Spring 2017 - CSEE W4119 Computer Networks
Programming Assignment 1 - Simple Chat Application

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1 Introduction

This programming assignment is to implement a *simple* chat application with at least *3* clients and a server using UDP. You are required to create one program. The program should have two modes of operation, one is the client and the other is the server. The client instances communicate directly with each other. The server instance is used for setting up the clients and for book-keeping purposes. The server is also used for storing off-line messages from clients. The functionalities and specification of each program are described in detail below. ***Please start early and read the entire assignment before you start!!***

2 Functionalities

The complete chat application can be broadly classified into four functions outlined below. Each function involves either the client part or the server part or a combination of the two. The four different functions and their respective parts in both the server and the client are explained in the following sections. Note that although the program is divided into separate functionalities, it is ok to test several processes (instances of client and server) on the same machine (same IP, different ports) by SSHing into the same machine a few times.

2.1 Registration

For this function, the server has to take in a registration or a subscription request from a client. The server needs to be started before the client. The server maintains a table with the IP addresses, port numbers, and nick-names of all the clients. This functionality involves both client and server modes.

Client mode:

- The client has to communicate with the server using the IP address and the port number of the server. [assume all clients by default know the server information]

  `$ UdpChat <mode> <command-line arguments>` : Start the program for server or client, (for example : UdpChat -c for client and UdpChat -s for server). The server mode takes one argument, its listening port. The client mode should take four arguments: the client's nick-name, the server ip address, the server's listening port number, and this client's port number for listening.

  `$ UdpChat -s <port>` : Initiate the server process

  `$ UdpChat -c <nick-name> <server-ip> <server-port> <client-port>` : Initiate the client's communication to the server. The nick-name is like the username for this chat client. The server IP address is given in dotted-decimal format. The port number is an integer value in the range `1024-65535`. For example, if the server IP is `198.123.75.45`, the server port is `1024`, the client's port number for listening is `2000` , then the command string is going to be:
  `$ UdpChat -c client-name 198.123.75.45 1024 2000`. If arguments are taken in a proper format, a prompt like `'>>>'` should be displayed. Otherwise, appropriate error messages should be displayed.

- Successful registration of the client on the server should also display the status message to the client:
  `$>>> [Welcome, You are registered.]`

- Every client should also maintain a local table with information about all the other clients (nick-name, ip, port number, online-status). Every client should update (overwrite) its local table when the server sends information about all the other clients (further detail on this in upcoming section).
- When the table has been successfully updated, the client should display the message :
  `$ >>> [Client table updated.]`
- To exit or close a client use: `$ >>> ctrl + c`
  Assume a client does not return once exited.

Server mode:

- The server process should maintain a table to hold the nick-names, IP addresses, and port numbers of all the clients.
- When a client sends a registration request, it should add the client information (name, IP address, port number, online-status) to the table.
- The server should *broadcast* the complete table of active clients to all the online clients so that they may update their local information. This should happen whenever the server updates its table.

2.2 Chatting

Once the clients are set up and registered with the server, the next step is to implement the actual chat functionality. The clients should communicate to each other *directly* and must not use the server for forwarding chat messages. Since it does not involve the server, there is just the client part for the chatting functionality.

Client:

- A client should communicate to another client with the information from its local-table.

  The client should support the following command for sending messages
  `$ >>> send <name> <message>.` : This command should make the client look up the IP address and port number of the recipient client from its local table and send the message to the appropriate client. (message length should be variable)
- The client which sent the message has to wait for an *ack* and likewise, the client which received the message has to send an *ack* once it receives the message.
- If *ack* times out (*500 msecs*) for a message sent to a another client, it means the client at the receiving end is off-line, and so the message has to be sent to the server. The server has to save these messages and show it later to the appropriate clients when they come back online and re-register. (details in offline-chat section).

  The appropriate status messages also needs to be displayed for each scenario:
  `$ >>> [Message received by <receiver nickname>.]`
  `$ >>> [No ACK from <receiver nickname>, message sent to server.]`

2.3 De-registering

This is a book-keeping function to keep track of the active clients. This functionality involves both client and server parts.

Server:

- When the server receives a de-registration request from a client, it has to change the respective client's status to offline in the table (do not close or exit the client to make it offline).
- It then has to *broadcast* the updated table to all the active (online) clients.
- The server then has to send an *ack* to the client which requested de-registration.

