# Distributed Sequencer

Rushikesh Pharate

## Overview

Distributed sequencer is an integral component of many real distributed systems. It is responsible for providing unique and monotonically increasing id's. Distributed sequencer as a system consists of multiple servers and the client can potentially call any server to get the id. The main purpose of the system is to maintain the same id on all the servers so that we can return it when called by the client.

The algorithm that I used for implementing distributed sequencer is primary based approach for total order broadcast which the professor taught in class. In this algorithm, there is one primary server that does the broadcasting, and all other servers, if contacted by the client, forward the request to the primary. PFB algorithm.

Primary-based protocol for total order broadcast:

1. The client issues a request to any of the servers.
2. After receiving the client request, the server, if not primary
    - Creates a new thread and makes an RPC call to primary
    - Maintains a connection to the client
    - Waits for an update message from the primary
3. Upon receiving the message from any server, the primary server
    - Maintains a queue for incoming requests using lock
    - Acquires lock to make updates to the id variable
    - Updates the id variable
    - Broadcasts the id variable to all the other servers
    - Releases the lock
4. After receiving the broadcast message, the server
    - Updates its id variable
    - If the requesting server, sends this updated id variable to the client.

## Steps to Run MapReduce

- **Prerequisites**
  - You have the submission folder
  - Your base directory is the Distrbuted-Sequencer folder

- **Starting the Servers:**
  - Open *config.json* file and change *NO_OF_SERVERS, PORT_START_RANGE*, or any other parameter as per your convenience.
  - Open a new terminal and run *python3 main.py* command
  - After this logs will be generated informing you about the servers and their accessibility on ports.

- **Starting the Client:**
  - *client.py* file contains a code to make a *get_id()* request.
  - There are 2 ways to run an client:
    - Run *python3 client.py [server address] [port number]* command. (ex *python3 client.py 0.0.0.0 6486*)
    - Run *bash run_clients.sh* command. This will in turn call the above command but you can change this shell file to make concurrent requests to the same or different servers.

- When a client is started, the logs will be generated in the server terminal and you can see the logic flow.

## Limitations and Future Improvement

1) Current algorithm is very centered around primary and this will create performance issues and primary is doing most of the heavy lifting. To overcome this we can ude a total-order multicast algorithm that will solve the performance issue but has its own complexity issues.
2) If one of the server fails, the whole system might crash. This can be avoided if we use some kind of fault tolerance.

## Testing:

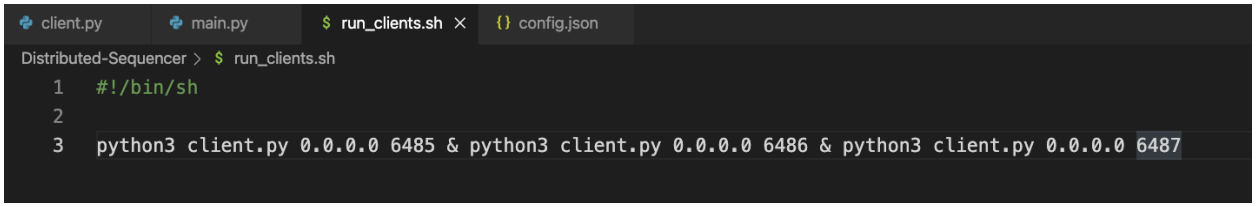
Test scenarios tested:

