7. Homework

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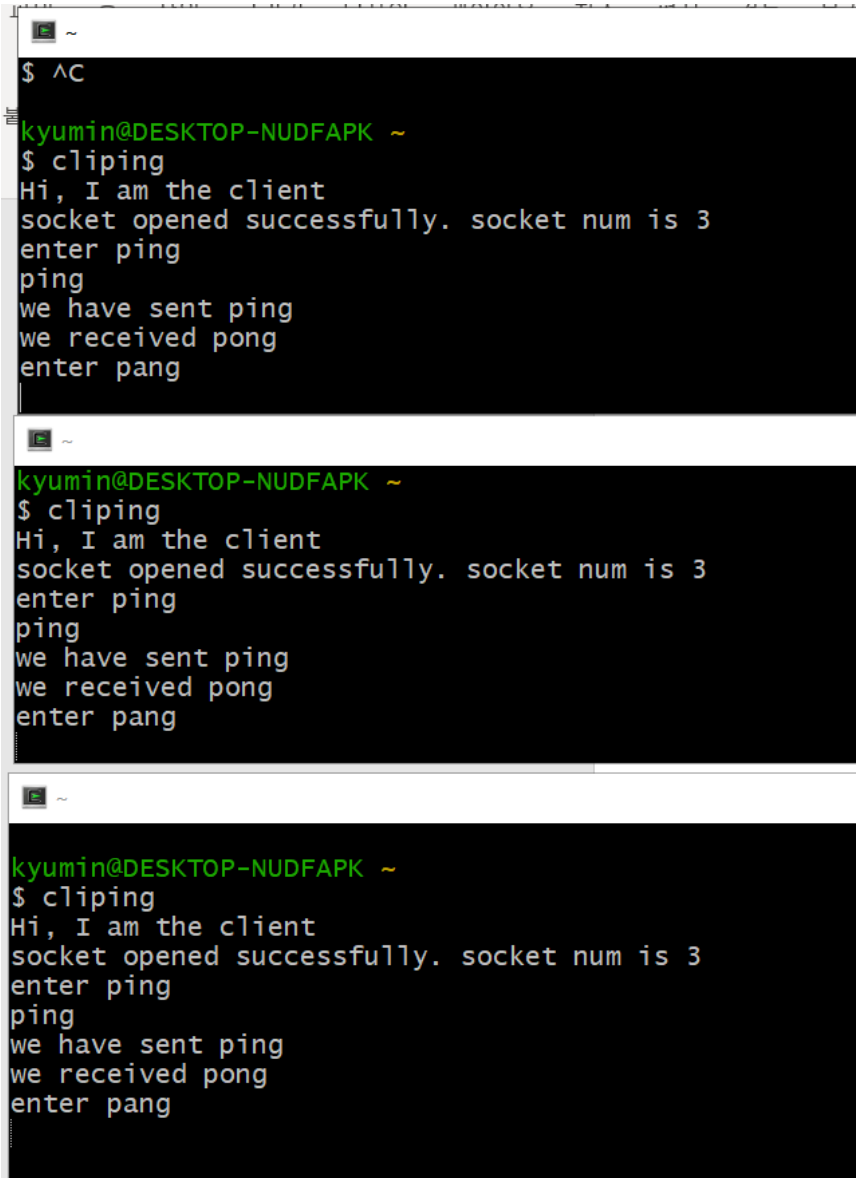
1) Download cliping.c and servping.c into your directory, modify IP and port number appropriately, and compile them. Run the server first and run client 3 times each in different window. Check if the server can handle multiple clients at the same time.

cliping1 -> servping: ping

cliping2 -> servping: ping

cliping3 -> servping: ping

.....



```
kyumin@DESKTOP-NUDFAPK ~
$ servping
Hi, I am the server
socket opened successfully. socket num is 3
binding passed
new cli at socket 4
new cli at socket 5
new cli at socket 6
we have received ping at socket 4
we have sent pong to socket 4
we have received ping at socket 5
we have sent pong to socket 5
we have received ping at socket 6
we have sent pong to socket 6
```

먼저 서버를 실행한 후 여러 클라이언트를 동시에 실행했다. 그리고 각 클라이언트마다 “ping”이라는 메시지를 보냈고, 정상적으로 송신 및 수신이 되는 것을 볼 수 있다.

