

UNIVERSITY OF EDINBURGH
COLLEGE OF SCIENCE AND ENGINEERING
SCHOOL OF INFORMATICS

INFR11088 EXTREME COMPUTING

Friday 1st May 2015

14:30 to 16:30

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

CALCULATORS MAY NOT BE USED IN THIS EXAMINATION

Year 4 Courses

Convener: I. Stark

External Examiners: A. Cohn, T. Field

THIS EXAMINATION WILL BE MARKED ANONYMOUSLY

1. (a) Describe the notion of local computation through a combiner in MapReduce. Give an example of applying this pattern that will benefit performance. [5 marks]
- (b) In a Hadoop cluster running both the Hadoop distributed file system (HDFS) and the MapReduce runtime, describe the functionality of the namenode and the job tracker. Does it make more sense to split the cluster into a subset of nodes only running HDFS with the remaining nodes responsible for MapReduce workflows? Explain your answer. [7 marks]
- (c) What do the shuffle and sort phases of the MapReduce workflow do? Give a brief description of their implementations. [7 marks]
- (d) Describe the basic three-tier architecture of a cloud. What aspects does each one of the tiers address and how? [6 marks]

2. (a) Consider the BitTorrent protocol.
- i. What is the tit-for-tat incentive in BitTorrent? How does it work in practice in terms of the data transfer protocol? [5 marks]
 - ii. We have mentioned in other parts of the course the need for replication and fault-tolerance. How do you think these concepts manifest in BitTorrent? [6 marks]
- (b) What is the motivation behind the BASE framework? What does BASE stand for and what do the terms it stands for mean? [6 marks]
- (c) What are the steps in taking an ACID-compliant transaction and turning it into one being executed using the BASE model? Give an example of the application of these steps for the following transaction:
- ```
Begin;
let employee t = Emp.Record('Tony');
t.status = 'retired';
 \forall customer c: c.AccountRep=='Tony' \rightarrow c.AccountRep = 'Sally';
Commit;
```
- [8 marks]

3. (a) Give three design goals and three guarantees that a Zookeeper cluster provides. [6 marks]
- (b) Describe the two-phase commit, abort, and rollback protocols. [5 marks]
- (c) In two-phase commit, there are two typical optimisations that are frequently applied during recovery. In particular, if during recovery we do not have a commit record for a transaction we can choose to either abort it (presumed abort) or commit it (presumed commit). Comment on the advantages and disadvantages of each approach and sketch their potential implementations. [7 marks]
- (d) You are tasked with implementing a computation over a data stream and you have chosen Storm for the task. The workflow calls for one bolt to receive non-duplicate items as input. Give two ways in which you can do so in Storm using techniques we have discussed during lectures. You can safely assume the domain of the items is finite and the number of unique values in the domain is less than the amount of main memory of a single Storm node. Note: you **do not** need to write any code, only sketch your implementations. [7 marks]