CS 15-440: Distributed Systems
Mock Quiz 2
November 8, 2016

Total Time: 20 minutes

Instructions:

- Write your answers in the spaces provided below each problem. If you make a mess, clearly indicate your final answers.
- The quiz has a maximum score of 20 points.
- Keep up with time.

Good Luck!

<table>
<thead>
<tr>
<th>Question No</th>
<th>Max. Points</th>
<th>Earned Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>
1. No-Brainers (4 Points):

This section tests your understanding and recollection of the basic concepts we discussed in the class about programming models, and the replication and consistency concepts. Answer the following precisely and concisely, or choose the correct answers.

(a) A causally consistent distributed data-store is always sequentially consistent:
   - [ ] True
   - [ ] False

(b) The shared memory programming model can be applied over a machine with a Uniform Memory Access (UMA) architecture:
   - [ ] True
   - [ ] False

(c) For which of the following reasons is replication usually used?
   - [ ] For performance reasons
   - [ ] For fault tolerance reasons
   - [ ] For scalability reasons
   - [ ] For concurrency reasons
   - [ ] For availability reasons
   - [ ] For security reasons
   - [ ] For redundancy reasons
   - [ ] For all of the above

(d) Briefly explain why programmers parallelize sequential programs.
2. Consistency & Replication (10 Points):

(a) Why is continuous consistency used and how can it be measured? Can continuous consistency be used for client-centric models? Explain. **(Points: 4)**

(b) Consider three processes P1, P2 and P3 executing multiple instructions on three shared variables x, y and z. There are two replicas R1 and R2 that store x, y and z. Assume that all the variables are initialized to zero. **(Points: 3)**

Given that the operations are executed at the replicas in the following order, answer the following:

**Update at R1**

- x = 1  
  print (y,z)  
- y = 1  
  print (x,z)  
- z = 1  
  print (x,y)

**Update at R2**

- x = 1  
  y = 1  
  print (x,z)  
  print (y,z)  
- z = 1  
  print (x,y)
a. Is the order of updates at each individual replica sequential? Explain why (or why not).

b. By looking at the ordering across the replicas, identify if the data-store is sequentially consistent. Explain why (or why not).

(c) Imagine in the future, you decide to program your own web-browser which you proudly name Tartanet. Given that browsers implement caching, describe how you would implement read-your-rights consistency. The model shall ensure that an up-to-date web-page is displayed when the web-page is updated. (3 Points)
3. Programming Models (6 Points):

(a) Running an application $P$ on two processors yields a speedup of $S_2$. Use Amdahl’s Law to derive a formula for $S_n$, the speedup on $n$ processors, in terms of $n$ and $S_2$. (Points: 2)

(b) Typically, with parallelization, programmers observe only a sub-linear performance improvement. Discuss two reasons of why this is the case. (2 Points)

(c) Discuss two main conditions by which deadlocks in MPI can happen. (2 points)