CS582: Distributed Systems

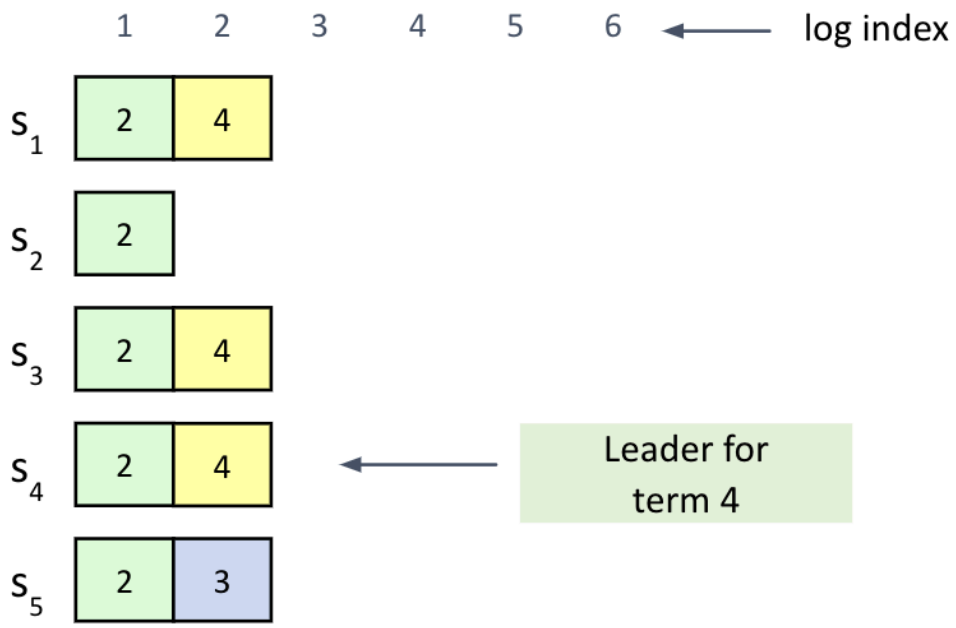
Quiz 5

Student Name:	**Student ID:**
Time Allowed: 20 mins.	**Total Marks:** 12

Question 1 (4 marks, expected time 4-6 minutes)

Suppose there are 5 servers in a cluster running Raft. The number inside the box represents the term in which a particular command was added to the log.

Suppose Server 4 is the leader for term 4. The number inside the box represents the term when that particular command was added to the log.Below are the logs for all the nodes.



Suppose Server 4 is trying to replicate a new log entry with term 4 on all servers. Answer the following questions.

a) **How many times will the AppendEntry to Server 2 and Server 5 fail until a successful AppendEntry is sent? (3 marks)**

In both cases (i.e considering new entry 4 either at index 2 or 3)

Server 2: 0 append entry will fail (1.5 marks)

Server 5: 0 append entry will fail (1.5 marks)

b) **How will the log of each server look like after successful AppendEntries?**

(1 mark)

With a new entry 4 at index 3

Each log will look exactly like the leader's log i.e

(1,2), (2,4), (2,4) (index, log entry)

Considering entry 4 at index 2 as the new entry

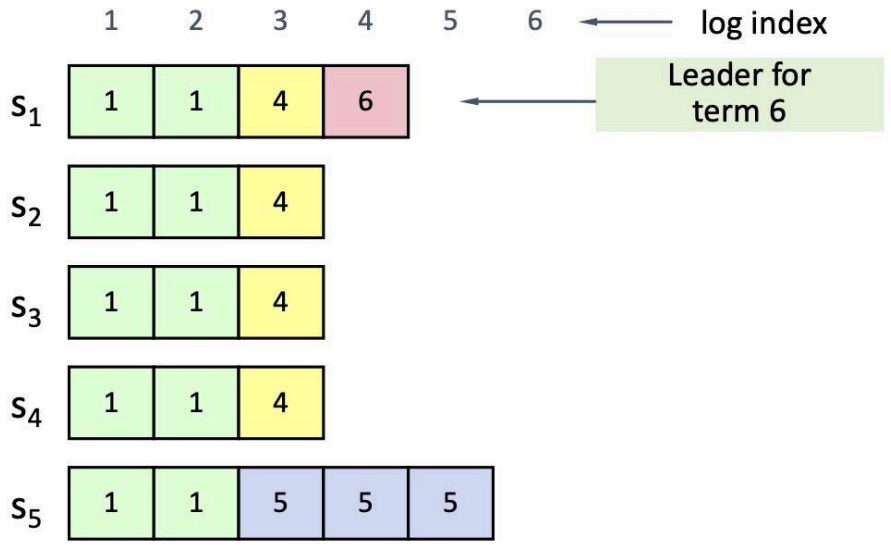
Each log will look exactly like the leader's log i.e

(1,2), (2,4) (index, log entry)

Question 2 (5 marks, expected time 7-9 minutes)

Suppose your TA Hammad implemented Raft from scratch. He hasn't tested his implementation, it is possible there are bugs in the implementation. He runs his Raft implementation on a cluster of 5 servers. The figure below shows the current state of the logs on each server in the cluster.

