%]

Part B (Problem Solving Questions)

11. A web-based election service is to be implemented in a small town with approximately 5000 voters. Voters must first register with the system (at most one registration is allowed per voter). Each voter is allowed only one vote for a candidate selected from the list of candidates known to the system. All voter registrations and votes cast should be recorded. The system should implement the following operations:

    register, which inputs the voter's name, then generates a unique number for each voter; if the voter is found to have registered already, the system rejects the current request;

    vote, which inputs the unique voter's number and the candidate's name, then registers the vote for this voter number; if a vote by this voter is found to have been recorded already, the system rejects the current request;.

    (a) Which invocation semantics would you recommend for this system? Justify your answer. [5%]

    (b) Assume the system has a single server connected to 50 terminals. The number of voters accessing the system simultaneously is close to 50 at all times. Discuss the advantages and disadvantages of using the worker pool as opposed to the thread-per-request multi-threaded architecture for this system. [5%]

    (c) Assume the server uses caching, and achieves a hit rate of 80%. File operations in the server cost 5 ms of CPU time when the server finds the requested block in the cache, and take an additional 15 ms of disk I/O time otherwise. Explaining any assumptions you make, estimate the server's maximum throughput capacity (average requests/sec) if it is two-threaded, running on a single processor machine.[5%]

    (d) The election service has been implemented and was running successfully on a single server until the server crashed unexpectedly and much of the data was lost. Can you suggest a suitable improved architecture that can tolerate one server crash? [5%]

12. Consider an asynchronous distributed system consisting of N processes arranged in a unidirectional ring connected via reliable links.

   (a) Briefly describe how the token passing ring-based mutual exclusion algorithm works. Does the algorithm respect causality order of requests? Justify your answer. [5%]

   (b) If the centralised mutual exclusion algorithm were used, would causality order of requests be respected? Justify your answer. [5%]

   (c) Assume the system is synchronous, links are unreliable but processes do not crash. What problems may arise if the token passing mutual exclusion algorithm is executed in such a system? [5%]

   (d) Assume all processes in the ring have unique identifiers. Suggest a method for electing a leader amongst them. [5%]

13. Consider a distributed banking system consisting of two accounts, x and y, held by two replica managers A and B.

   (a) Assuming the order of execution is as shown below, is the following sequence of operations linearizable? Justify your answer. [7%]

Client 1	Client 2
$credit_B(x,1)$	
	$getBalance_A(y) \rightarrow 0$
	$getBalance_A(x) \rightarrow 0$
$credit_A(y,2)$	

   (b) Assume that passive replication is used in the banking system, with A acting as the primary. Describe the steps taken to credit account x. [7%]

   (c) What steps should be taken if the primary fails? Are the same steps necessary in active replication? [6%]

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