2) The server in Prob 1) cannot give error message to clients even when the client doesn't follow the protocol. Run server and run client and let the client send "pang" instead of "ping" as the first message. The server gives "pung" instead of error message as below.

```
Hi, I am the client
socket opened successfully. socket num is 3
enter ping
pang
pung
enter pang
pang
```

Modify servping.c so that it can send error message when the client sends something other than "ping" for the first message. You need to remember the state of each socket to do this. The beginning state of each socket is 1 which means this socket is waiting for the first message “ping”. If a socket at state 1 receives a message other than “ping”, the server should send protocol error message. Try to solve this problem by yourself and look at the code in Problem 2-1) if you need help.

[servping.c]

```
    int state[50];

    // and loop on select
    for(;;){
       rset = pset;  // step 2
       select(maxfd, &rset, NULL, NULL, NULL); // step 3
       // now we have some packets
       for(x=0; x<maxfd; x++){ // check which socket has a packet
          if (FD_ISSET(x, &rset)){ // socket x has a packet
             // s1 is a special socket for which we have to do "accept"

             if (x == s1){ // new client has arrived
                 // create a socket for this client
                 s2 = accept(s1, (struct sockaddr *)&cli_addr, &xx);
                 printf("new cli at socket %d\n",s2);
                 FD_SET(s2, &pset); // and include this socket in pset
                 state[s2] = 1;
             }else{ // if x is not s1, it must be already connected client.
                     // handle protocol which is ping-pong-pang-pung
                 handle_protocol(x, &pset, state);
             }
          }
       }
    }
}
```

함수 state를 배열 형태로 선언했다. 새로운 클라이언트와 연결이 될 때 s2 값이 몇 번째소켓인지 표시해주는 값인데 state[s2] = 1을 하면 특정 클라이언트의 상태를 1로 표시할 수 있다.

```c
void handle_protocol(int x, fd_set * pset, int state[]){
    // we have a data packet in socket x. do protocol.
    int y; char buf[50];
    y = read(x, buf, 50);  // read data from socket x
    buf[y] = 0;            // make it a string
    printf("we have received %s at socket %d\n", buf, x);
    if (state[x] == 1 && strcmp(buf, "ping") == 0){
        state[x] = 2;
        write(x, "pong", 4);
        printf("we have sent pong to socket %d\n", x);
    }else if (state[x] == 2 && strcmp(buf, "pang") == 0){
        write(x, "pung", 4);
        printf("we have sent pung to socket %d. protocol ended. closing this socke
t\n", x);
        state[x] = 0;
        close(x);
        FD_CLR(x, pset);  // don't monitor this socket anymore
    }else{
        printf("protocol error. disconnecting socket %d\n", x);
        write(x, "protocol error", 14);
        state[x] = 0;
        close(x);
        FD_CLR(x, pset);
    }
}
```

연결되어있는 클라이언트로부터 메시지를 입력 받으면 프로토콜이 실행되는데 이 때 x 또한 몇 번째 소켓인지 표시해주는 값이다. 프로토콜이 실행되고, state값에 따라 몇 번째 입력된 메시지인지 확인할 수 있다. 이 때 state가 1이면서 ping이 입력되어야만 pong을 반환해주고, 아니라면 프로토콜 에러 메시지를 출력하며 연결을 끊는다.

```
kyumin@DESKTOP-NUDFAPK ~
$ cliping
Hi, I am the client
socket opened successfully. socket num is 3
enter ping
ping
we have sent ping
we received pong
enter pang
pang
we sent pang
we received pung. ending protocol.
```

```
kyumin@DESKTOP-NUDFAPK ~
$ cliping
Hi, I am the client
socket opened successfully. socket num is 3
enter ping
pang
we have sent ping
we received protocol error
enter pang
```

Ping 이 입력되었다면 정상 작동하지만 pang 이 입력된다면 에러 메시지가 출력된다.

