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Code:

Client.py

```
# Python3 program imitating a client process

from timeit import default_timer as timer

from dateutil import parser

import threading

import  datetime

import socket

import time


# client thread function used to send time at client side

def startSendingTime(slave_client):


    while True:

        # provide server with clock time at the client

        slave_client.send(str(

                    datetime.datetime.now()).encode())


        print("Recent time sent successfully",

                                end = "\n\n")

        time.sleep(5)
```

```
# client thread function used to receive synchronized time
def startReceivingTime(slave_client):

    while True:
        # receive data from the server
        Synchronized_time = parser.parse(
                        slave_client.recv(1024).decode())

        print("Synchronized time at the client is: " + \
                                    str(Synchronized_time),
                                    end = "\n\n")

# function used to Synchronize client process time
def initiateSlaveClient(port = 8080):

    slave_client = socket.socket()

    # connect to the clock server on local computer
    slave_client.connect(('127.0.0.1', port))

    # start sending time to server
    print("Starting to receive time from server\n")
    send_time_thread = threading.Thread(
                    target = startSendingTime,
                    args = (slave_client, ))
    send_time_thread.start()


    # start receiving synchronized from server
    print("Starting to receiving " + \
                        "synchronized time from server\n")
    receive_time_thread = threading.Thread(
                    target = startReceivingTime,
                    args = (slave_client, ))
    receive_time_thread.start()


# Driver function
if __name___== '__main__':


    # initialize the Slave / Client
    initiateSlaveClient(port = 8080)
```

