Mini Project 3

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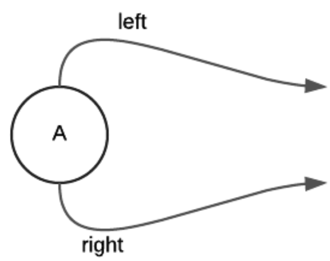
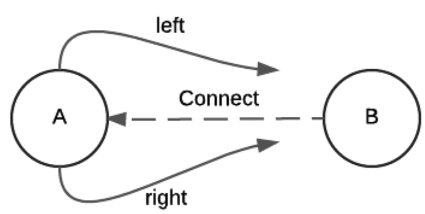
1 Question 1: Briefly explain your solution and why it works

A Node can hold the information on a right and left neighbor Node, by storing the IP and port of the specific Node.



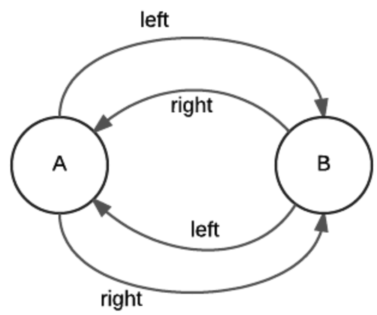
Figur 1: Single node before connection

The initial Node will have no Nodes stored for its left and right neighbor as is shown in Figure 1.



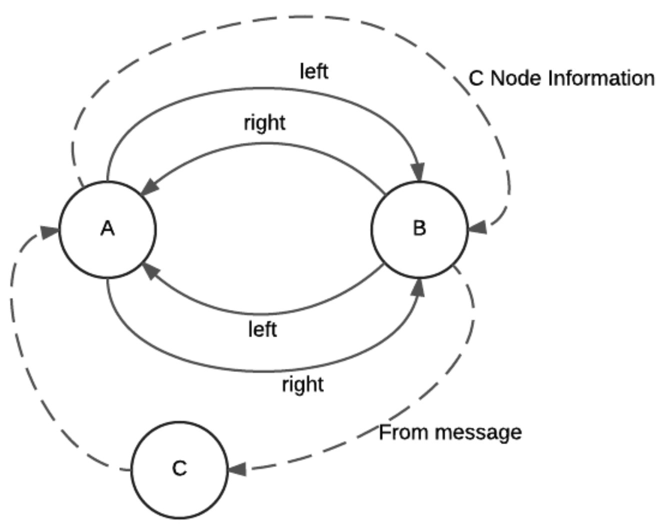
Figur 2: Incoming connection from Node B

When a new Node wants to connect it sends a From message containing information about its IP and port to the Node it wants to connect to. The existing Node (A) will check if it holds any information about a neighbor in its right or left variable Figure 2.



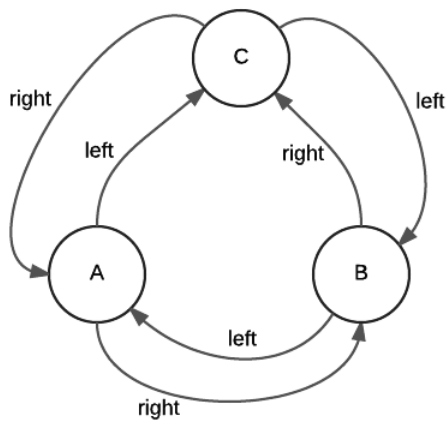
Figur 3: Nodes after connection

In Figure 2 Node A is not holding any neighbor information at all, and so it will store the information about the incoming Node (B) in both its right and left value Figure 3. The arrows shown illustrates that the Node pointing to another Node holds that Node's IP and port info in its left and/or right value. To store this information a connection is established between the Nodes, but it is closed immediately after, and so no permanent connection is held open. E.g. in Figure 3 both Node A and B store each others IP and port in both their right and left value. The Nodes will echo the Nodes according to their left and right values to see if they are alive.



