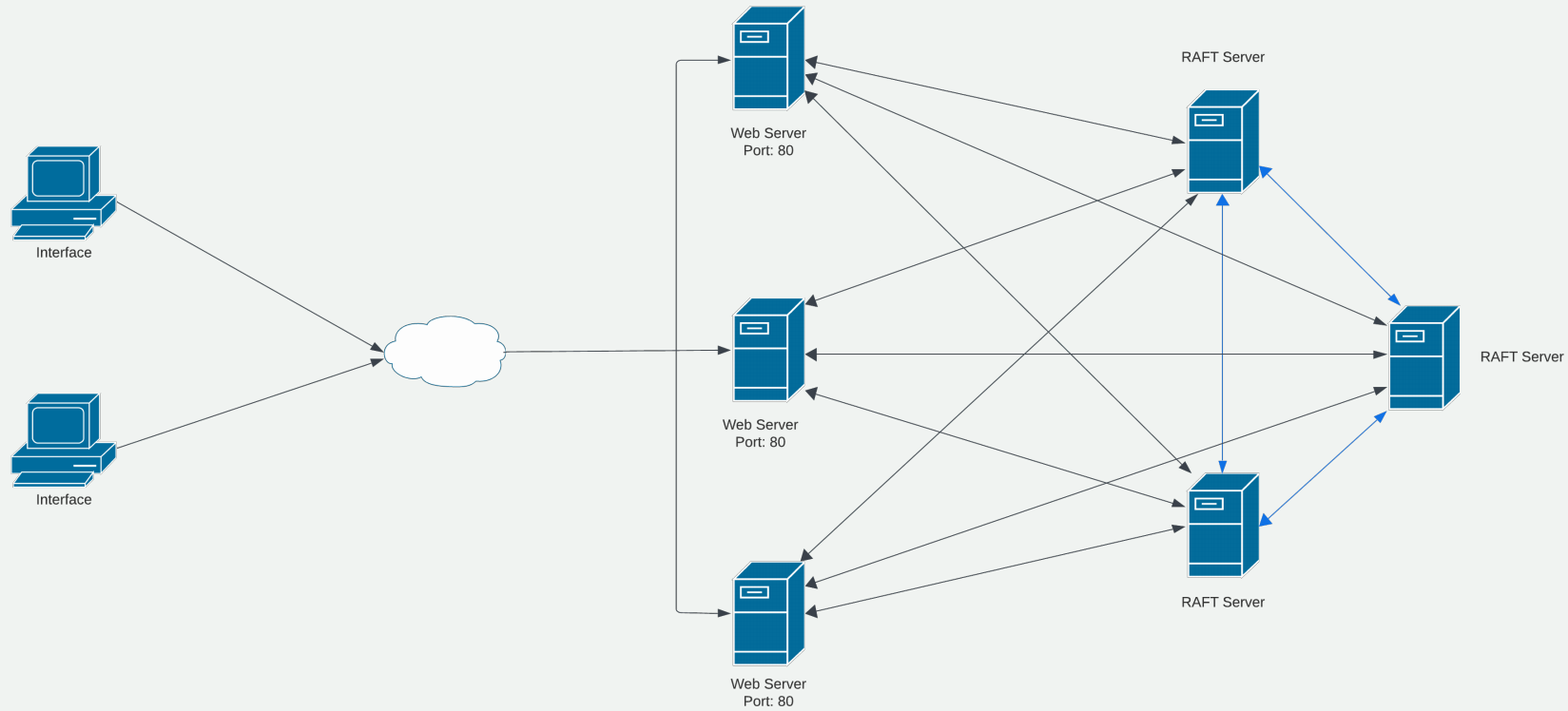
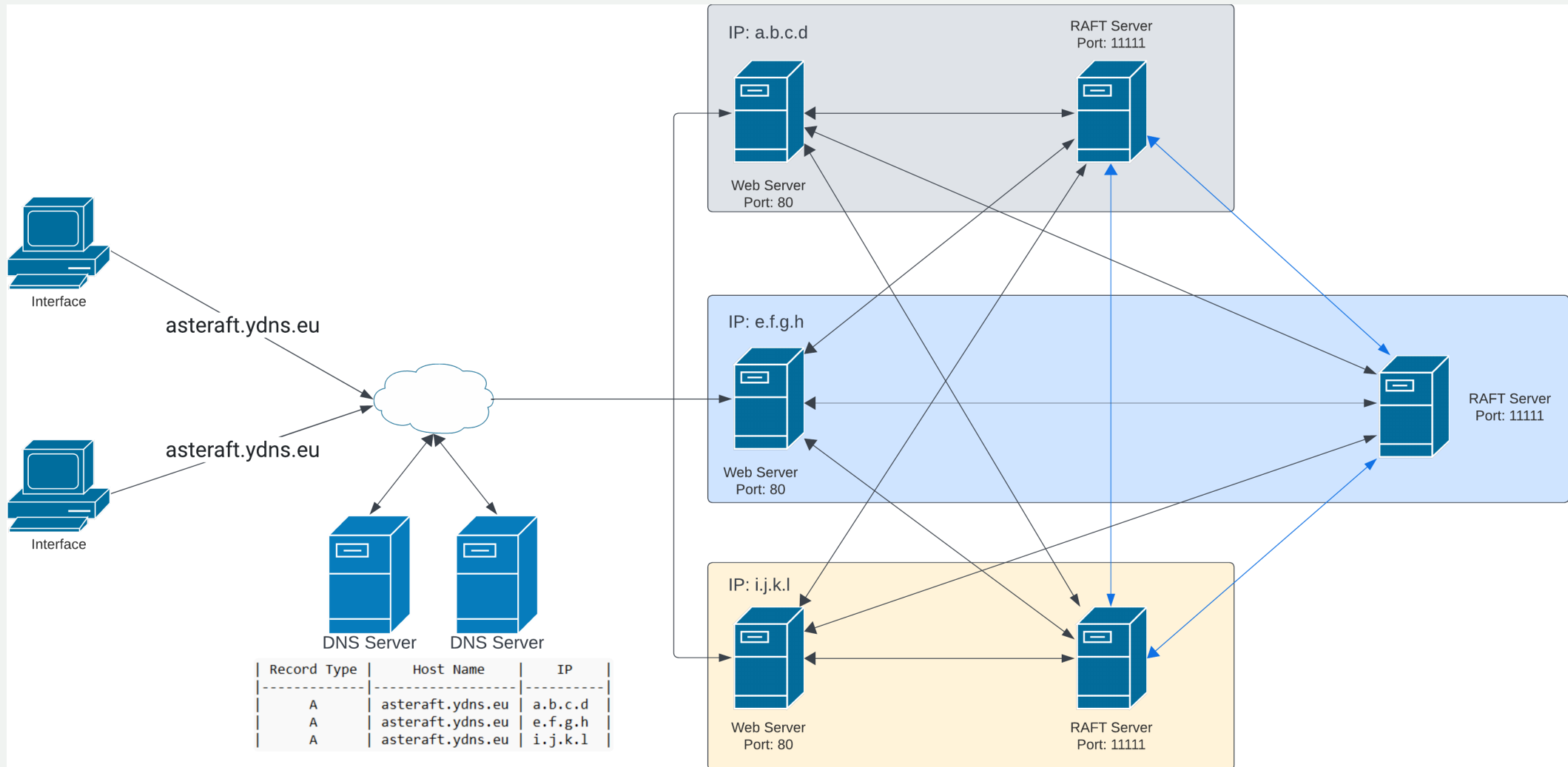


RAFT

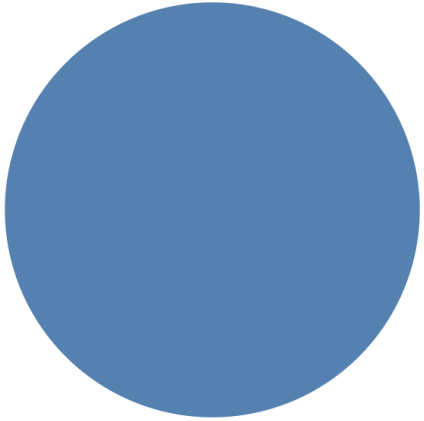
ARCHITETTURA LOGICA



ARCHITETTURA DELLA RETE



ALGORITMO RAFT



A **node** as a database server that stores a single value.



We also have a **client** that can send a value to the server.



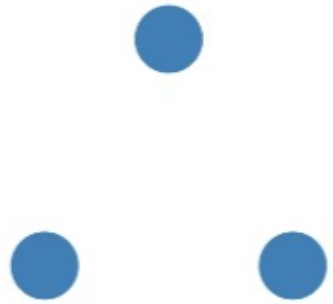
We also have a **client** that can send a value to the server.



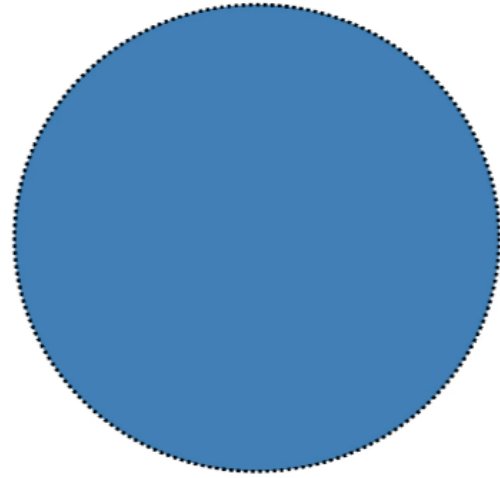
Coming to agreement, or *consensus*, on that value is easy with one node.