2-1) Modify the server such that it disconnects the connection if the client doesn't follow the protocol. You need to keep track of the state of each client to do this. (The client will act strange when the server disconnects it. You don't have to change the client code for this since we don't care about what happens to the client when it does not follow the protocol.)

```
int state[50]; // state of each client (state of each client socket)
                // 1: the server is waiting for "ping" from this client
                // 2: the server is waiting for "pang" from this client
...........
for(x=0;x<maxfd;x++){ // check all fd
    if (FD_ISSET(x, &rset)){ // if we have packet in socket x
        if (x==s1){ // if x is the connection accepting socket, we have a new client
                    // and we must have the connection request packet(SYN) at x
            s2=accept(s1, ........); // now s2 is this client's socket
            printf("new cli at socket %d. it's sate is 1₩n", s2);
            state[s2]=1;   // init the state of this client.
                           // the server is expecting "ping" from this client
            FD_SET(s2, &pset);
        }else{ // we must have the data packet at socket x
            handle_protocol(x, &pset, state);
        } // else
    }//if
}//for
................
void handle_protocol(int x, fd_set * pset, int state[]){
// we have data packet in socket x. state[x] shows the state of socket x.
// handle the protocol.
    int y; char buf[50];
    y=read(x, buf, 50); // read the data
    buf[y]=0; // make it a string
   printf("we have received %s at socket %d₩n", buf, x);
    if (state[x]==1){ // the state of this socket is 1 meaning we are
                      // expecting "ping" from this socket
        handle_state_1(x, pset, buf, state);
    }else if (state[x]==2){ // expecting "pang"
```

```
        handle_state_2(x, pset, buf, state);
    }
}
void handle_state_1(int x, fd_set *pset, char* buf, int state[]){
// socket x is in state 1. Expecting "ping" in buf. if we have ping, send "pong" and
// just update state[x]=2; otherwise send error message and disconnect the connection
        printf("socket %d is in state 1 waiting for ping₩n", x);
        if (strcmp(buf, "ping")==0){ // yes we have "ping"
            printf("yes it is ping. send pong₩n");
            write(x, "pong", 4);   // send pong to this client
            printf("we sent pong to socket %d. now state of socket %d is 2₩n", x, x);
            state[x]=2; // now we are waiting for "pang" from this client
        }else{ // no we didn't receive "ping"
            printf("protocol error. disconnected skt %d₩n", x);
            write(x, "protocol error", 14); // send err message to the client
            close(x);     // end the connection
            FD_CLR(x, pset); // remove from the watch list.
                                // we don't monitor socket x any more
        }
}
void handle_state_2(int x, fd_set *pset, char* buf, int state[]){
// socket x is in state 2. we are expecting "pang" in buf. If we have "pang", send "pung"
// and close the connection. If we didn't receive "pang", send "protocol error" to the
// client and disconnect.
printf("socket %d is in state 2 waiting for pang₩n", x);
        if (strcmp(buf, "pang")==0){ // yes we have "pang"
            printf("yes it is pang. send pung₩n");
            write(x, "pung", 4);   // send pong to this client
            printf("we sent pung to socket %d. protocol done₩n", x);
            close(x);
            FD_CLR(x, pset);

        }else{ // no we didn't receive "pang"
            printf("protocol error. disconnected skt %d₩n", x);
            write(x, "protocol error", 14); // send err message to the client
            close(x);     // end the connection
```

```
            FD_CLR(x, pset); // remove from the watch list.
                                // we don't monitor socket x any more
        }
}
```

