Homework 4

Due: 11:59 PM, May 4, 2017

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1 Three Phase Commit

We have a transaction system employing three-phase commit. It's composed of four servers running the participant algorithm, with one of them also running the coordinator algorithm. Everything was going fine until, in the midst of deciding whether to commit a transaction, there was a massive power failure and all servers simultaneously crashed. A short time later power was restored and the servers came back up one at a time in some random order. Though the network also went down, it was fully restored before any of the servers restarted. All servers fully recovered their pre-crash state on restarting. Keep in mind that, on restart, none of the servers is aware that all had crashed simultaneously. However, servers may assume that there are no communication problems, i.e., if one cannot contact another server, then that server must be down.

- 1. Consider a server that restarts and discovers that it is the only active server. Under what circumstances (i.e., in what states) may it (unilaterally) decide that the transaction has (or is to be) aborted or committed?
- 2. Are there situations in which all servers must restart before an abort/commit decision can be made? Explain. You may assume that once restarted, servers will remain operational until such a decision has been made.

2 Byzantine Generals

In class we discussed the Byzantine Generals Problem in terms of agreeing upon orders—either attack or retreat. But it also works for larger sets of values, such as non-negative integers. The value used by a general in [4,1]BGP, is the majority value in the three messages received from the other generals. E.g., if General A hears 10, 10, 20 from Generals B, C, and D, she'll use 10. (You may assume there always is a majority.)

In this problem we are investigating the Byzantine Agreement Problem (slide XIX-5), in which all generals are coequal—there is no designated commanding general—and we are seeking agreement on a set of values, one for each general. It is solved using n instances of the Byzantine Generals problem, one for each of our generals as commanding general. Thus we'll have agreement on a set of values, one associated with each general.

We'd like to use Byzantine Agreement to solve the following problem. Each general commands a certain number of troops. The decision to attack or retreat should be based on total troop strength: if the total number of troops from loyal generals is at least 100,000, they attack, but if not, they retreat. Traitorous generals are assumed to provide no troops, regardless of what they say. Our plan is that each general communicates to the others, using BGP, a value equal to his or her troop strength. Then, after the n instances of BGP, each general knows the troop strength of the others and can thus decide whether to attack or retreat. Assuming four generals, of whom at most one is a traitor, explain why this approach does not work.

3 Handing In

Once finished, you should hand in a PDF with your answers on Gradescope. Gradescope will allow you to select which pages contain your answers for each part of each question.

Please do not put your name on any page of your handin! This will allow us to do fully anonymized grading through Gradescope.

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