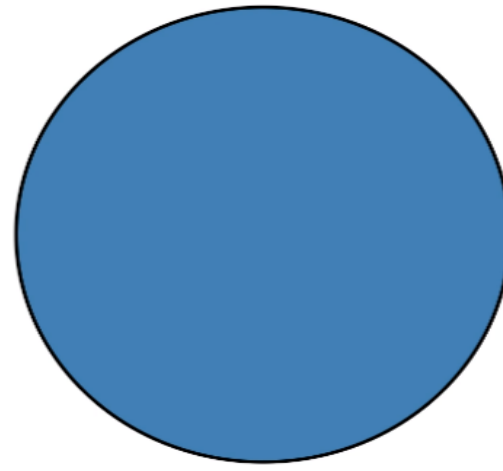
Raft is a protocol for implementing distributed consensus.



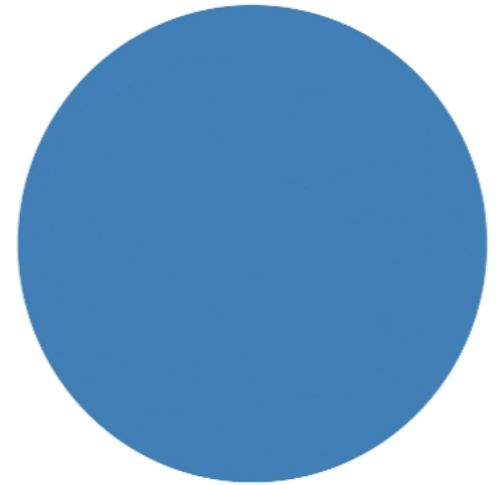
A node can be in 1 of 3 states:



the *Candidate* state,

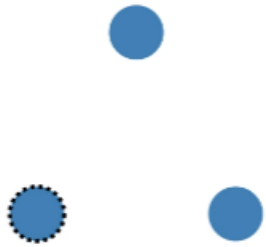


or the *Leader* state.

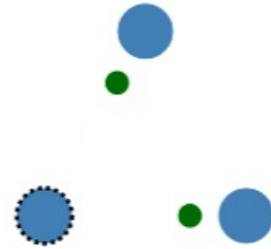


The *Follower* state,

LOG REPLICATION



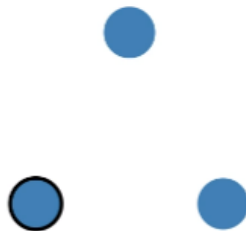
If followers don't hear from a leader then they can become a candidate.



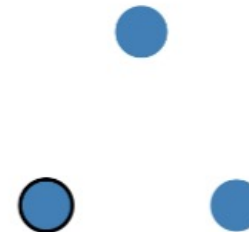
The candidate then requests votes from other nodes.



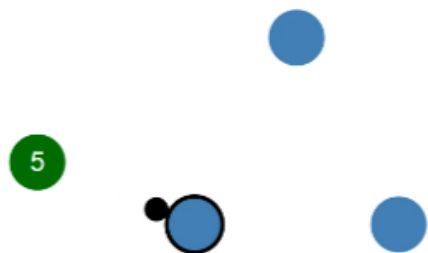
Nodes will reply with their vote.



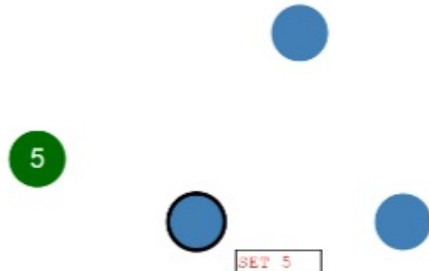
The candidate becomes the leader if it gets votes from a majority of nodes.



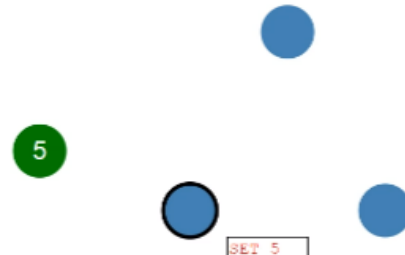
This process is called *Leader Election*.



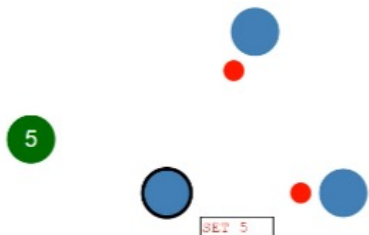
All changes to the system now go through the leader.



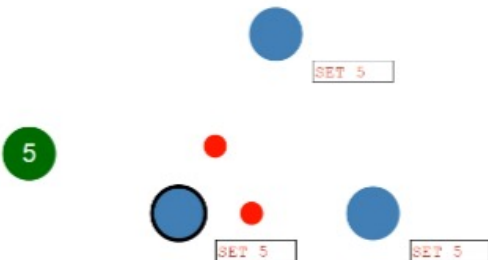
Each change is added as an entry in the node's log.



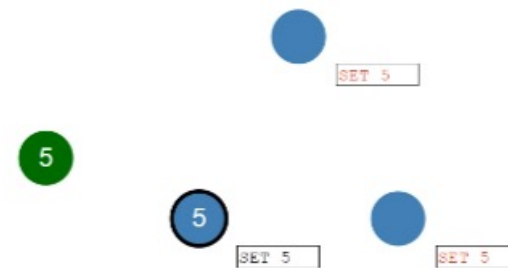
This log entry is currently uncommitted so it won't update the node's value.



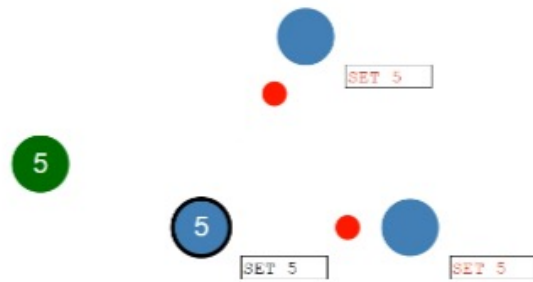
To commit the entry the node first replicates it to the follower nodes...



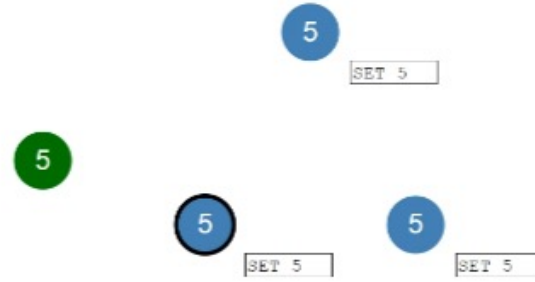
then the leader waits until a majority of nodes have written the entry.



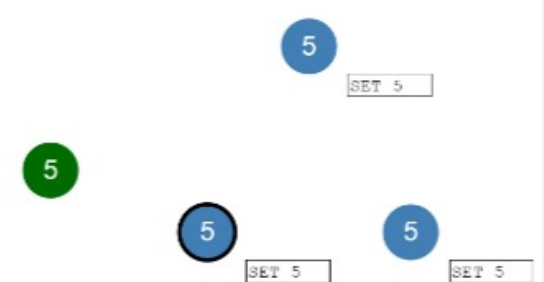
The entry is now committed on the leader node and the node state is "5".



The leader then notifies the followers that the entry is committed.

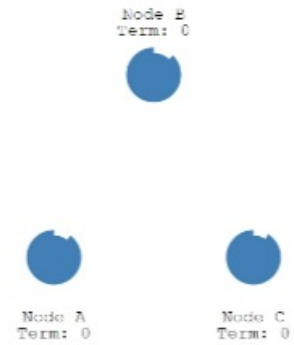


The cluster has now come to consensus about the system state.

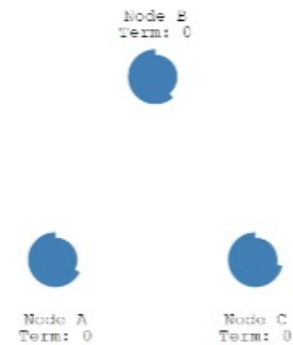


This process is called *Log Replication*.

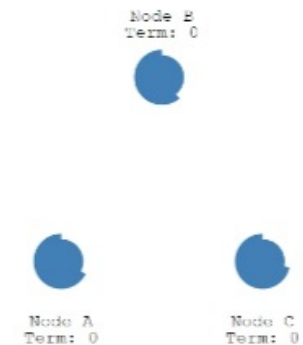
LEADER ELECTION



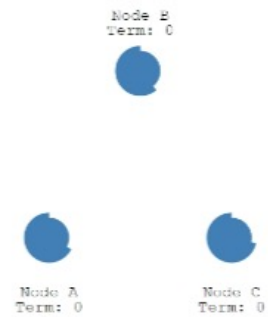
In Raft there are two timeout settings which control elections.



First is the **election timeout**.



The election timeout is the amount of time a follower waits until becoming a candidate.



The election timeout is randomized to be between 150ms and 300ms.

