

98-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 any Casio or Sharp approved models.
3. Answer any five of the seven questions.
Only the first five questions as they appear in the answer book will be marked.
4. All questions carry equal weight.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Question # 1. Characteristics of distributed systems

- a. Give two types of hardware resource and two types of data or software resource that can usefully be shared. Give examples of their sharing as it occurs in distributed systems.
- b. Explain what is meant by a client program and a server program. Explain and illustrate (in graphical form) the client-server architecture of one major Internet applications (for example the Web, email or ftp).

Question # 2. Fundamental concepts and mechanisms

- a. A client sends a 300 byte request message to a service, which produces a response containing 6000 bytes. Estimate the total time to complete the request in each of the following cases, with the performance assumptions listed below:
 - i) Using connectionless (datagram) communication (for example, UDP);
 - ii) Using connection-oriented communication (for example, TCP);
 - iii) 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: 2000 bytes

Server request processing time: 2 milliseconds

Assume that the network is lightly loaded.]

- b. Comment on the use of Connectionless (UDP) and connection-oriented (TCP) communication for of each of the following application:
 1. Mail access protocols (for example, IMAP);
 2. Internet radio;
 3. Information browsing (for example, HTTP);
 4. Remote procedure call.

Question # 3. Client-server systems & inter-process communications

- a. Suppose you were developing a distributed multimedia conferencing application. Which of the following mechanisms would you choose to implement communication between processes in the applications, and why?
 - i) Stream sockets
 - ii) Datagram sockets
 - iii) RPC over streams sockets
 - iv) RPC over datagram sockets
- b. Assume the RRA protocol is in use. How long should servers retain unacknowledged reply data? Should servers repeatedly send the reply in an attempt to receive an acknowledgement?

Question # 4. *Operating systems for distributed architectures*

- a. A file server uses caching. The average hit rate achieved is 80%. If the requested block is in the cache, file operations in the server cost 4 ms of CPU time; otherwise, it takes an additional 10 ms of disk I/O time otherwise. Estimate the server's throughput capacity (average requests/sec) if it is: (Explain any assumptions you make)
 1. single-threaded;
 2. two-threaded, running on a single processor;
 3. two-threaded, running on a two-processor computer
- b. Compare the thread-per-request architecture with the worker pool multi-threading architecture.
- c. What the kernel must provide for a user-level implementation of threads (such as Java on UNIX)? In user-level threads implementations, do page faults present a problem?

Question # 5. *Security*

- a. Initial exchanges of public keys are vulnerable to the man-in-the-middle attack. Describe as many defences against it as you can.
- b. PGP is widely used to secure email communication. Describe the steps that a pair of users using PGP must take before they can exchange email messages with privacy and authenticity guarantees. What scope is there to make the preliminary negotiations invisible to the users?

Question # 6. *Distributed file systems*

- a. Name and discuss three key design issues for distributed file systems.
- b. How does the NFS Automounter help to improve the performance and scalability of NFS?
- c. Compare AFS and NFS from stability point view? Are there any limits on AFS scalability, assuming that servers can be added as required? Are there any recent technological developments that would help to offer greater scalability?

Question # 7. *Principles of fault tolerance continual*

- a. What are the benefits of replication?
- b. Write pseudocode for dependency checks and combine measures (as used in Bayou) appropriate for simple room-booking application.