STIJ3063 / DISTRIBUTED COMPUTING

5 JUNE 2012
9:00 AM – 12:00 AM (3 HOURS)

DSB K.T/WD

INSTRUCTION:
1. THIS EXAM PAPER CONSISTS OF FOUR (4) PRINTED PAGES.
2. YOU ARE ALLOWED TO USE CALCULATOR.
3. ANSWER ALL QUESTIONS IN THE ANSWER BOOKLET PROVIDED.
4. FOR SECTION 1, ANSWER THREE (3) OF FOUR (4) QUESTIONS; FOR SECTION 2, ANSWER ALL QUESTIONS; FOR SECTION 3, ANSWER FOUR (4) OF FIVE (5) QUESTIONS; FOR SECTION 4, ANSWER TWO (2) OF THREE (3) QUESTIONS; FOR SECTION 5, ANSWER TWO (2) OF THREE (3) QUESTIONS.
5. YOU ARE NOT ALLOWED TO REMOVE THE EXAM PAPER FROM THE EXAM HALL.

MATRIC NO: ____________________________
(with word) (with number)

IDENTIFICATION CARD NO.: ____________________

LECTURER: ____________________________

GROUP: ______ TABLE NO.: ______

DO NOT OPEN THIS EXAMINATION PAPER UNTIL INSTRUCTED

CONFIDENTIAL
STIJ3063 Distributed Computing

SECTION 1: ANSWER THREE OF THE FOLLOWING QUESTIONS: (18 MARKS)

1. A search engine is a web server that responds to client requests to search in its stored indexes and (concurrently) runs several web crawler tasks to build and update the indexes. What are the requirements for synchronization between these concurrent activities? (6 Marks)

2. A distributed data and transaction management system (DDTMS) is middleware responsible for managing all data (files plus databases) and the operations on the data in a distributed computing environment.
   a) What is the primary objective of a DDTMS. (3 Marks)
   b) List THREE (3) types of enterprise data. (3 Marks)

3. Many attempts have focused on standardized middleware to support object-oriented distributed systems. CORBA, DCOM and RMI are three Distributed Object middleware technologies.
   a) Write the full form of the above three abbreviations. (3 Marks)
   b) Briefly explain the similarities between CORBA and DCOM. (3 Marks)

4. Compare and contrast cloud computing with more traditional client-server computing? What is novel about cloud computing as a concept? (6 Marks)

SECTION 2: ANSWER ALL OF THE FOLLOWING QUESTIONS: (18 MARKS)

1. Replication is a key to providing high availability and fault tolerance in distributed system.
   a) Explain briefly the sequence of events when a client requests an operation to be performed in the active replication. (10 Marks)

   b) The probability of a server crash is 10%. The customer requires a service with at least 97% availability. What is the minimum number of replicated servers needed to achieve such availability? (4 Marks)
2. Consider a simple server that carries out client requests without accessing other servers. Explain why it is generally not possible to set a limit on the time taken by such a server to respond to a client request. What would need to be done to make the server able to execute requests within a bounded time? Is this a practical option? (4 Marks)

SECTION 3: ANSWER FOUR OF THE FOLLOWING QUESTIONS: (12 MARKS)

1. Draw and briefly explain the architecture of the multiple server distributed system model. (4 Marks)

2. Describe the ways in which the request-reply protocol masks the heterogeneity of operating systems and of computer networks. (4 Marks)

3. Give a brief description of the following types of failure:

   a) Arbitrary Failure
   b) Send Omission Failure
   c) Timing Failure
   d) Fail-stop Failure

4. Explain the TWO (2) advantages of the following distributed system models, (4 Marks)

   a) Thin client model
   b) Proxy server model

5. Differentiate between Web Cookies and Web Proxies. (4 Marks)

SECTION 4: ANSWER TWO OF THE FOLLOWING QUESTIONS: (18 MARKS)

1. A client sends a 200 byte request message to a service, which produces a response containing 5000 bytes. Estimate the total time to complete the request in each of the following cases, with the performance assumptions listed below: (9 Marks)

   a) Using connectionless (datagram) communication (for example, UDP);
   b) Using connection-oriented communication (for example, TCP);
   c) The server process is in the same machine as the client.
[Latency per packet (local or remote, incurred on both send and receive):
5 milliseconds
Connection setup time (TCP only): 5 milliseconds
Data transfer rate: 10 megabits per second
MTU: 1000 bytes
Server request processing time: 2 milliseconds
Assume that the network is lightly loaded.]

2. A file 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 throughput capacity (average requests/sec) if it is:

   a) single-threaded;
   b) two-threaded, running on a single processor;
   c) two-threaded, running on a two-processor computer.

   (9 Marks)

3. A client makes remote procedure calls to a server. The client takes 5 milliseconds to compute the arguments for each request, and the server takes 10 milliseconds to process each request. The local operating system processing time for each send or receive operation is 0.5 milliseconds, and the network time to transmit each request or reply message is 3 milliseconds. Marshalling or unmarshalling takes 0.5 milliseconds per message.

   (9 Marks)

   a) Calculate the time taken by the client to generate and return from two requests:
      i) if it is single-threaded, and
      ii) if it has two threads that can make requests concurrently on a single processor.
   b) You can ignore context-switching times. Is there a need for asynchronous RPC if client and server processes are threaded?

SECTION 5: ANSWER TWO OF THE FOLLOWING QUESTIONS: (14 MARKS)

1. Discuss the invocation semantics that can be achieved when the request-reply protocol is implemented over a TCP/IP connection, which guarantees that data is delivered in the order sent, without loss or duplication. Take into account all of the conditions causing a connection to be broken.

   (7 Marks)

2. What are the main guarantees that users expect conventional servers (e.g. web servers or file servers) to offer?

   (7 Marks)
3. Explain why the RPC interface to early implementations of NFS is potentially insecure. The security loophole has been closed in NFS 3 by the use of encryption. How is the encryption key kept secret? Is the security of the key adequate?

(7 Marks)