Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Distributed Computing

Date: Wednesday 3rd June 2009
Time: 09:45 – 11:45

Please answer Question ONE and any two from Questions TWO, THREE and FOUR
This is a CLOSED book examination

The use of electronic calculators is NOT permitted.
1. **Compulsory**

   a) Explain briefly what is meant by the term *middleware*. (2 marks)
   
   b) In a distributed system, what is the purpose of an IDL? (2 marks)
   
   c) Why is it practically impossible to achieve exact synchronisation of clocks in a distributed system? (2 marks)
   
   d) What is meant by the term *totally ordered multicast*? (2 marks)
   
   e) When using JAVA RMI, what is the purpose of the rmiregistry? (2 marks)
   
   f) What is meant when a service is provided with *at least once* semantics? (2 marks)
   
   g) In distributed systems, what sort of thing is “REST”? Explain the origin of the name. (2 marks)
   
   h) What properties are provided by a *secure channel*? (2 marks)
   
   i) In distributed systems, what is SOAP, and what is it used for? (2 marks)
   
   j) What is meant by *parameter marshalling*? (2 marks)
Answer any two from Questions TWO, THREE and FOUR

2. a) Explain the ACID properties of transactions. (6 marks)
   
   b) What is meant by two-phase locking? (4 marks)
   
   c) Describe in detail how two-phase commit can implement distributed transactions. (6 marks)
   
   d) Why might an implementation of distributed transactions lead to distributed deadlock? Outline one mechanism for attempting to detect distributed deadlock. (4 marks)

3. Discuss, with appropriate examples from real systems, the following issues in the design of distributed file systems:
   
   a) views of the directory structure, as seen by the clients. (5 marks)
   
   b) the advantages and disadvantages of stateless servers. (5 marks)
   
   c) file update semantics and the caching of files. (5 marks)
   
   d) callbacks and timestamps. (5 marks)
4. a) Give the reasoning that leads to the conclusion that the commanding generals of two separate armies cannot agree a plan of attack using solely a finite sequence of unreliable messages. (3 marks)

b) Outline the Byzantine Generals problem, and illustrate how one of three being a traitor makes a solution impossible, whereas with one of four it is achievable. (6 marks)

c) Explain the relevance of parts (a) and (b) to distributed computer systems. (3 marks)

d) The following 4 processes access a shared variable $x$. Each process accesses a different replica of the store used to hold this variable. Before any process starts executing, the value of $x$ is 0 in all the replicas.

<table>
<thead>
<tr>
<th>Process 1</th>
<th>Process 2</th>
<th>Process 3</th>
<th>Process 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x = 2$ ;</td>
<td>$x = 1$ ;</td>
<td>$\text{while } (x == 0)$;</td>
<td>$\text{while } (x == 0)$;</td>
</tr>
<tr>
<td>$x = 3$ ;</td>
<td>$y3 = x$ ;</td>
<td>$y4 = x$ ;</td>
<td>$y4 = 4*y4 + x$ ;</td>
</tr>
<tr>
<td></td>
<td>$y3 = 4*y3 + x$ ;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

i) When all 4 processes have completed executing the statements given, are 6 and 13 possible values of $y3$ and $y4$ respectively, if the replication uses the sequential consistency model? Justify your answer. (4 marks)

ii) When all 4 processes have completed executing the statements given, are 6 and 13 possible values of $y3$ and $y4$ respectively, if the replication uses the causal consistency model? Justify your answer. (4 marks)