Node B
Term: 1
Vote Count: 1

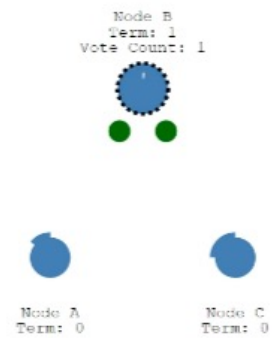


After the election timeout the follower becomes a candidate and starts a new *election term*...

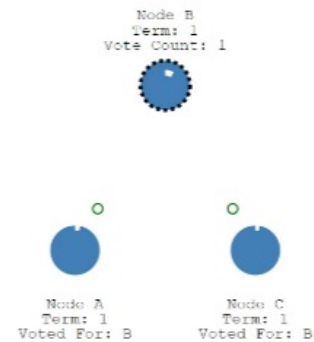
Node B
Term: 1
Vote Count: 1



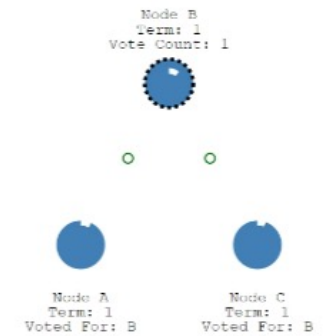
...votes for itself...



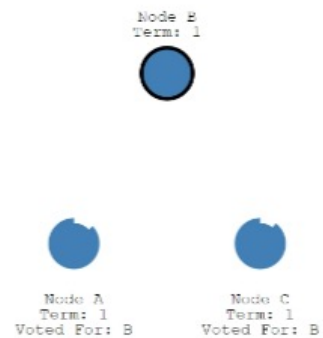
...and sends out *Request Vote* messages to other nodes.



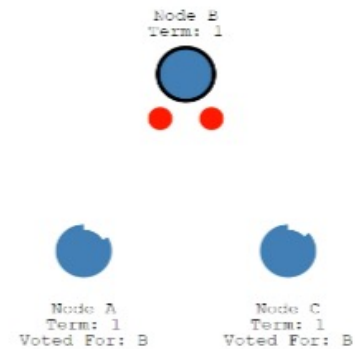
If the receiving node hasn't voted yet in this term then it votes for the candidate...



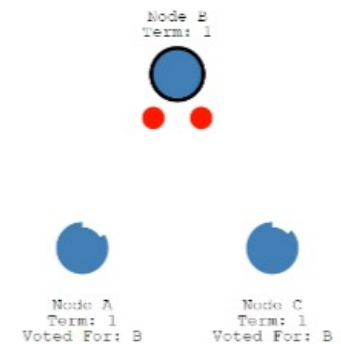
...and the node resets its election timeout.



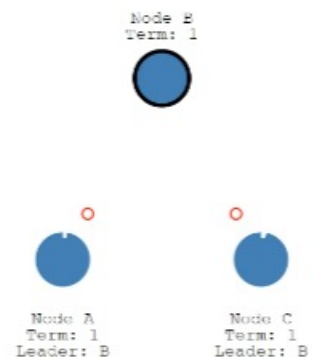
Once a candidate has a majority of votes it becomes leader.



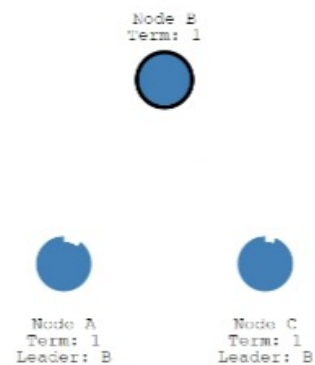
The leader begins sending out *Append Entries* messages to its followers.



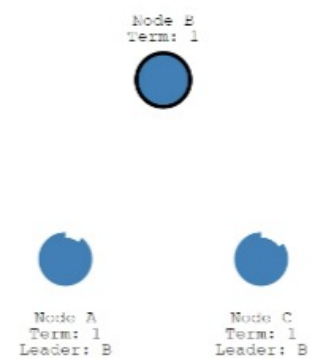
These messages are sent in intervals specified by the **heartbeat timeout**.



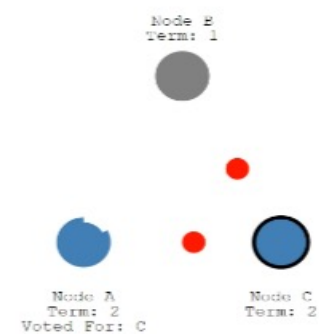
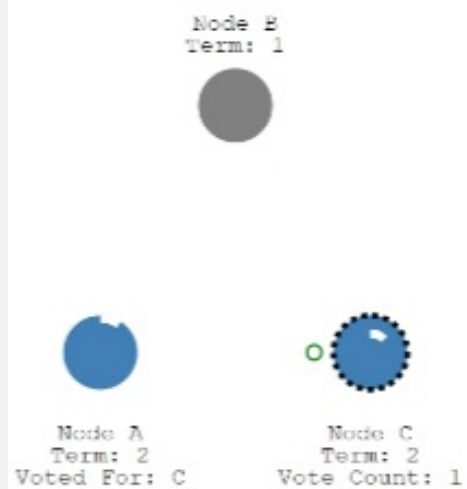
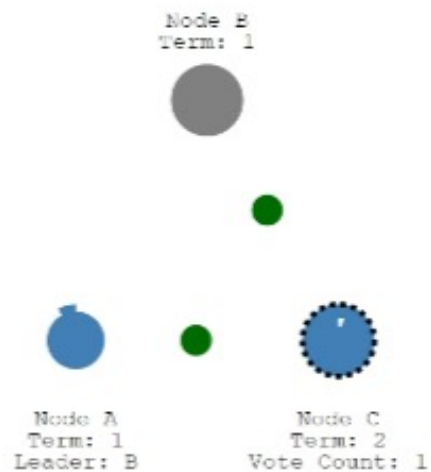
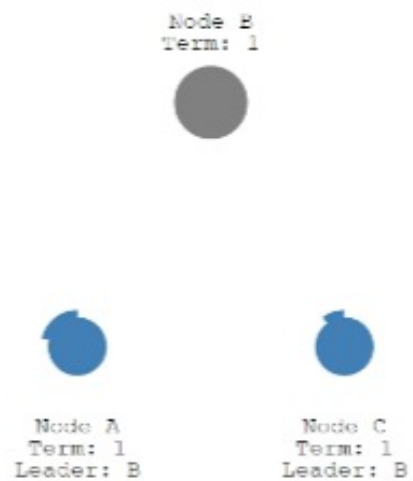
Followers then respond to each *Append Entries* message.



This election term will continue until a follower stops receiving heartbeats and becomes a candidate.

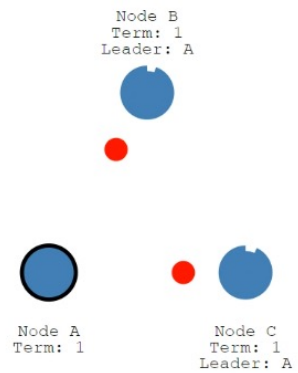


Let's stop the leader and watch a re-election happen.

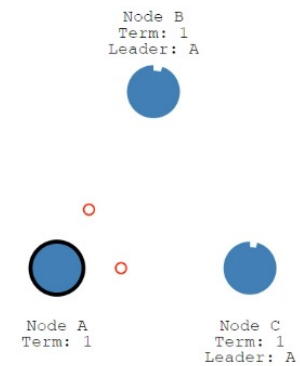


Node C is now leader of term 2.

