

## CMSC 621

### Project 2: Clocks, Multicast, and COMMIT: Assignment 1

#### Berkeley Algorithm with logical clocks

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- **Requirements specifications**

The goal of 'n' node distributed system is to synchronize clock of each node with the help of a time daemon. A node will work as the time daemon which will connect with all the other nodes and synchronize the time with Berkeley algorithm.

- **Program Design**

The project consists of two files.

- 1) *server.cpp*
- 2) *client.cpp*.

Server will accept the connection from number of clients and perform the synchronization task with Berkeley algorithm and client will send the data requested by server. The server's code will be executed once but number of clients will be spawned to achieve distributed environment. Server will wait for all clients to connect and then only it will start the Berkeley algorithm.

- **Code Overview**

The connection between clients and the server is achieved with the help of *UNIX-based TCP sockets*. Following socket programming functions are used for communication purposes.

*socket()*: To create a communication endpoint and will return a file descriptor.

*accept()*: To accept new connections.

*bind()*: To assign the address to the socket.

*listen()*: To make server to listen (look for) connection requests.

*connect()*: Used by client to connect to a server.

To handle multiple clients, *POSIX threads* are used. Each client is handled by a thread. Following commands are used for threads.

*pthread\_t* : Declaration of thread.

*pthread\_create* : Creation of thread function.

*pthread\_join* : Command to wait for a thread to finish.

#### Flow of the code

- 1) Once the connection is established between time daemon and all the nodes, it will start the implementation of Berkeley algorithm.
- 2) Time daemon will send its local time to all the connected nodes.
- 3) Each client will compare its local timestamp and return the difference to the time daemon.

- 4) Time daemon will calculate the average of differences and adjust its own clock.
- 5) Time daemon will send the value to be adjusted on client's side.

- **Compiling instructions**

1. Run the make file.
2. Server will start first. Run './server' to start server.
3. Run `python3 spawn.py` in terminal with same directory as code folder, it will spawn clients.

(Note: If you get 'Binding Failed' error please change the port number in both files.)

- **Tradeoffs and possible improvements**

The time daemon can handle 'n' number of clients but in order to achieve this one need to update the definition of 'number\_of\_clients' from the header file to that particular number.

`#define number_of_clients 5`

Same change is required in 'spawn.py' file. The range of the for loop in the file needs to be adjusted according to number of clients.

- **Thoroughness of evaluation**

Code has been tested with different number of clients, screenshot as below:

Execution with 3 clients:

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File Edit View Search Terminal Help
anurag@anurag-VirtualBox:~$ make
make: *** No targets specified and no makefile found. Stop.
anurag@anurag-VirtualBox:~$ cd A05
anurag@anurag-VirtualBox:~/A05$ cd P2
anurag@anurag-VirtualBox:~/A05/P2$ make
g++ -c -lpthread server.cpp
g++ server.o -o server -lpthread
anurag@anurag-VirtualBox:~/A05/P2$ ./server
Daemon's local time: 14
Socket created with FD: 3
Client connected 4 Thread ID 140184245118720
Client connected 5 Thread ID 140184236726016
Time 14 sent to client with file descriptor: 5
Client connected 6 Thread ID 140184228333312
Time 14 sent to client with file descriptor: 6
Time 14 sent to client with file descriptor: 4
Time difference Time difference -6 received from client with descriptor:4
-4 received from client with descriptor:5
Time difference -4 received from client with descriptor:6

Daemon's adjusted clock after synchronization: 11
Clients informed.....!!
^Z
[1]+  Stopped                  ./server
anurag@anurag-VirtualBox:~/A05/P2$

File Edit View Search Terminal Help
anurag@anurag-VirtualBox:~/A05/P2$ python3 spawn.py
spawning client 1

Local time: 20
spawning client 2

Local time: 18
spawning client 3

Local time: 18
Time received from daemon: 14
Time received from daemon: 14
Time received from daemon: 14
Difference received from daemon: -7
Synchronized time: 11
Difference received from daemon: -9
Synchronized time: 11
Difference received from daemon: -7
Synchronized time: 11
anurag@anurag-VirtualBox:~/A05/P2$

