National Exams May 2019

17-Comp-B10, Distributed Systems

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.
2. This is a CLOSED BOOK examination. One of two calculators is permitted - a Casio or Sharp approved model.
3. Answer any **five of the six** questions. Only the first five questions as they appear in the answer book will be marked.
4. Most questions require an answer in essay format. Clarity and organization of the answer are important.

MARKING SCHEME:

1. (a) 6 marks; (b) 4 marks ; (c) 6 marks ; (d) 4 marks
2. (a) 6 marks; (b) 4 marks ; (c) 6 marks ; (d) 4 marks
3. (a) 5 marks; (b) 5 marks ; (c) 5 marks ; (d) 5 marks
4. (a) 4 marks; (b) 4 marks ; (c) 4 marks ; (d) 4 marks; (e) 4 marks
5. (a) 5 marks; (b) 5 marks ; (c) 5 marks ; (d) 5 marks
6. (a) 5 marks; (b) 5 marks ; (c) 5 marks ; (d) 5 marks

Question 1. ***Characteristics of distributed systems*** (20 marks)

(a) The construction of distributed systems produces many challenges. Briefly explain **three** of the most common challenges encountered.

(b) Define and briefly discuss the term transparency as it pertains to distributed systems. Why is it important? Provide an example.

(c) What is an open distributed system and what benefits does openness provide?

(d) Use the World Wide Web as an example to illustrate the concept of resource sharing, client and server. What are the advantages and disadvantages of HTML, URLs and HTTP as core technologies for information browsing?

Question 2. ***Fundamental concepts and mechanisms.*** (20 marks)

(a) Compare connectionless (UDP) and connection-oriented (TCP) communication for the implementation of file transfer (FTP), information browsing (HTTP) and remote produce call.

(b) How does a newly installed personal computer connected to an Ethernet discover the IP addresses of local servers? How does it translate them to Ethernet addresses?

(c) Outline and explain **three** main advances that IPv6 embodies.

(d) TCP/IP functionality is divided into five layers, each of which include specific protocols. Describe the work done by each of the five layers of the TCP/IP model and list some of the most important protocols at each layer.

Question 3. ***Client-server systems and inter-process communications.*** (20 marks)

(a) Assume a client calls an asynchronous RPC to a server, and subsequently waits until the server returns a result using another asynchronous RPC. Is this approach the same as letting the client execute a normal RPC? What if we replace the asynchronous RPCs with asynchronous RPCs?

(b) A single-threaded 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. Calculate the time taken by the client to generate and return from two request. You can ignore context-switching times.

(c) Explain and illustrate (in graphical form) the architecture of RPC. Include in your explanation the main components of the architecture of RPC.

(d) Define and provide examples of marshalling and unmarshalling. You can use the technology of your choice.

Question 4. ***Security.*** (20 marks)

(a) Explain the use of cryptographic protocols when encrypting web site traffic and when digitally signing and encrypting email.

(b) Name a few advantages and disadvantages of using centralized servers for key management.

(c) Describe some of the ways in which conventional email is vulnerable to eavesdropping, masquerading, tampering, replay and denial of service attacks. Suggest methods by which email could be protected against each of these forms of attack.

(d) There is no authentication in the Diffie-Hellman key-exchange protocol. By exploiting this property, a malicious third party can easily break into the key exchange taking place between Alice and Bob, and subsequently ruin the security. Explain how this would work.

(e) Suppose that you were asked to develop a distributed application that would allow the PEO office to set up exams. Give at least three statements that would be part of the security policy for such an application.

Question 5. ***Distributed file systems.*** (20 marks)

(a) Discuss about the transparency, fault tolerance and file-replication requirements when designing Distributed files systems.

(b) Explain whether or not NFS is to be considered a distributed file system.

(c) What is the difference between stateful and stateless servers?

(d) Compare AFS and NFS from the scalability point of view. List their advantages and disadvantages.

Question 6. ***Operating System Support.*** (20 marks)

(a) Suggest a scheme for balancing the load on a set of computers. You should discuss:

- what user or system requirements are met by such a scheme;
- to what categories of applications it is suited;
- how to measure load and with what accuracy;
- how to monitor load and choose the location for a new process.

(b) Explain how a shared region could be used for a process to read data written by the kernel. Include in your explanation what would be necessary for synchronization.

(c) Explain what are the two main approaches to kernel architecture.

(d) Discuss virtualization at the operating system level. What are the main goals, challenges and use cases?

END OF EXAM