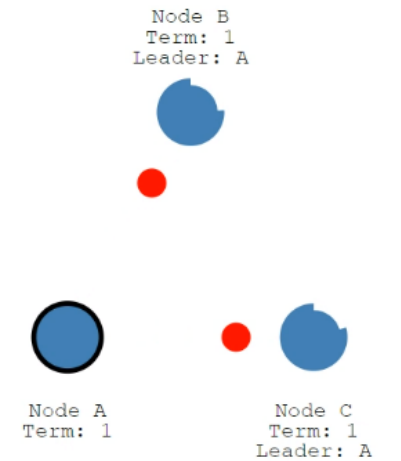
LOG REPLICATION



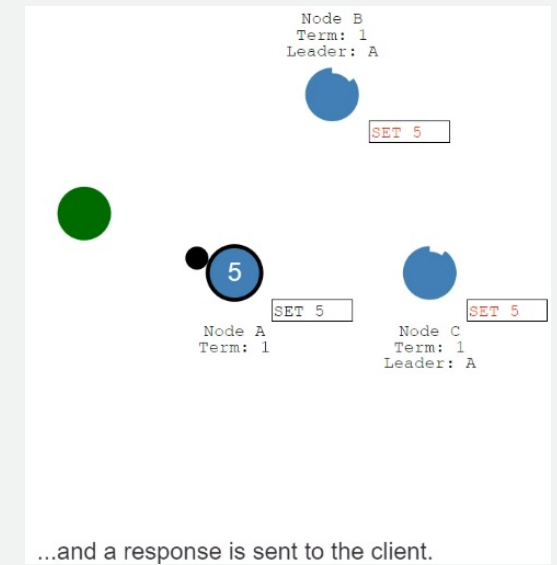
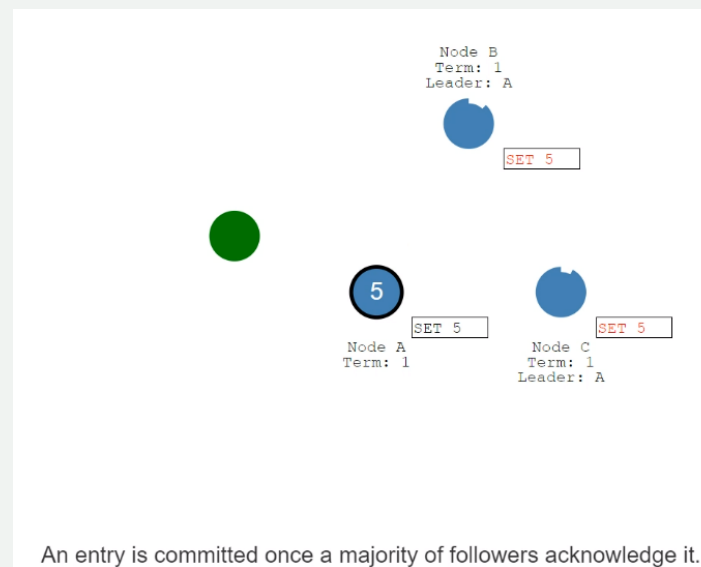
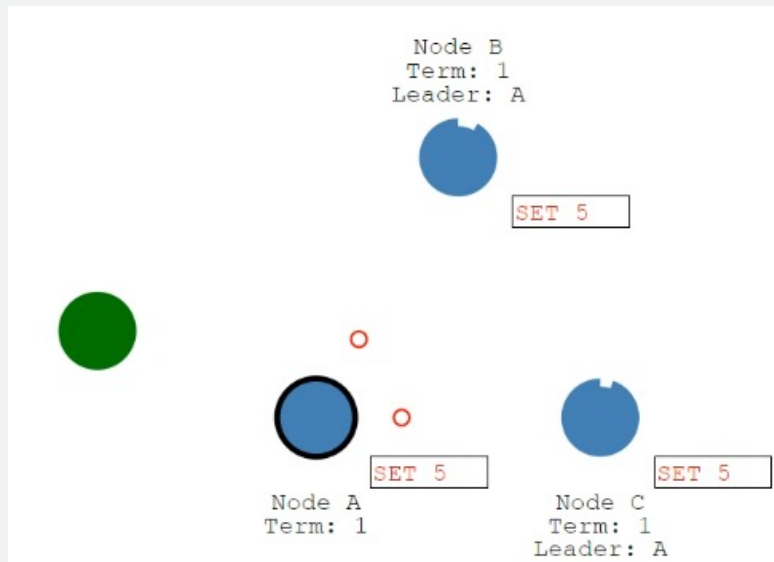
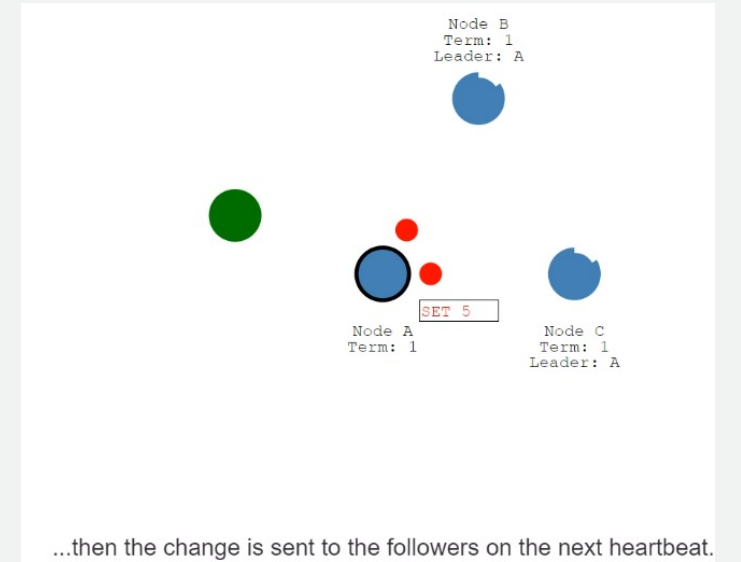
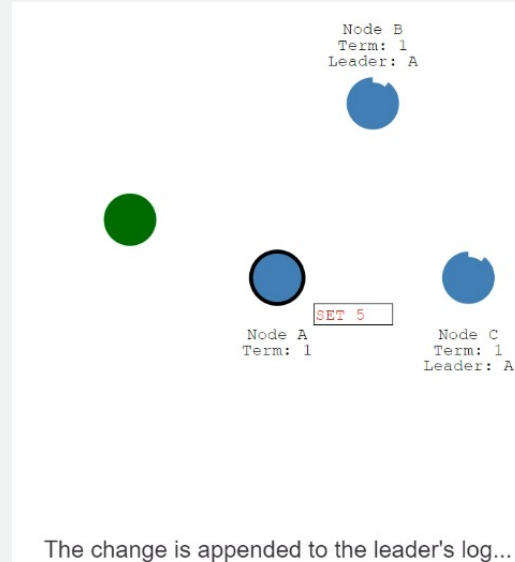
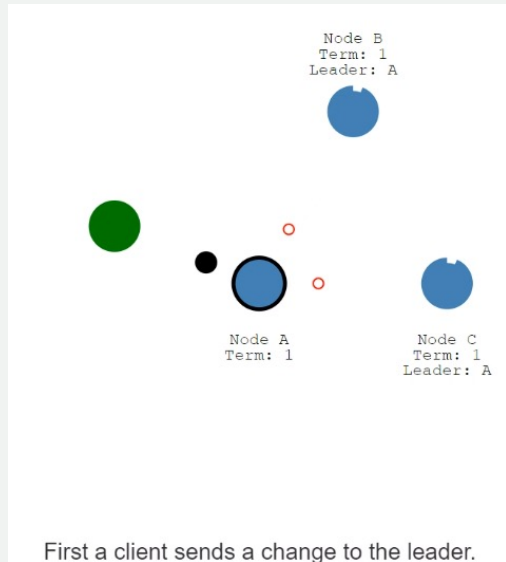
Once we have a leader elected we need to replicate all changes to our system to all nodes.