1) Sending single client requests to different servers

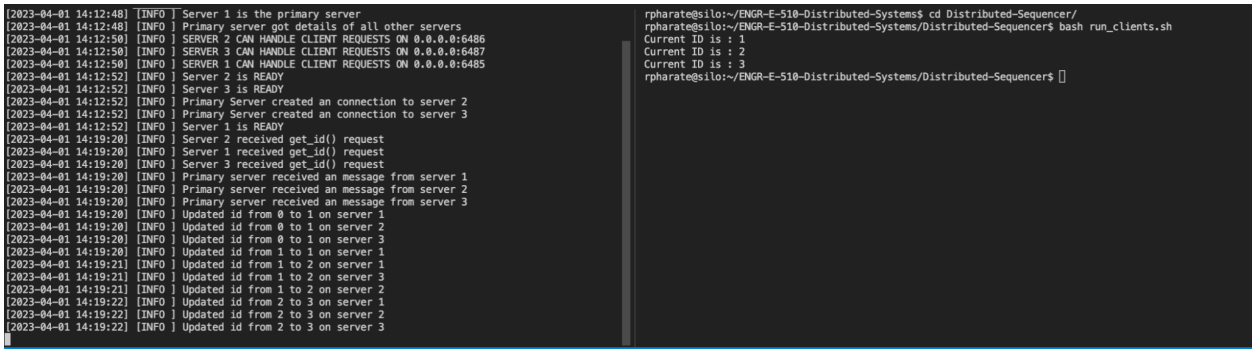
Server

[2023-04-01 14:12:46] [INFO ] Controller Node started on 0.0.0.0:3896
[2023-04-01 14:12:46] [INFO ] Starting 3 servers
[2023-04-01 14:12:48] [INFO ] Server 1 is the primary server
[2023-04-01 14:12:48] [INFO ] Primary server got details of all other servers
[2023-04-01 14:12:50] [INFO ] SERVER 2 CAN HANDLE CLIENT REQUESTS ON 0.0.0.0:6486
[2023-04-01 14:12:50] [INFO ] SERVER 3 CAN HANDLE CLIENT REQUESTS ON 0.0.0.0:6487
[2023-04-01 14:12:50] [INFO ] SERVER 1 CAN HANDLE CLIENT REQUESTS ON 0.0.0.0:6485
[2023-04-01 14:12:52] [INFO ] Server 2 is READY
[2023-04-01 14:12:52] [INFO ] Server 3 is READY
[2023-04-01 14:12:52] [INFO ] Primary Server created an connection to server 2
[2023-04-01 14:12:52] [INFO ] Primary Server created an connection to server 3
[2023-04-01 14:12:52] [INFO ] Server 1 is READY

Client:




Server logs on left window and Client response on the right window.



2) Sending multiple requests to the same server one after another

Server:
Same server as above:

Client:

client.py | main.py | $ run_clients.sh | {} config.json

Distributed-Sequencer > $ run_clients.sh

```
1  #!/bin/sh
2
3  python3 client.py 0.0.0.0 6486
4  python3 client.py 0.0.0.0 6486
5  python3 client.py 0.0.0.0 6486
6  python3 client.py 0.0.0.0 6486
7  python3 client.py 0.0.0.0 6486
8  python3 client.py 0.0.0.0 6486
```