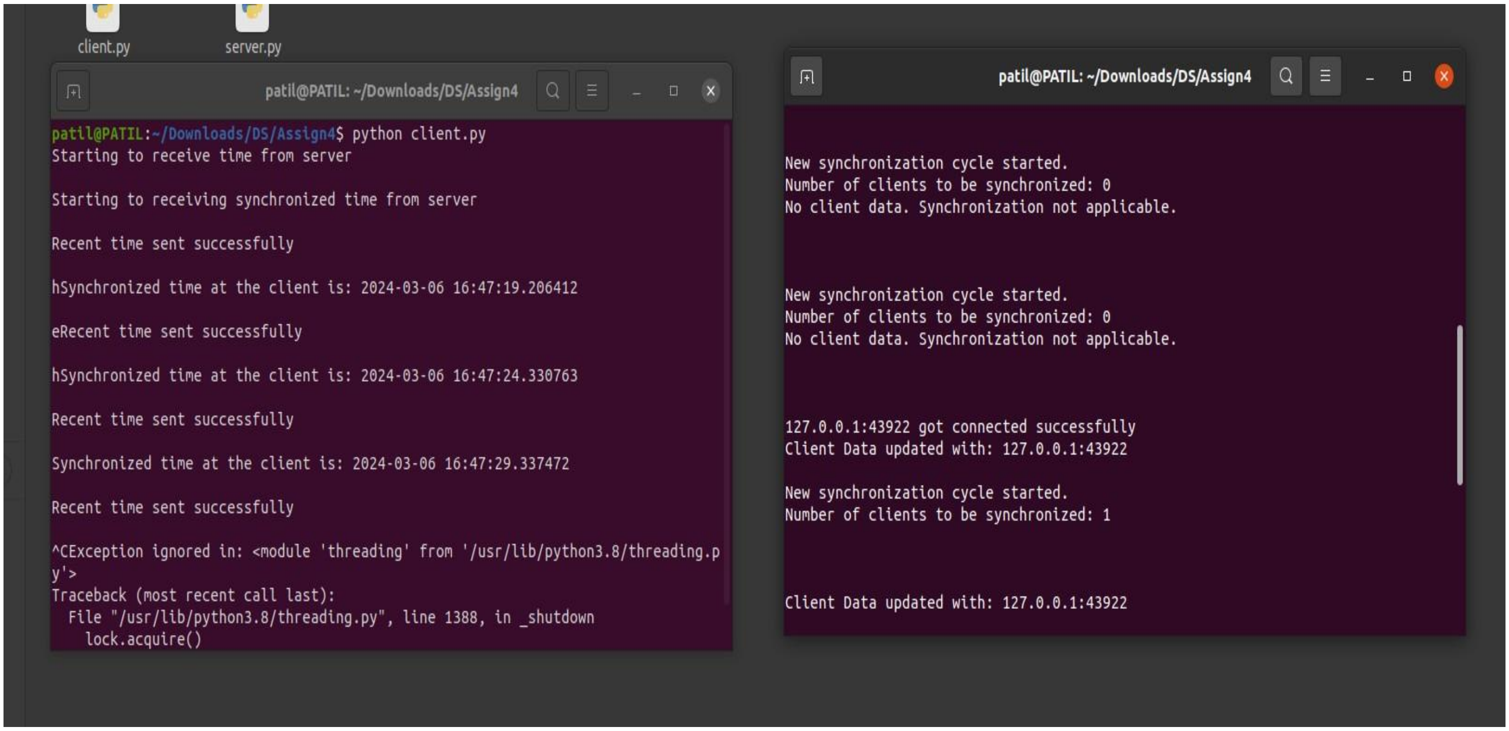
server.py

```
# Python3 program imitating a clock server
from dateutil import parser
import threading
import datetime
import socket
import time
```

```
# datastructure used to store client address and clock data
client_data = {}


''' nested thread function used to receive
    clock time from a connected client '''
def startReceivingClockTime(connector, address):


    while True:
        # receive clock time
        clock_time_string = connector.recv(1024).decode()
        clock_time = parser.parse(clock_time_string)
        clock_time_diff = datetime.datetime.now() - \
                                               clock_time


        client_data[address] = {
                    "clock_time"     : clock_time,
                    "time_difference" : clock_time_diff,
                    "connector"  : connector
                    }


        print("Client Data updated with: "+ str(address),
                                           end = "\n\n")
        time.sleep(5)


''' master thread function used to open portal for
```

```
    accepting clients over given port '''
def startConnecting(master_server):


    # fetch clock time at slaves / clients
    while True:
        # accepting a client / slave clock client
        master_slave_connector, addr = master_server.accept()
        slave_address = str(addr[0]) + ":" + str(addr[1])


        print(slave_address + " got connected successfully")


        current_thread = threading.Thread(
                        target = startReceivingClockTime,
                         args = (master_slave_connector,
                                       slave_address, ))
        current_thread.start()


# subroutine function used to fetch average clock difference
def getAverageClockDiff():


    time_difference_list = list(client['time_difference']
                               for client_addr, client
                                   in client_data.items())
    sum_of_clock_difference = sum(time_difference_list, \
                                  datetime.timedelta(0, 0))

    average_clock_difference = sum_of_clock_difference \
                                     / len(client_data)

    return average_clock_difference

''' master sync thread function used to generate
    cycles of clock synchronization in the network '''
def synchronizeAllClocks():

    while True:

        print("New synchronization cycle started.")
        print("Number of clients to be synchronized: " + \
                              str(len(client_data)))

        if len(client_data) > 0:

            average_clock_difference = getAverageClockDiff()

            for client_addr, client in client_data.items():
                try:
                    synchronized_time = \
                        datetime.datetime.now() + \
                                    average_clock_difference

                    client['connector'].send(str(
                            synchronized_time).encode())

                except Exception as e:
                    print("Something went wrong while " + \
                        "sending synchronized time " + \
                        "through " + str(client_addr))

        else :
            print("No client data." + \
                        " Synchronization not applicable.")

        print("\n\n")

        time.sleep(5)

# function used to initiate the Clock Server / Master Node
def initiateClockServer(port = 8080):

    master_server = socket.socket()
    master_server.setsockopt(socket.SOL_SOCKET,
                                socket.SO_REUSEADDR, 1)
    print("Socket at master node created successfully\n")
    master_server.bind(('', port))
    # Start listening to requests
    master_server.listen(10)
    print("Clock server started...\n")
    # start making connections
    print("Starting to make connections...\n")
    master_thread = threading.Thread(
                    target = startConnecting,
                    args = (master_server, ))
    master_thread.start()
    # start synchronization
    print("Starting synchronization parallelly...\n")
    sync_thread = threading.Thread(
                    target = synchronizeAllClocks,
                    args = ())
    sync_thread.start()
# Driver function
if __name___== '__main__':

    # Trigger the Clock Server
    initiateClockServer(port = 8080)
```

Output:


client.py
server.py
patil@PATIL: ~/Downloads/DS/Assign4
patil@PATIL: ~/Downloads/DS/Assign4

```
patil@PATIL:~/Downloads/DS/Assign4$ python client.py
Starting to receive time from server

Starting to receiving synchronized time from server

Recent time sent successfully

hSynchronized time at the client is: 2024-03-06 16:47:19.206412

eRecent time sent successfully

hSynchronized time at the client is: 2024-03-06 16:47:24.330763

Recent time sent successfully

Synchronized time at the client is: 2024-03-06 16:47:29.337472

Recent time sent successfully

^CException ignored in: <module 'threading' from '/usr/lib/python3.8/threading.p
y'>
Traceback (most recent call last):
  File "/usr/lib/python3.8/threading.py", line 1388, in _shutdown
    lock.acquire()
```

```
New synchronization cycle started.
Number of clients to be synchronized: 0
No client data. Synchronization not applicable.



New synchronization cycle started.
Number of clients to be synchronized: 0
No client data. Synchronization not applicable.



127.0.0.1:43922 got connected successfully
Client Data updated with: 127.0.0.1:43922

New synchronization cycle started.
Number of clients to be synchronized: 1



Client Data updated with: 127.0.0.1:43922
```