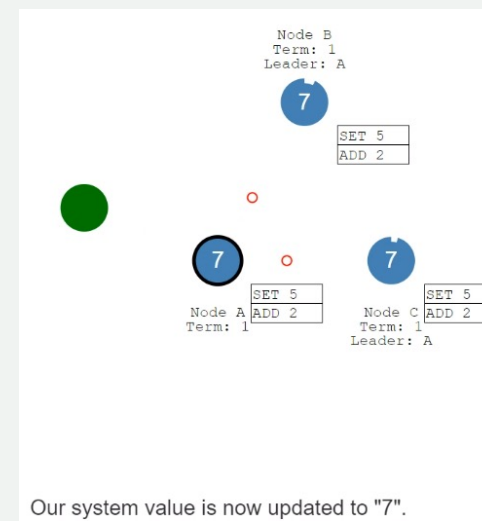
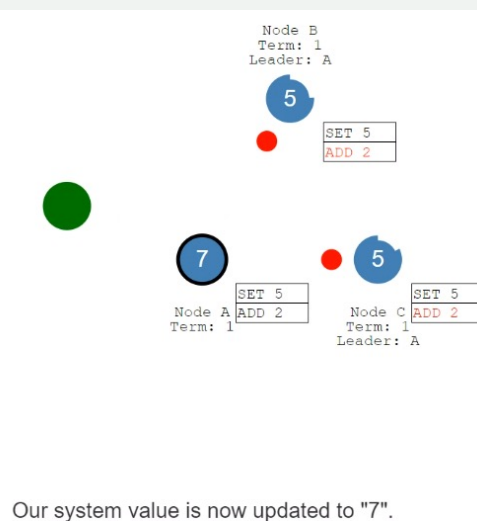
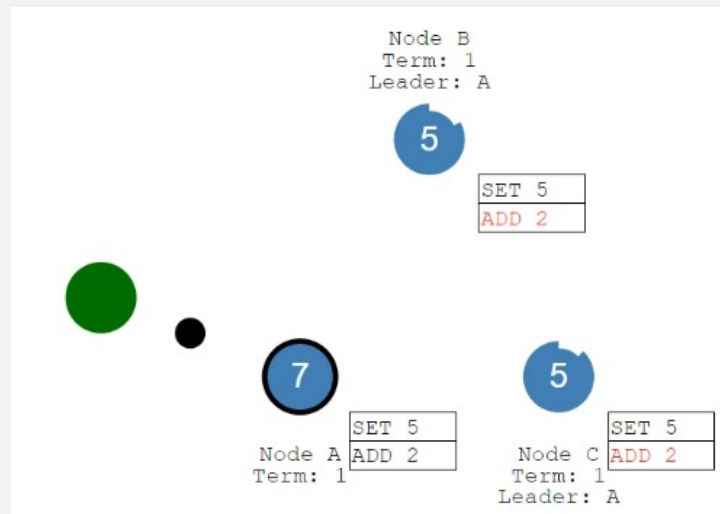
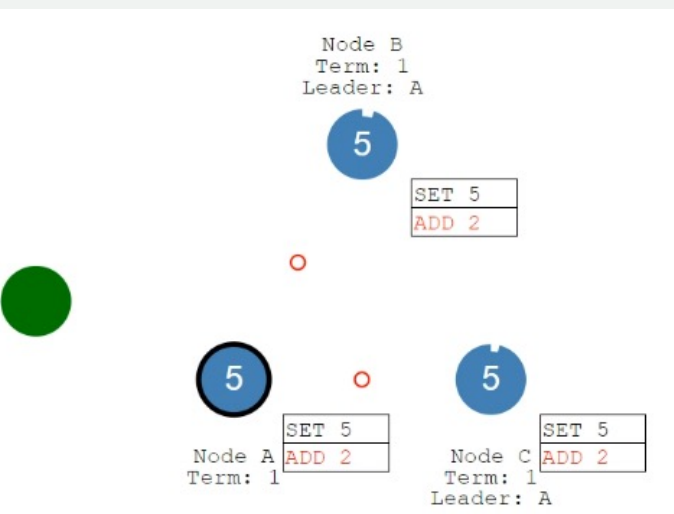
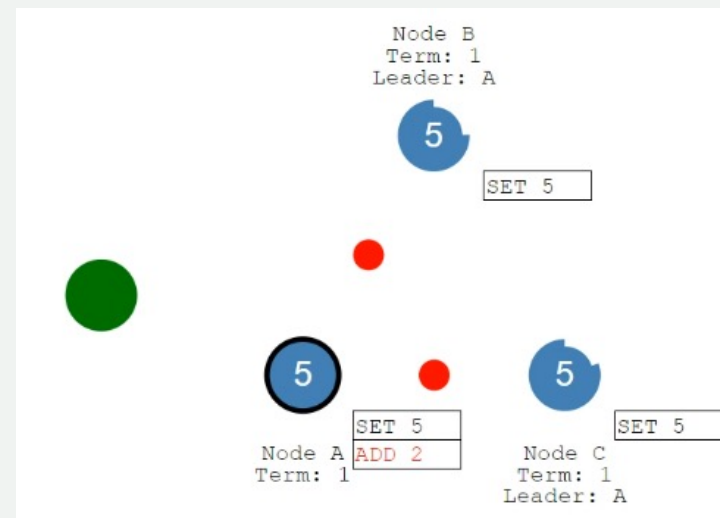
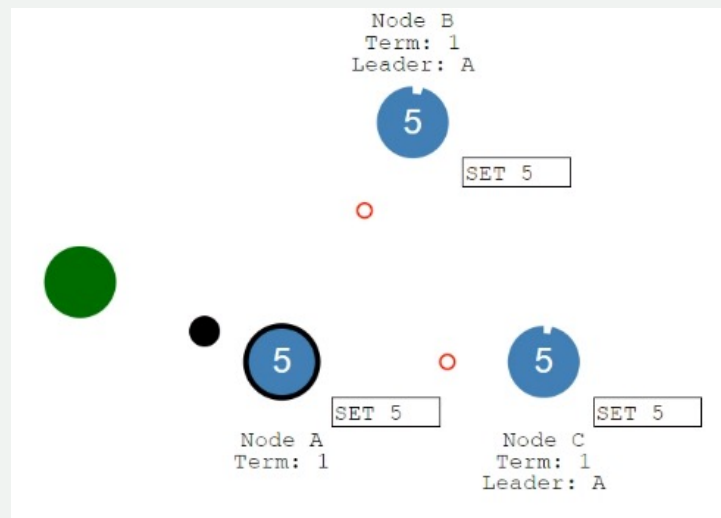
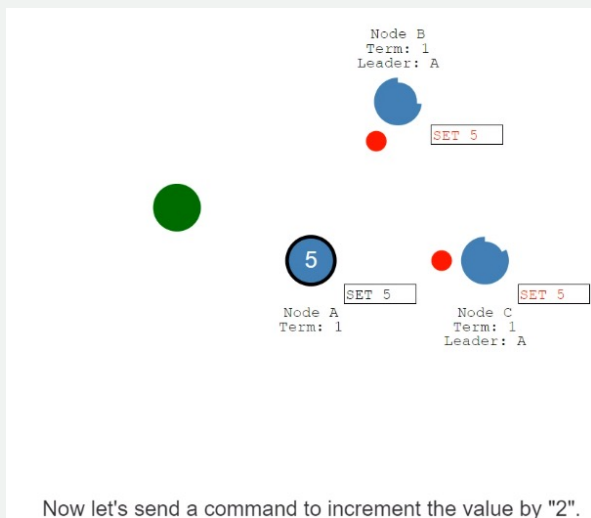


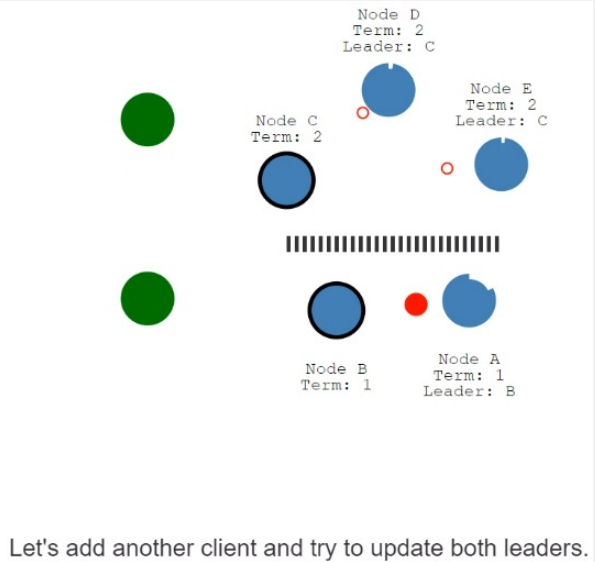
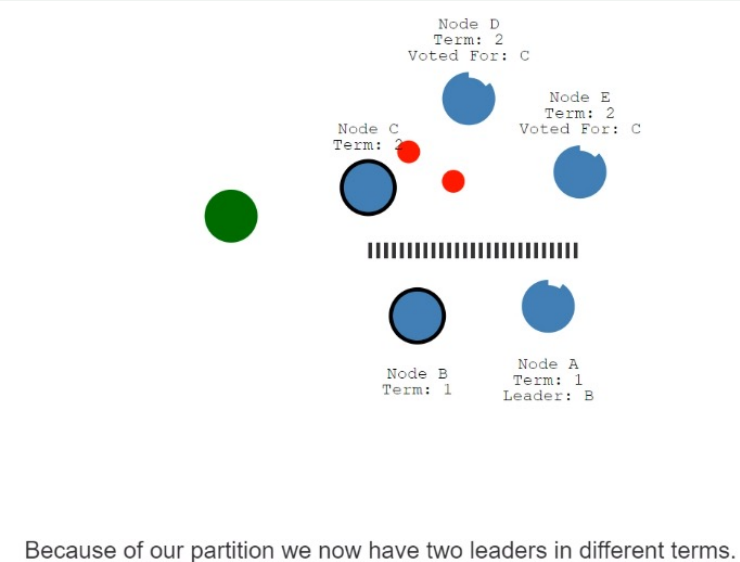
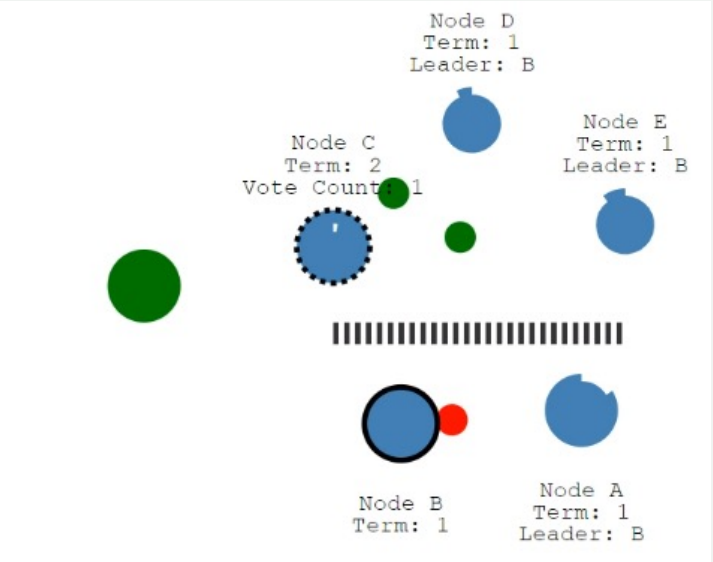
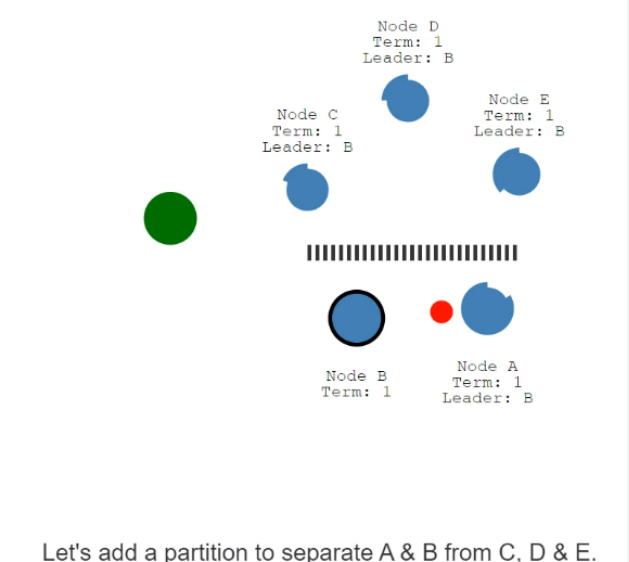
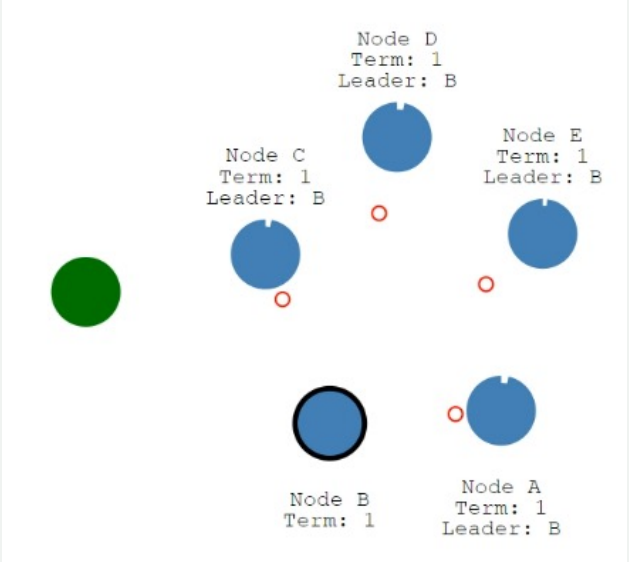
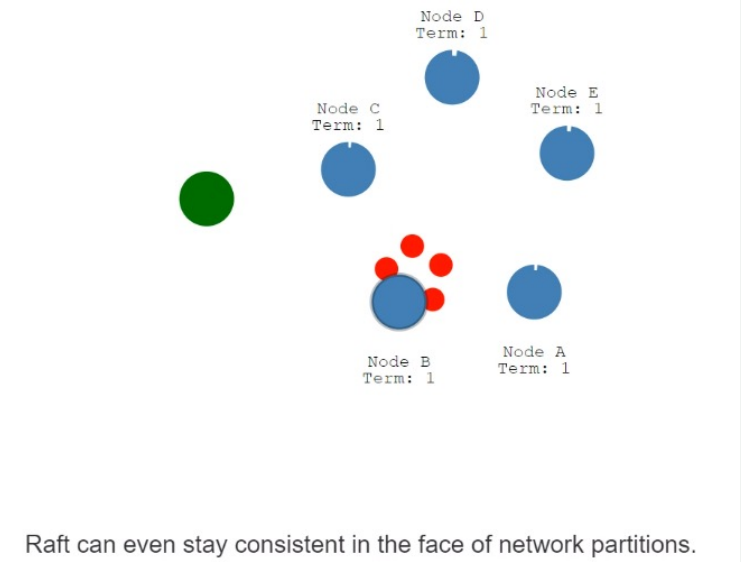
This is done by using the same *Append Entries* message that was used for heartbeats.