Logs:

```
[2023-04-01 14:12:52] [INFO ] Server 1 is READY
[2023-04-01 14:19:20] [INFO ] Server 2 received get_id() request
[2023-04-01 14:19:20] [INFO ] Server 1 received get_id() request
[2023-04-01 14:19:20] [INFO ] Server 3 received get_id() request
[2023-04-01 14:19:20] [INFO ] Primary server received an message from server 1
[2023-04-01 14:19:20] [INFO ] Primary server received an message from server 2
[2023-04-01 14:19:20] [INFO ] Primary server received an message from server 3
[2023-04-01 14:19:20] [INFO ] Updated id from 0 to 1 on server 1
[2023-04-01 14:19:20] [INFO ] Updated id from 0 to 1 on server 2
[2023-04-01 14:19:20] [INFO ] Updated id from 0 to 1 on server 3
[2023-04-01 14:19:20] [INFO ] Updated id from 1 to 1 on server 1
[2023-04-01 14:19:21] [INFO ] Updated id from 1 to 2 on server 1
[2023-04-01 14:19:21] [INFO ] Updated id from 1 to 2 on server 3
[2023-04-01 14:19:21] [INFO ] Updated id from 1 to 2 on server 2
[2023-04-01 14:19:22] [INFO ] Updated id from 2 to 3 on server 1
[2023-04-01 14:19:22] [INFO ] Updated id from 2 to 3 on server 2
[2023-04-01 14:19:22] [INFO ] Updated id from 2 to 3 on server 3
[2023-04-01 14:24:19] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:19] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:19] [INFO ] Updated id from 3 to 4 on server 1
[2023-04-01 14:24:19] [INFO ] Updated id from 3 to 4 on server 3
[2023-04-01 14:24:19] [INFO ] Updated id from 3 to 4 on server 2
[2023-04-01 14:24:19] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:19] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:20] [INFO ] Updated id from 4 to 5 on server 1
[2023-04-01 14:24:20] [INFO ] Updated id from 4 to 5 on server 3
[2023-04-01 14:24:20] [INFO ] Updated id from 4 to 5 on server 2
[2023-04-01 14:24:20] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:20] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:21] [INFO ] Updated id from 5 to 6 on server 1
[2023-04-01 14:24:21] [INFO ] Updated id from 5 to 6 on server 3
[2023-04-01 14:24:21] [INFO ] Updated id from 5 to 6 on server 2
[2023-04-01 14:24:21] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:21] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:22] [INFO ] Updated id from 6 to 7 on server 1
[2023-04-01 14:24:22] [INFO ] Updated id from 6 to 7 on server 3
[2023-04-01 14:24:22] [INFO ] Updated id from 6 to 7 on server 2
[2023-04-01 14:24:22] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:22] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:23] [INFO ] Updated id from 7 to 8 on server 1
[2023-04-01 14:24:23] [INFO ] Updated id from 7 to 8 on server 3
[2023-04-01 14:24:23] [INFO ] Updated id from 7 to 8 on server 2
[2023-04-01 14:24:23] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:23] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:24] [INFO ] Updated id from 8 to 9 on server 1
[2023-04-01 14:24:24] [INFO ] Updated id from 8 to 9 on server 3
[2023-04-01 14:24:24] [INFO ] Updated id from 8 to 9 on server 2
```

```
rpharate@silo:~/ENGR-E-510-Distributed-Systems$ cd Distributed-Sequencer/
rpharate@silo:~/ENGR-E-510-Distributed-Systems/Distributed-Sequencer$ bash run_clients.sh
Current ID is : 1
Current ID is : 2
Current ID is : 3
rpharate@silo:~/ENGR-E-510-Distributed-Systems/Distributed-Sequencer$ bash run_clients.sh
Current ID is : 4
Current ID is : 5
Current ID is : 6
Current ID is : 7
Current ID is : 8
Current ID is : 9
rpharate@silo:~/ENGR-E-510-Distributed-Systems/Distributed-Sequencer$
```

3) Sending multiple requests to the same server at the same time (concurrent requests)

Server:
Same server as above

Client:

client.py | main.py | $ run_clients.sh | {} config.json

Distributed-Sequencer > $ run_clients.sh

```
#!/bin/sh

python3 client.py 0.0.0.0 6486 & python3 client.py 0.0.0.0 6486 & python3 client.py 0.0.0.0 6486 & python3 client.py 0.0.0.0 6486
```