Local time: 11
spawning client 4

Local time: 11
spawning client 5

```

## Execution with 5 clients:

<pre> anurag@anurag-VirtualBox: ~/AOS/P2\$ ./server Daemon's local time: 14 Socket created with FD: 3 Client connected 4 Thread ID 140157569328896 Client connected 5 Thread ID 140157560936192 Client connected 6 Thread ID 140157552543488 Client connected 7 Thread ID 140157544150784 Time 14 sent to client with file descriptor: 4 Client connected 8 Thread ID 140157535758080 Time 14 sent to client with file descriptor: 8 Time difference 5 received from client with descriptor: 4 Time 14 sent to client with file descriptor: 5 Time 14 sent to client with file descriptor: 6 Time difference 3 received from client with descriptor: 8 Time 14 sent to client with file descriptor: 7 Time difference 5 received from client with descriptor: 5 Time difference 3 received from client with descriptor: 6 Time difference 3 received from client with descriptor: 7  Daemon's adjusted clock after synchronization: 17 Clients informed.....!! ^Z [1]+  Stopped                  ./server anurag@anurag-VirtualBox: ~/AOS/P2\$ █ </pre>	<pre> anurag@anurag-VirtualBox: ~/AOS/P2\$ python3 spawn.py spawning client 1  Local time: 9 spawning client 2  Local time: 9 spawning client 3  Local time: 11 spawning client 4  Local time: 11 spawning client 5  Local time: 11 Time received from daemon: 14 Time received from daemon: 14 Time received from daemon: 14 Time received from daemon: 14 Time received from daemon: 14 Difference received from daemon: 8 Difference received from daemon: 8 Synchronized time: 17 Synchronized time: 17 Difference received from daemon: 6 Synchronized time: 17 Difference received from daemon: 6 Synchronized time: 17 Difference received from daemon: 6 Synchronized time: 17 Synchronized time: 17 anurag@anurag-VirtualBox: ~/AOS/P2\$ █ </pre>
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## Execution with 10 clients:

<pre> anurag@anurag-VirtualBox: ~/AOS/P2\$ ./server Daemon's local time: 8 Socket created with FD: 3 Client connected 4 Thread ID 140556204103424 Client connected 5 Thread ID 140556195710720 Client connected 6 Thread ID 140556187318016 Client connected 7 Thread ID 140556178925312 Client connected 8 Thread ID 140556170532608 Client connected 9 Thread ID 140556162139904 Client connected 10 Thread ID 140556153747200 Client connected 11 Thread ID 140556145354496 Client connected 12 Thread ID 140556136961792 Time 8 sent to client with file descriptor: 6 Client connected 13 Thread ID 140556128569088 Time 8 sent to client with file descriptor: 13 Time difference -13 received from client with descriptor: 13 Time 8 sent to client with file descriptor: 7 Time 8 sent to client with file descriptor: 9 Time 8 sent to client with file descriptor: 10 Time 8 sent to client with file descriptor: 5 Time 8 sent to client with file descriptor: 11 Time 8 sent to client with file descriptor: 4 8 sent to client with file descriptor: 8 Time difference -14 received from client with descriptor: 6 Time 8 sent to client with file descriptor: 12 Time difference 8 received from client with descriptor: 4 Time difference -4 received from client with descriptor: 11 Time difference -4 received from client with descriptor: 12 Time difference -14 received from client with descriptor: 9 Time difference -14 received from client with descriptor: 7 Time difference -4 received from client with descriptor: 10 Time difference 8 received from client with descriptor: 5 Time difference -14 received from client with descriptor: 8  Daemon's adjusted clock after synchronization: 3 Clients informed.....!! ^Z[1] Killed                  ./server  [2]+  Stopped                  ./server anurag@anurag-VirtualBox: ~/AOS/P2\$ █ </pre>	<pre> anurag@anurag-VirtualBox: ~/AOS/P2\$ File Edit View Search Terminal Help  Local time: 21 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Time received from daemon: 8 Difference received from daemon: 3 Synchronized time: 3 Difference received from daemon: -19 Synchronized time: 3 Difference received from daemon: 3 Synchronized time: 3 Difference received from daemon: -19 Synchronized time: 3 Difference received from daemon: -19 Synchronized time: 3 Difference received from daemon: -19 Synchronized time: 3 Difference received from daemon: -19 Synchronized time: 3 Difference received from daemon: -9 Synchronized time: 3 Difference received from daemon: -9 Synchronized time: 3 Difference received from daemon: -9 Synchronized time: 3 Difference received from daemon: -9 Synchronized time: 3 Difference received from daemon: -18 Synchronized time: 3 anurag@anurag-VirtualBox: ~/AOS/P2\$ █ </pre>
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