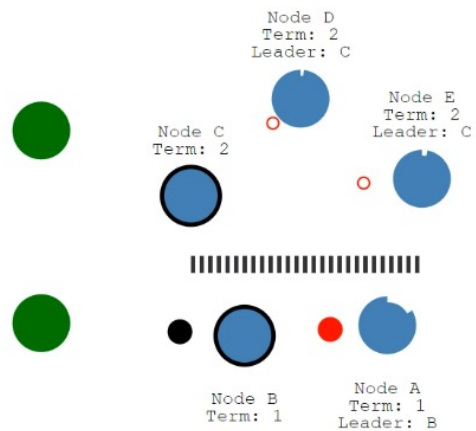


Let's walk through the process.

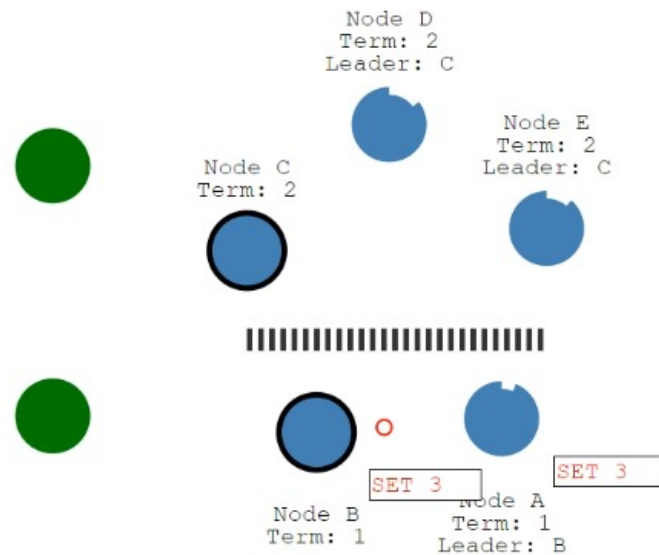




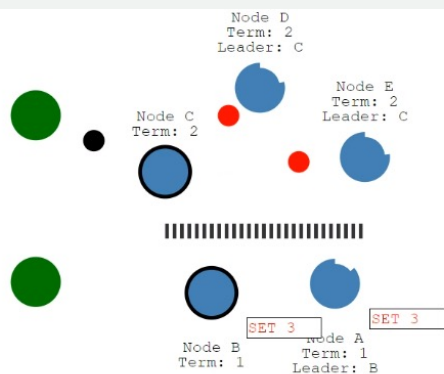




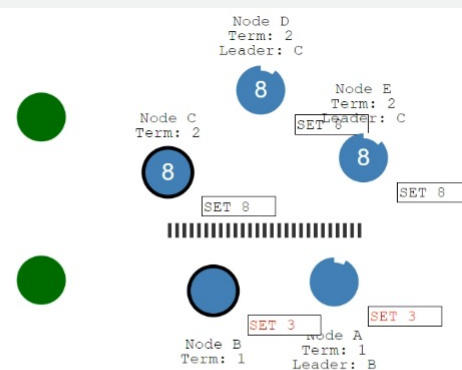
One client will try to set the value of node B to "3".



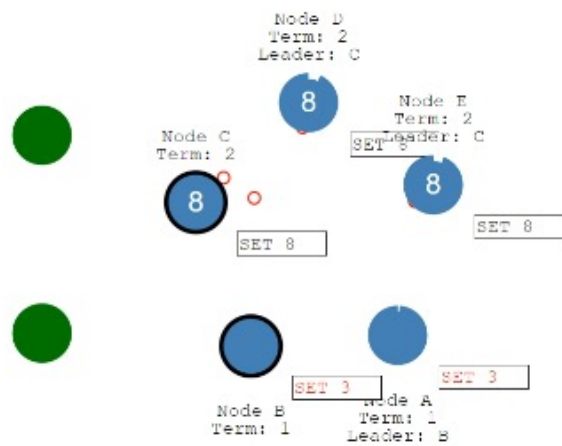
Node B cannot replicate to a majority so its log entry stays uncommitted.



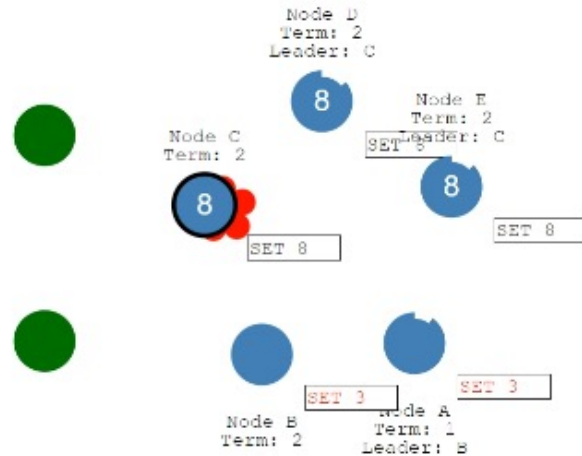
The other client will try to set the value of node C to "8".



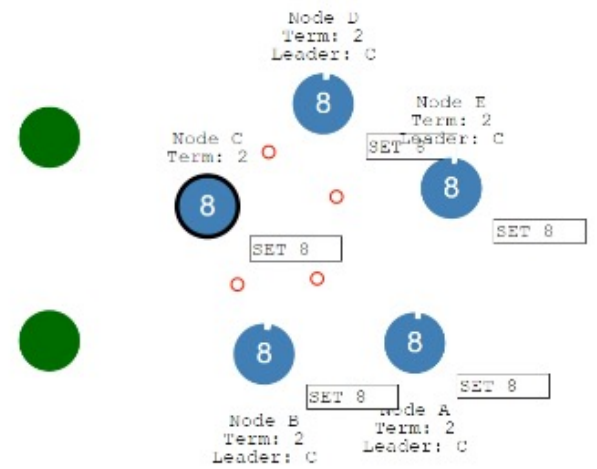
This will succeed because it can replicate to a majority.