Client:

- When a client is about to go offline, it has to send a de-registration request to the server to announce that it is going offline.
- The client has to wait for an *ack* from the server within *500 msecs*. If it does not receive, the client should retry for *5* times. If it fails all five times the client should display the message:
  `$>>> [Server not responding]`
  `$>>> [Exiting]`
  and exit.
- All the other active clients, when they receive the table from the server, should update their respective local tables (just overwrite the existing table).

  `$ >>> dereg <nick-name>` : This is a de-registration request to the server from the client to go offline. We don't expect clients to log back in with the same IP and port number after they have exited.
- Successful de-registration from the server should display the following status message in the client:

  `$ >>> [You are Offline. Bye.]`

2.4 Off-line Chat

The last functionality of the chat-application is to implement an off-line chat. This is similar to the feature in google-chat. When the user is off-line, the server records the chat messages the user receives from other clients and provides it later when the user comes back online . In a similar fashion, when a client quits the chat session, the server should save the off-line chat messages. This also has both client and server parts.

Client:

A client sends off-line messages in two cases:

- When the recipient or end-client is offline in its local-table of clients.
- When there is a time-out on a message sent to a client.

In both the above given cases the client has to send an automatic *save-message* request to the server. This request should also include the

- Nick-name of the intended recipient
- Message

On success, the following status message should be displayed in the client:
`$ >>> [Messages received by the server and saved]`

A logged-out client should be able to log back in using :
`$ >>> reg <nick-name>` : Instruct the server to sign-in or register the client (i.e., change the associated client's status to online in the table).

Server:

- When the server receives an offline-message, it has to save it separately for different clients. (For example, you can use files for each client and save all off-line messages for a client in its appropriate file).
- When a server receives a *save-message* request from a client it has to check for the status of the intended recipient.
- If the recipient client is still active, then send the client which sent the *save-message* request an *err* message :
  `$ >>> [Client <nick-name> exists!!]`
  and also send the table to the client for it to get updated.
- If the recipient client is not active, then the server should change the status of the appropriate client to offline, broadcast the updated table to all active clients and save the messages in the files associated.
- The messages while saved should also have their associated *time-stamp* information. (You can get this using `gettimeofday()`).
- An *ack* also needs to be sent to the client which made a save-message request.

When a logged out client returns :

- The server needs to check for any off-line messages for that client :
  - If *yes*
    - Send all the off-line messages to the client
    - Clear them in the server
    - Change the status of the client to online
    - *broadcast* the table to all the online clients.
  - If *no*
    - Change the client's status to online
    - *broadcast* the table to all the clients.
- Clearing the messages in the server makes sure that the server does not send the same off-line messages repeatedly. This status message should also be displayed in the client before the offline messages are displayed:
  `$ >>> [You have messages]`

For example:
Assume :

- There are three clients
- Client 1 goes offline
- The other two clients send messages to client 1

The off-line messages in the server for client 1 should be saved as

```
>>> client 2:  Hi!
>>> client 3:  Hello!!
```

When client 1 returns (log back in) this should be printed in client 1
Client 1 :

```
>>> You Have Messages
>>> client 2:  <timestamp> Hi!
>>> client 3:  <timestamp> Hello!!
```

3 Testing

Before submitting your work, please do **test your programs thoroughly**. Your chat application should *at least* work with

- *One* instance of the program in server mode.
- *Three* instances of the program in client mode.

To start-off with you can assume fixed sizes for the client table and extend your implementation to handle dynamic length if you have time, however full points will be awarded only if you handle dynamic lengths. You must handle business-logic errors such as a user trying to login with an already connected nick-name.

Two simple example test cases have been provided for you. You should also test your program with your own test cases.