The leader for term 6 is S1. In addition, assume S2 was the leader for term 4 and it has applied the entry with log index 3 and term 4 to its state machine. S5 was the leader for term 5.



Given the above scenario:

a) **If S1 crashes, which servers can become leaders? Identify a scenario where a new leader is elected and Raft's safety requirement is violated. [2.5 marks]**

S2, S3, S4, S5 can become leaders (1 mark)

In scenario when S5 is elected leader, it starts replicating the log entry 5 on all servers, thus overwriting the already committed log entry 4 which violates the Raft's safety requirement. (1.5 marks)

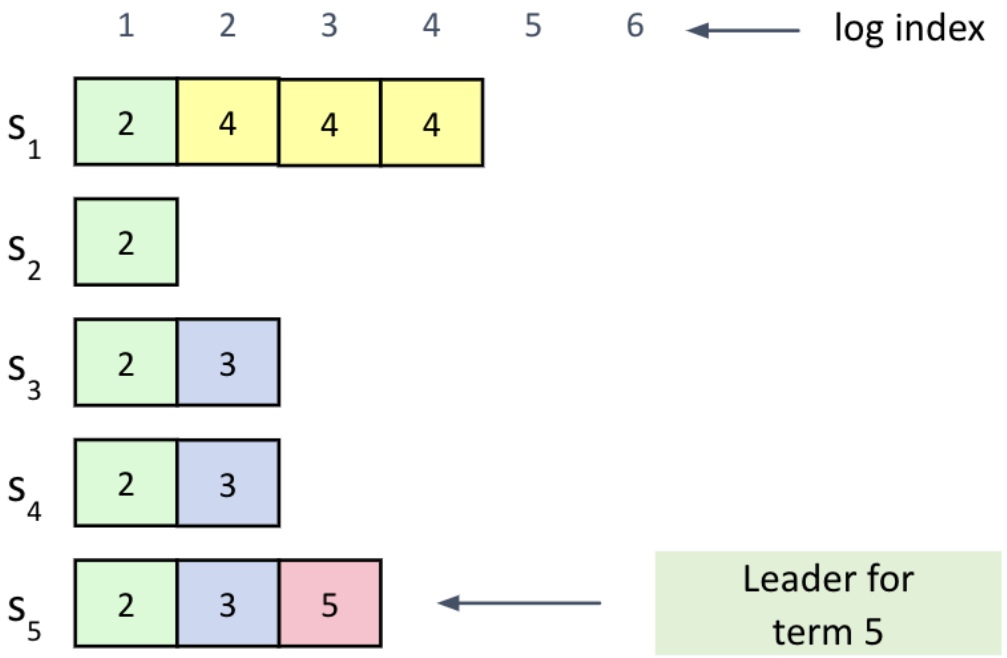
b) **Based on the observation in a) determine if Hamad's implementation is buggy and whether this scenario can happen in a correct implementation of Raft? Provide correct reasoning to get any points [2.5 marks]**

Yes hammad's implementation is buggy since it commits a log entry upon replication on the majority of servers. It does not take into account the second rule for commitment i.e at least one new entry from leader's term must also be stored on majority of servers (1.5 marks)

Had this been a correct implementation of Raft, this situation would not have arisen since 4 would not have been committed yet. And hence overwriting it would have been safe. (1 mark)

Question 3 (3 marks, expected time 3-5 minutes)

Suppose there are 5 servers in a cluster running Raft. The number inside the box represents the term in which a particular command was added to the log. Suppose Server 5 is the leader for term 5.



1) **If server 5 crashes, which servers can become the leader? Briefly explain your answer (1.5 marks)**

   S1,S3 and S4 can all become leaders. (0.5 marks)
   S3 can get majority votes from {S2,S3,S4}, similar for S4
   S1 can get majority votes from {S1,S2,S3,S4}
   S2 will not get any vote except from itself. (1 mark)

2) **Your TA Ahmed claims that in Raft the leader always has the most complete log among the whole cluster of servers? Do you agree or disagree? Provide clear reasoning for full credit (1.5 mark)**

   Disagree (0.5 marks)

   The raft leader always has the most complete log in voting majority and not necessarily in the entire cluster of servers. (1 mark)