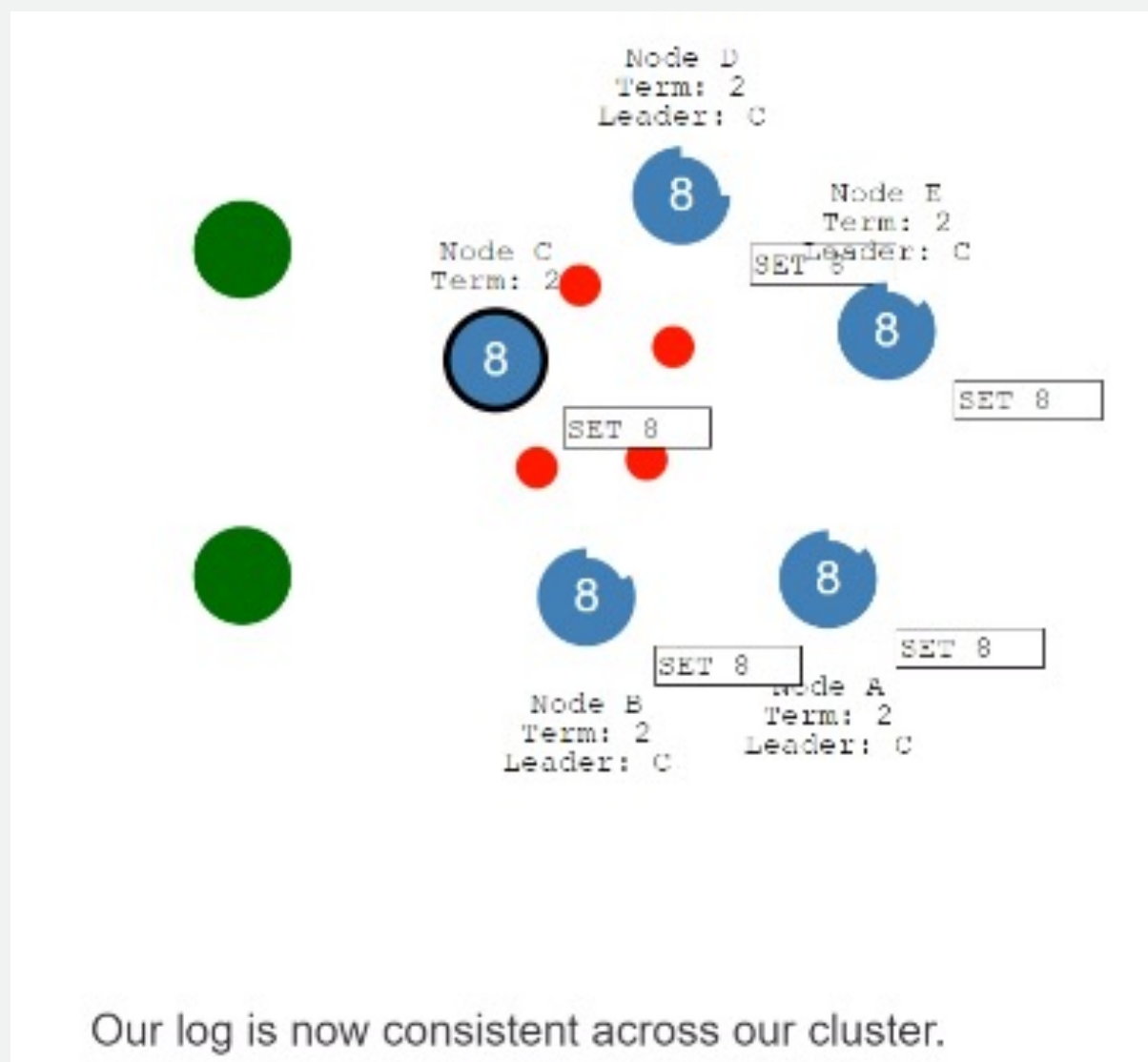
Now let's heal the network partition.



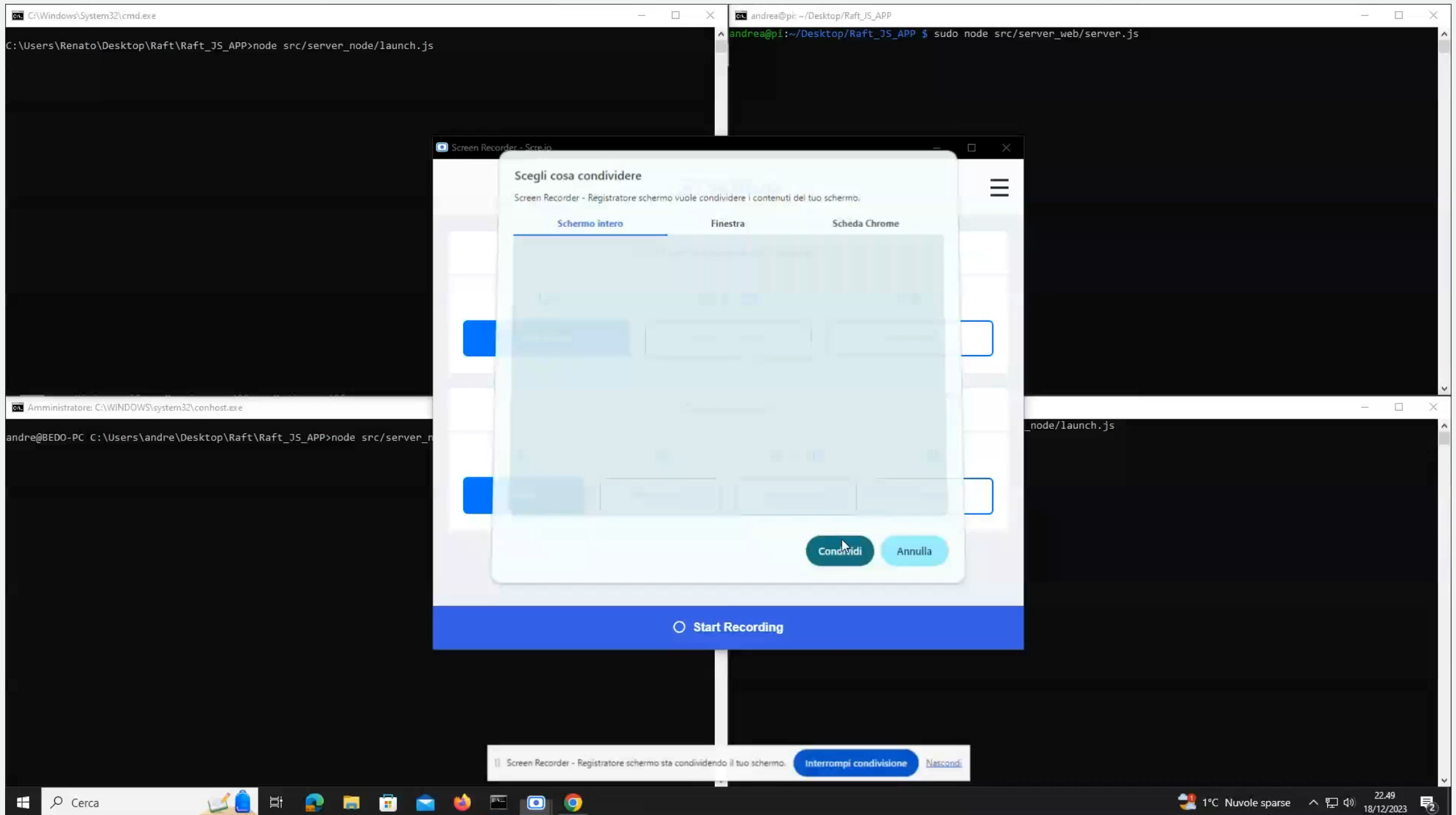
Node B will see the higher election term and step down.



Both nodes A & B will roll back their uncommitted entries and match the new leader's log.