Logs:

```
[2023-04-01 14:24:19] [INFO ] Updated id from 3 to 4 on server 2
[2023-04-01 14:24:19] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:19] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:20] [INFO ] Updated id from 4 to 5 on server 1
[2023-04-01 14:24:20] [INFO ] Updated id from 4 to 5 on server 3
[2023-04-01 14:24:20] [INFO ] Updated id from 4 to 5 on server 2
[2023-04-01 14:24:20] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:20] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:21] [INFO ] Updated id from 5 to 6 on server 1
[2023-04-01 14:24:21] [INFO ] Updated id from 5 to 6 on server 3
[2023-04-01 14:24:21] [INFO ] Updated id from 5 to 6 on server 2
[2023-04-01 14:24:21] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:21] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:22] [INFO ] Updated id from 6 to 7 on server 1
[2023-04-01 14:24:22] [INFO ] Updated id from 6 to 7 on server 3
[2023-04-01 14:24:22] [INFO ] Updated id from 6 to 7 on server 2
[2023-04-01 14:24:22] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:22] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:23] [INFO ] Updated id from 7 to 8 on server 1
[2023-04-01 14:24:23] [INFO ] Updated id from 7 to 8 on server 3
[2023-04-01 14:24:23] [INFO ] Updated id from 7 to 8 on server 2
[2023-04-01 14:24:23] [INFO ] Server 2 received get_id() request
[2023-04-01 14:24:23] [INFO ] Primary server received an message from server 2
[2023-04-01 14:24:24] [INFO ] Updated id from 8 to 9 on server 1
[2023-04-01 14:24:24] [INFO ] Updated id from 8 to 9 on server 3
[2023-04-01 14:24:24] [INFO ] Updated id from 8 to 9 on server 2
[2023-04-01 14:28:12] [INFO ] Server 2 received get_id() request
[2023-04-01 14:28:12] [INFO ] Primary server received an message from server 2
[2023-04-01 14:28:12] [INFO ] Server 2 received get_id() request
[2023-04-01 14:28:12] [INFO ] Server 2 received get_id() request
[2023-04-01 14:28:12] [INFO ] Updated id from 9 to 10 on server 1
[2023-04-01 14:28:12] [INFO ] Server 2 received get_id() request
[2023-04-01 14:28:12] [INFO ] Updated id from 9 to 10 on server 3
[2023-04-01 14:28:12] [INFO ] Primary server received an message from server 2
[2023-04-01 14:28:12] [INFO ] Primary server received an message from server 2
[2023-04-01 14:28:12] [INFO ] Primary server received an message from server 2
[2023-04-01 14:28:12] [INFO ] Updated id from 9 to 10 on server 2
[2023-04-01 14:28:13] [INFO ] Updated id from 10 to 11 on server 1
[2023-04-01 14:28:13] [INFO ] Updated id from 10 to 11 on server 3
[2023-04-01 14:28:13] [INFO ] Updated id from 10 to 11 on server 2
[2023-04-01 14:28:14] [INFO ] Updated id from 11 to 12 on server 1
[2023-04-01 14:28:14] [INFO ] Updated id from 11 to 12 on server 3
[2023-04-01 14:28:14] [INFO ] Updated id from 11 to 12 on server 2
[2023-04-01 14:28:15] [INFO ] Updated id from 12 to 13 on server 1
[2023-04-01 14:28:15] [INFO ] Updated id from 12 to 13 on server 3
[2023-04-01 14:28:15] [INFO ] Updated id from 12 to 13 on server 2
```

```
rpharate@silo:~/ENGR-E-510-Distributed-Systems$ cd Distributed-Sequencer/
rpharate@silo:~/ENGR-E-510-Distributed-Systems/Distributed-Sequencer$ bash run_clients.sh
Current ID is : 1
Current ID is : 2
Current ID is : 3
rpharate@silo:~/ENGR-E-510-Distributed-Systems/Distributed-Sequencer$ bash run_clients.sh
Current ID is : 4
Current ID is : 5
Current ID is : 6
Current ID is : 7
Current ID is : 8
Current ID is : 9
rpharate@silo:~/ENGR-E-510-Distributed-Systems/Distributed-Sequencer$ bash run_clients.sh
Current ID is : 10
rpharate@silo:~/ENGR-E-510-Distributed-Systems/Distributed-Sequencer$ Current ID is : 11
Current ID is : 12
Current ID is : 13
```