CS 451: Distributed Systems
Spring 2007
Assignment #5
Due Tuesday, May 1, 12:30 pm
No late submissions accepted!

(Answer all 14 questions)

Show all work to receive partial credit. Note: You must do these questions by yourself. You are required to use a word processing program to write your answers to homework assignments in this class (submissions should be in PDF). Whenever something is unclear in the question, form assumptions, and make those assumptions explicit in your answers. In all answers, be as specific as possible. Limit your answer to each question or each part of a question to a maximum of approximately 1/4 page.

1. Exercise 19.1 from the book: Compare the request reply protocol as described in Section 4.4 with the implementation of client-server communication in SOAP. State two reasons why the use of asynchronous messages by SOAP is more appropriate for use over the Internet. To what extent does the use of HTTP by SOAP reduce the difference between the two approaches?

2. Exercise 19.6. Define a Java interface for the Election service suitable for use as a web service. State why you think the interface you defined is suitable. Explain how a WSDL document for the service is generated and how it is made available to clients.

3. Exercise 19.11. Explain why UDDI can be described as being both a name service and a directory service, mentioning the types of enquiries that can be made. The second ‘D’ in the name UDDI refers to ‘discovery’ – is UDDI really a discovery service?

4. Exercise 19.13. Documents protected by XML security may be signed or encrypted long before anyone can predict who will be the ultimate recipients. What measures are taken to ensure that the latter have access to the algorithms used by the former?

5. Exercise 10.1. Early file-sharing applications such as Napster were restricted in their scalability by the need to maintain a central index of resources and the hosts that hold them. What other solutions to the indexing problem can you identify?

6. Variation of Exercise 10.6. Assess the availability and trustworthiness of the personal computers Thornton A233 (Stacks). You should estimate:
   - Uptime: hours per day when the computer is operating and connected to the Internet.
   - Software consistency: is the software managed by a competent technician?
   - Security: is the computer fully protected against tampering by its users or others?
Based on your assessment, discuss the feasibility of running a data-sharing service on the Thornton A233 (Stacks) computers and outline the problems that must be addressed in a peer-to-peer data sharing service.

7. Exercise 11.3. A scheme for implementing at-most-once reliable message delivery uses synchronized clocks to reject duplicate messages. Processes place their local clock value (a ‘timestamp’) in the messages they send. Each receiver keeps a table giving, for each sending process, the largest message timestamp it has seen. Assume that clocks are synchronized to within 100 ms, and that messages can arrive at most 50 ms after transmission.
   (i) When may a process ignore a message bearing a timestamp T, if it has recorded the last message received from that process as having timestamp?
(ii) When may a receiver remove a timestamp 175,000 (ms) from its table? (Hint: use the receiver’s local clock value.)

(iii) Should the clocks be internally synchronized or externally synchronized?


9. Exercise 11.10. By considering a chain of zero or more messages connecting events $e$ and $e'$ and using induction, show that $e \rightarrow e' \implies L(e) < L(e')$.

10. Exercise 11.14. Two processes $P$ and $Q$ are connected in a ring using two channels, and they constantly rotate a message $m$. At any one time, there is only one copy of $m$ in the system. Each process’s state consists of the number of times it has received $m$, and $P$ sends $m$ first. At a certain point, $P$ has the message and its state is 101. Immediately after sending $m$, $P$ initiates the snapshot algorithm. Explain the operation of the algorithm in this case, giving the possible global state(s) reported by it.

11. Exercise 12.5. Adapt the central server algorithm for mutual exclusion to handle the crash failure of any client (in any state), assuming that the server is correct and given a reliable failure detector. Comment on whether the resultant system is fault tolerant. What would happen if a client that possesses the token is wrongly suspected to have failed?

12. Exercise 12.8. In the Bully algorithm, a recovering process starts an election and will become the new coordinator if it has a higher identifier than the current incumbent. Is this a necessary feature of the algorithm?

13. Exercise 15.1. Three computers together provide a replicated service. The manufacturers claim that each computer has a mean time between failure of five days; a failure typically takes four hours to fix. What is the availability of the replicated service?

14. Exercise 15.10 Explain why allowing backups to process read operations leads to sequentially consistent rather than linearizable executions in a passive replication system.

What to hand in AND email

You must both hand-in a paper copy of your answers to both parts of this assignment AND email an electronic copy (PDF) of both parts of this assignment to humphrey@cs.virginia.edu by 12:30pm on Tuesday May 1. No late submissions accepted!