REPLICAZIONE



LEADER ELECTION

```
C:\Windows\System32\cmd.exe - node src/server_node/launch.js
[node4 (leader)]: Sending new heartbeat to node1: {"currentTerm":1,"prevLogIndex":2,"prevLogTerm":1,"missingEntries":[],"commitIndex":2}
[node4 (leader)]: Received successful "appendentries" response from node1 -> ignored (ok).
[node4 (leader)]: Sending new heartbeat to node3: {"currentTerm":1,"prevLogIndex":2,"prevLogTerm":1,"missingEntries":[],"commitIndex":2}
[node4 (leader)]: Received successful "appendentries" response from node3 -> ignored (ok).
[node4 (leader)]: Sending new heartbeat to node5: {"currentTerm":1,"prevLogIndex":2,"prevLogTerm":1,"missingEntries":[{"term":1,"commandType":"new_user","logData":{"username":"a","password":"a"},"callback":null}, {"term":1,"commandType":"new_auction","logData":{"username":"a","startPrice":10,"startPrice":10,"callback":null}, {"term":1,"commandType":"close_auction","logData":{"auctionId":1,"closingDate":"2023-12-18T21:50:40.666Z"},"callback":null}], "commitIndex":2}
[node4 (leader)]: Received successful "appendentries" response from node5
[node4 (follower)]: New election detected. Changing to follower state...
[node4 (follower)]: Received "requestvote" request from node5 -> cast vote.
[node4 (follower)]: Conflicting entry/ies found and removed from log. Log is now 0 records long.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Failed to connect: xhr poll error
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node4 (follower)]: Failed to connect: xhr poll error
[node4 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.

Amministratore: C:\WINDOWS\system32\cmd.exe - node src/server_node/launch.js
[node5 (leader)]: Sending new heartbeat to node2: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node3: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node4: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Received successful "appendentries" response from node4 -> ignored (ok).
[node5 (leader)]: Received successful "appendentries" response from node3 -> ignored (ok).
[node5 (leader)]: Sending new heartbeat to node1: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node2: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node3: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node4: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Received successful "appendentries" response from node4 -> ignored (ok).
[node5 (leader)]: Received successful "appendentries" response from node4 -> ignored (ok).
[node5 (leader)]: Received successful "appendentries" response from node3 -> ignored (ok).
[node5 (leader)]: Sending new heartbeat to node1: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node2: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node3: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Sending new heartbeat to node4: {"currentTerm":2,"prevLogIndex":-1,"prevLogTerm":null,"missingEntries":[],"commitIndex":-1}
[node5 (leader)]: Received successful "appendentries" response from node1 -> ignored (ok).
[node5 (leader)]: Received successful "appendentries" response from node4 -> ignored (ok).

andrea@pi: ~/Desktop/Raft_JS_APP
Connetting to node4 abedo.ddns.net:15003
Server listening at http://localhost:80
Connected to non-leader node4!
Connetting to node3 79.23.243.113:15001
Connetting to node5 abedo.ddns.net:15005
Connected to non-leader node5!
Connetting to node4 abedo.ddns.net:15003
Connected to leader node4!

andrea@pi: ~/Desktop/Raft_JS_APP
[node1 (follower)]: Failed to connect: xhr poll error
[node1 (follower)]: Received "appendentries" request from node4 with term 1 -> responded.
[node1 (follower)]: Received "requestvote" request from node5 -> refuse vote.
[node1 (follower)]: Connection established with node5.
[node1 (follower)]: Connection accepted.
[node1 (follower)]: Received "appendentries" request from node4 with term 1 -> responded.
[node1 (follower)]: Received "appendentries" request from node4 with term 1 -> responded.
[node1 (follower)]: Failed to connect: xhr poll error
[node1 (follower)]: Received "appendentries" request from node4 with term 1 -> responded.
[node1 (follower)]: Received "appendentries" request from node4 with term 1 -> responded.
[node1 (follower)]: New election detected. Changing to follower state...
[node1 (follower)]: Received "requestvote" request from node5 -> cast vote.
[node1 (follower)]: Conflicting entry/ies found and removed from log. Log is now 0 records long.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Failed to connect: xhr poll error
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Failed to connect: xhr poll error
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Failed to connect: xhr poll error
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Failed to connect: xhr poll error
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
[node1 (follower)]: Received "appendentries" request from node5 with term 2 -> responded.
```

NODE SETUP

```
andrea@pi: ~/Desk... Discord | #risorse | D... Downloads components andrea@pi: ~/Desk...
andrea@pi: ~/Desktop/Raft_JS_APP
File Edit Tabs Help
andrea@pi:~/Desktop/Raft_JS_APP $ node src/server_node/launch.js
(22:54:08) [node1 (follower)]: Starting node...
(22:54:08) [node1 (follower)]: Protocol server listening on port 15000
(22:54:08) [node1 (follower)]: Web server listening on port 15001
(22:54:08) [node1 (follower)]: Connecting to node2
(22:54:08) [node1 (follower)]: Connecting to node3
(22:54:08) [node1 (follower)]: Node started.
(22:54:09) [node1 (follower)]: Connection established with node2.
(22:54:09) [node1 (follower)]: Connection established with node3.
(22:54:09) [node1 (follower)]: Connection accepted.
(22:54:09) [node1 (follower)]: Connection accepted.
(22:54:12) [node1 (follower)]: /-----\
(22:54:12) [node1 (follower)]: (requestvote): {"senderId":"node2","term":291,"isResponse":false,"lastLogIndex":"node2","lastLogTerm":19}
(22:54:12) [node1 (follower)]: \-----/
(22:54:12) [node1 (follower)]: New election detected. Changing to follower state...
(22:54:12) [node1 (follower)]: Received "requestvote" request from node2 -> refuse vote.
(22:54:13) [node1 (follower)]: /-----\
(22:54:13) [node1 (follower)]: (requestvote): {"senderId":"node3","term":291,"isResponse":false,"lastLogIndex":"node3","lastLogTerm":19}
(22:54:13) [node1 (follower)]: \-----/
(22:54:13) [node1 (follower)]: Received "requestvote" request from node3 -> refuse vote.
(22:54:14) [node1 (follower)]: /-----\
(22:54:14) [node1 (follower)]: (requestvote): {"senderId":"node3","term":292,"isResponse":false,"lastLogIndex":19,"lastLogTerm":280}
(22:54:14) [node1 (follower)]: \-----/
(22:54:14) [node1 (follower)]: New election detected. Changing to follower state...
(22:54:14) [node1 (follower)]: Received "requestvote" request from node3 -> cast vote.
(22:54:14) [node1 (follower)]: /-----\
(22:54:14) [node1 (follower)]: (appendentries): {"senderId":"node3","term":292,"isResponse":false,"messageNum":0,"prevLogIndex":19,"prevLogTerm":280,"entries":[],"leaderCommit":19}
(22:54:14) [node1 (follower)]: \-----/
(22:54:14) [node1 (follower)]: Received appendentries message from node3 with prevLogIndex (19) that is not in the log.
(22:54:15) [node1 (follower)]: /-----\
(22:54:15) [node1 (follower)]: (requestvote): {"senderId":"node2","term":292,"isResponse":false,"lastLogIndex":19,"lastLogTerm":280}
(22:54:15) [node1 (follower)]: \-----/
(22:54:15) [node1 (follower)]: Received "requestvote" request from node2 -> refuse vote.
(22:54:17) [node1 (follower)]: /-----\
(22:54:17) [node1 (follower)]: (appendentries): {"senderId":"node3","term":292,"isResponse":false,"messageNum":0,"prevLogIndex":18,"prevLogTerm":280,"entries":[{"term":280,"commandType":"new_auction","logData":{"username":"bertu","startDate":"2024-01-02T20:56:48.599Z","objName":"Francobollo raro","objDesc":"Datato 1955","startPrice":50,"callback":null}],"leaderCommit":19}
(22:54:17) [node1 (follower)]: \-----/
(22:54:17) [node1 (follower)]: Received appendentries message from node3 with prevLogIndex (18) that is not in the log.
(22:54:20) [node1 (follower)]: /-----\
(22:54:20) [node1 (follower)]: (appendentries): {"senderId":"node3","term":292,"isResponse":false,"messageNum":0,"prevLogIndex":17,"prevLogTerm":163,"entries":[{"term":280,"commandType":"new_bid","logData":{"username":"fabio","auctionId":1,"value":104},"callback":null}, {"term":280,"commandType":"new_auction","logData":{"username":"bertu","startDate":"2024-01-02T20:56:48.599Z","objName":"Francobollo raro","objDesc":"Datato 1955","startPrice":50,"callback":null}],"leaderCommit":19}
(22:54:20) [node1 (follower)]: \-----/
(22:54:20) [node1 (follower)]: Received appendentries message from node3 with prevLogIndex (17) that is not in the log.
(22:54:23) [node1 (follower)]: /-----\
(22:54:23) [node1 (follower)]: (appendentries): {"senderId":"node3","term":292,"isResponse":false,"messageNum":0,"prevLogIndex":16,"prevLogTerm":162,"entries":[{"term":163,"commandType":"new_bid","logData":{"username":"andrea","auctionId":1,"value":103}}, {"term":280,"commandType":"new_bid","logData":{"username":"fabio","auctionId":1,"value":104},"callback":null}, {"term":280,"commandType":"new_auction","logData":{"username":"bertu","startDate":"2024-01-02T20:56:48.599Z","objName":"Francobollo raro","objDesc":"Datato 1955","startPrice":50,"callback":null}],"leaderCommit":19}
(22:54:23) [node1 (follower)]: \-----/
(22:54:23) [node1 (follower)]: Received appendentries message from node3 with prevLogIndex (16) that is not in the log.
(22:54:27) [node1 (follower)]: /-----\
(22:54:27) [node1 (follower)]: (appendentries): {"senderId":"node3","term":292,"isResponse":false,"messageNum":0,"prevLogIndex":15,"prevLogTerm":82,"entries":[{"term":162,"commandType":"new_bid","logData":{"username":"fabio","auctionId":2,"value":104},"callback":null}, {"term":163,"commandType":"new_bid","logData":{"username":"andrea","auctionId":1,"value":103}}, {"term":280,"commandType":"new_bid","logData":{"username":"fabio","auctionId":1,"value":104},"callback":null}, {"term":280,"commandType":"new_auction","logData":{"username":"bertu","startDate":"2024-01-02T20:56:48.599Z","objName":"Francobollo raro","objDesc":"Datato 1955","startPrice":50,"callback":null}],"leaderCommit":19}
(22:54:27) [node1 (follower)]: \-----/
(22:54:27) [node1 (follower)]: Received appendentries message from node3 with prevLogIndex (15) that is not in the log.
```

ACCEDI

Screen Recorder - Scre.io

Scegli cosa condividere

Screen Recorder - Registratore schermo vuole condividere i contenuti del tuo schermo.

Schermo intero

Finestra

Scheda Chrome

Condividi

Annulla

Start Recording