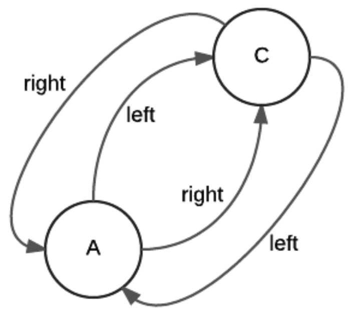
Figur 4: Incoming Node connection from Node C

When another Node (C) wants to connect to one of the existing Nodes (A), the requested Node (A) will send the IP and port info to the Node according to its left value (B) assuming that it exists. When the Node (B) receives the IP and port it will change its right value to this (C), and send a From message to the Node (C) Figure 4.



Figur 5: Nodes after connection

Now the initially requested Node (A) will change its left value to match the incoming Node (C) and lastly the incoming Node (C) will set its right value to match the requested Node (A) and its left value to the incoming Node (B) Figure 5.



Figur 6: Nodes after 3rd Node disconnect

If one of the Nodes (B) disconnects, the Node which is connected to this node through its right value (A) will send a message to its neighbor Node (C) on the left value asking if this Node's left value is the same as the requesting Node's (A) right value. If this is not the case the message will go to the next Node and the next and so on until finding a match. Then the matching Node (C) will get the info of the requesting Node (A) and connect its left value to it. The requesting Node (A) will then store this Node's (C) info in its right value, and the circle is complete again. If a Node holds any resources one of its neighbors will always have a reference to these resources. When the Node is disconnected, the neighbor Node will inherit these resources, and pass on a reference for these resources to one of its neighbors.

The solution works under the assumption that whenever a Node is disconnected from the system, the neighbors to this Node will have sufficient time to reconnect themselves and send new resource references to their neighbors. If this condition is upheld the system will work, because the resources will always be stored in 2 places unless only a single Node exists, which will then hold all the resources.

2 Space Consumption

If this assumption is upheld, the system will be able to handle N Nodes and disconnection of N-1 Nodes, because the remaining Nodes will always reconstruct their connections and create new references whenever

3 Number and Size of Messages

3.1 PUT message from a client

When a message is being PUT it is always stored at the Node to which it is send. Therefore both the best and worst case of a PUT message is 1 and thus the average-case number of messages is also 1.
A PUT message holds 3 fields two of which is constant (int for a key, and boolean for the version) and a String which can vary in size. And as such the size of all PUT messages is linear in the length of the message String, inputted by the user.

3.2 Successful GET message

The best case for the number of messages from a successful GET message is 2, first the request for a resource and then the message with the resource. The worst-case number of messages is $(N-1)+2 = N+1$ where N is the number of Nodes and +2 for the initial GET message and the returned resource. The average-case number of messages is dependent on the number of Nodes in the network in the way that when the number of Nodes increases the potential of not finding the resource at the first Node becomes lower and the number of potential messages needed to find the resource increases as well.

3.3 Unsuccessful message

If a GET message is asking for a resource with a non existing key, the GET message will go around in the system for ever. This means that in this case both the best- worst- and average-case number of messages will be infinitely high increasing until the system stops running.

4 Scalability

Handling clustering of resources

The resources in the Nodes are never redistributed to create an even allocation of the resources, which means that the system can end up with big clusters of resources in single Nodes. This could have been avoided by having some kind of capacity indicator for each Node. When a resource is PUT in a Node, it could then ask its neighbors if they had less resources than itself. If this is the case, the resource would be passed on to this Node. This would continue, until arriving at a Node with less resources than its neighbors or until the resource arrives at the initial Node. In this way the resources would be somewhat evenly distributed across the network.

Handling GET message for none existing resource

If a request comes in asking for a key which does not exist, the GET message will go around forever. This constitutes a scalability problem if one assume that the users of the system does not always ask for a key in the system. A possible scenario could be an adversary who wants to crash the system and therefor generates an arbitrarily high number of messages asking for non existing resources and eventually the number of messages going around in the system will make it crash. This could have been avoid by letting the GET message know if it had already visited a Node, for instance by saving some of the Node information in the message when the Node is requested. This would mean that the message would be dropped after asking the last Node for the resource.