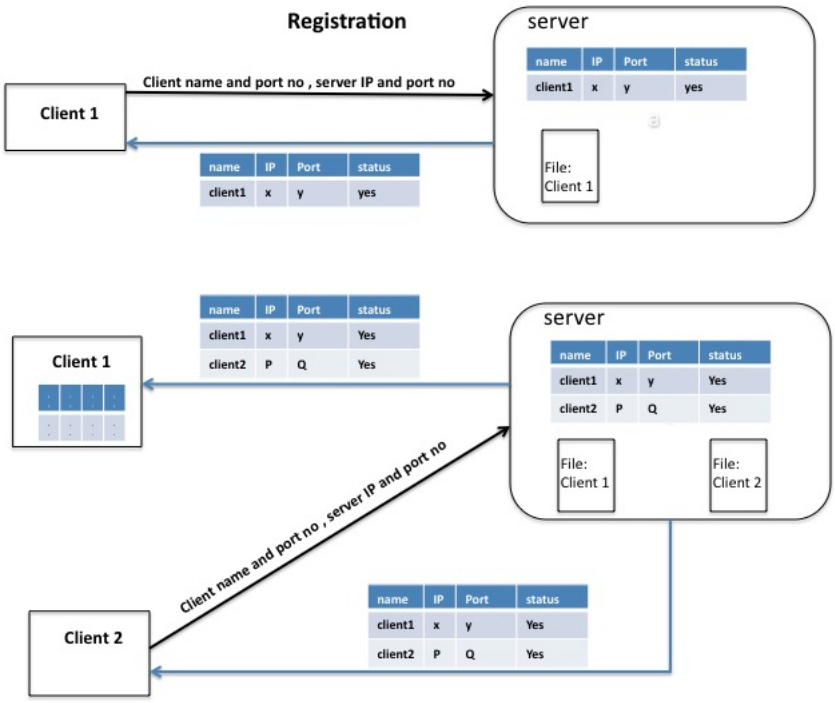
Test-case 1:

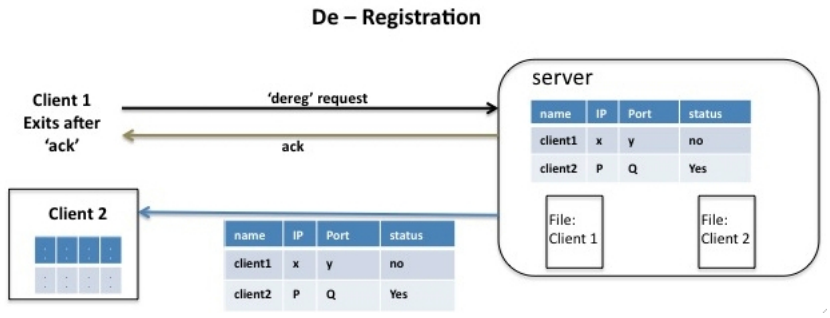
1. start server
2. start client `x`(the table should be sent from server to x)
3. start client `y`(the table should be sent from server to x and y)
4. start client `z`(the table should be sent from server to x and y and z)
5. chat `x -> y, y->z, ... , x ->z` (All combinations)
6. dereg x (the table should be sent to y, z. x should receive 'ack')
7. chat `y->x` (this should fail and message should be sent to server, and message has to be saved for x in the server)
8. chat `z->x` (same as above)
9. reg `x` (messages should be sent from server to x, x's status has to be broadcasted to all the other clients)
10. `x, y, z` : exit

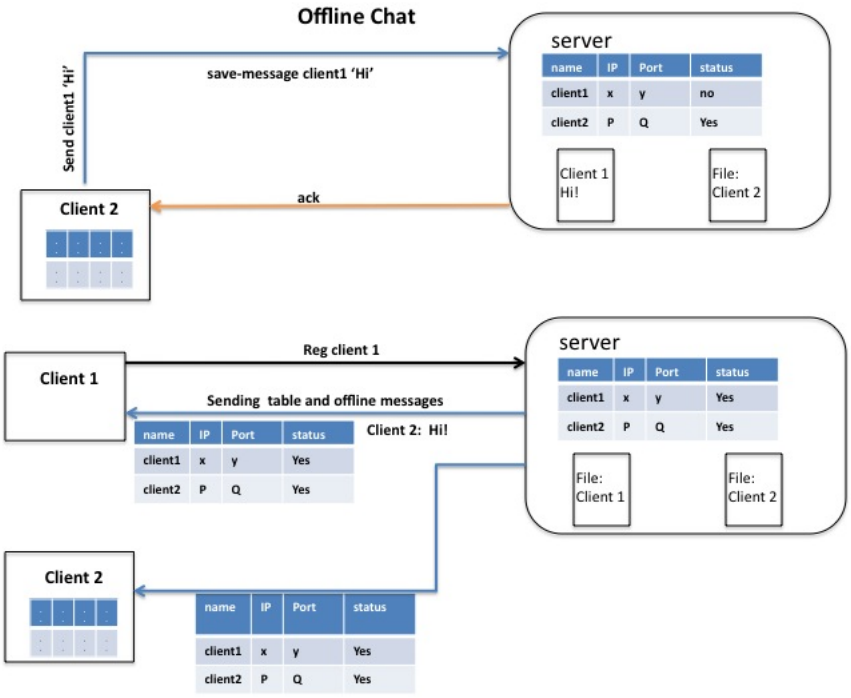
Test-case 2:

1. start server
2. start client `x` (the table should be sent from server to `x`)
3. start client `y`(the table should be sent from server to `x` and `y`)
4. dereg `y`
5. server exit
6. send message `x-> y` (will fail with both `y` and server, so should make *5* attempts and exit)

The figures below shows the registration process, de-registration process and offline messaging involving two clients. To provide some more *clarity!!!*.


Registration
server
Client 1
Client name and port no , server IP and port no
name IP Port status
client1 x y yes
File: Client 1
name IP Port status
client1 x y yes
Client 1
name IP Port status
client1 x y Yes
client2 P Q Yes
server
name IP Port status
client1 x y Yes
client2 P Q Yes
File: Client 1
File: Client 2
Client name and port no , server IP and port no
Client 2
name IP Port status
client1 x y Yes
client2 P Q Yes


De – Registration
Client 1
Exits after
'ack'
'dereg' request
ack
server
name IP Port status
client1 x y no
client2 P Q Yes
File: Client 1
File: Client 2
Client 2
name IP Port status
client1 x y no
client2 P Q Yes



4 Submission Instructions

You may use either C, Java, or Python for developing the chat application. Your submission package should include the following deliverables.

- `README`: Please put your name and UNI at the top of your README. The next thing in your README should be explicit command line instructions for compiling and running your program. The file should also contain contain basic project documentation, program features, brief explanation of algorithms or data structures used, a list of known bugs, and the description of any additional features/functions you may have implemented (fully optional).
- `Makefile`: This file is used to compile your program. If you have written the program in C, the output file name should be `UdpChat`. If you used Java, the file name should be `UdpChat.class`. If Python, have your program be called `UdpChat.py`. You do not need to supply a Makefile to compile your code if implementing in Python.
- Your source code. Please comment your code well, and use clear and sensible variable names.
- `test.txt`: This file should contain some output samples from the command line on several test cases. This will help others to understand how your programs work in each test scenario. It is optional to include this as a section of your `README` document.

Your submission should be made via Courseworks. Zip all the deliverables mentioned above, and name the zip file as `<last-name>_<your UNI>_PA1.zip` (e.g. `Zussman_gz2136_PA1.zip` for Professor Zussman). Upload your zip file to Canvas, under `Assignments -> Programming Assignment 1`.

No windows programming environments like (.net, Visual studio, VC++ etc) will be allowed. Before you begin programming, install the required packages for your choice of the languages above. Before proceeding, be sure to run `sudo apt-get update`.
If using C, use this command in the terminal to download gcc.

```
sudo apt-get install build-essential
```

If using Java, use this command to download the jdk: `sudo apt-get install default-jdk`. This will install java 1.7.0.
If using Python, the Google Cloud Ubuntu 14.04 LTS images already have Python 2.7.6 as well as Python3 (3.4.3) installed. If using Python 3.4.3, clearly state so in the README. Otherwise, it will be assumed that you are using 2.7.6.
All submissions will be compiled, run, and evaluated on Ubuntu 14.04 LTS. If you have any issues with your environment, please see the TAs early on.

In the grading of your work, we will take the following points into account.

- The documentation clearly describes your work and the test result.
- The program takes command line arguments in the ***exact same format as specified by the assignment***.
- You handle all errors (Exceptions, memory management and business-logic) and exiting the program gracefully.
- The source code is complied properly by using the `Makefile` and generate appropriate output files.
- The programs run properly, including 1) take appropriate commands and arguments, 2) handle different situations and support required functions, and 3) display correct status messages in given scenarios.

Happy Coding and Good luck!!

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