[servping 결과]

```
kyumin@DESKTOP-NUDFAPK ~
$ servping
Hi, I am the server
socket opened successfully. socket num is 3
binding passed
new cli at socket 4
we have received ping at socket 4
we have sent pong to socket 4
we have received pang at socket 4
we have sent pung to socket 4. protocol ended. closing this socket
new cli at socket 4
we have received pang at socket 4
protocol error. disconnecting socket 4
```

이전 문제에서 만든 코드 그대로 실행하면 된다. 클라이언트와 연결이 되고, ping 과 pang 이 순서대로 입력되면 정상적으로 진행 후 종료된다.

그러나 pang이 먼저 입력된 경우 에러가 발생한 것을 볼 수 있다.

3) Modify the protocol such that the server expects a final “ping” again from the client. Make sure the server give error message and disconnect the client if the client doesn't follow the protocol.

cli=>serv: ping

serv=>cli: pong

cli=>serv: pang

serv=>cli: pung

cli=>serv: ping (final ping)

serv=>cli: protocol completed

[servping.c]

```
void handle_protocol(int x, fd_set * pset, int state[]){
   // we have a data packet in socket x. do protocol.
   int y; char buf[50];
   y = read(x, buf, 50);  // read data from socket x
   buf[y] = 0;          // make it a string
   printf("we have received %s at socket %d\n", buf, x);
   if (state[x] == 1 && strcmp(buf, "ping") == 0){
      write(x, "pong", 4);
      printf("we have sent pong to socket %d\n", x);
      state[x]++;

   }else if (state[x] == 2 && strcmp(buf, "pang") == 0){
      write(x, "pung", 4);
      printf("we have sent pung to socket %d. protocol ended. closing this socke
t\n", x);
      state[x]++;
   }else if(state[x] == 3){
      write(x, "protocol completed", 18);
      printf("protocol completed");
      state[x] = 0;
      close(x);
      FD_CLR(x, pset);
   }else{
      printf("protocol error. disconnecting socket %d\n", x);
      write(x, "protocol error", 14);
      state[x] = 0;
      close(x);
      FD_CLR(x, pset);
   }
}
```

Ping 또는 pang 이 입력될 경우 state[x]++;을 해서 state를 바꿔준다.

상태가 3일 때 ping이 입력된다면 완료 메시지를 보내고, 통신을 끊는다.

[cliping 결과]

```
kyumin@DESKTOP-NUDFAPK ~
$ cliping
Hi, I am the client
socket opened successfully. socket num is 3
enter ping
ping
we have sent ping
we received pong
enter pang
pang
we sent pang
we received pung
enter ping
ping
we have sent ping
we received protocol completed. ending protocol.
```

[servping결과]

```
kyumin@DESKTOP-NUDFAPK ~
$ servping
Hi, I am the server
socket opened successfully. socket num is 3
binding passed
new cli at socket 4
we have received ping at socket 4
we have sent pong to socket 4
we have received pang at socket 4
we have sent pung to socket 4. protocol ended. closing this socket
we have received ping at socket 4
protocol completedwe have sent pong to socket 4
```

Ping/pang/ping 입력하니 정상적으로 종료된 것을 볼 수 있다.

4) Modify the protocol such that the server relays a message from a client to all other clients after the “ping-pong-pang-pung” sequence is completed. The clients should fork itself after the “ping-pong-pang-pung” sequence so that the parent part keeps reading while the child part keeps writing. The server does not fork since it doesn't do the chatting by itself; it just relays a message from one client to all other clients. The server checks state[] array to see which socket is ready to receive message.

cli at socket 3 => serv: ping
serv => cli at socket 3 : pong
cli at socket 3 => serv: pang
serv => cli at socket 3 : pung. Protocol completed. Start chatting.

cli at socket 4 => serv: ping
serv => cli at socket 4 : pong
cli at socket 4 => serv: pang
serv => cli at socket 4 : pung. Protocol completed. Start chatting.

cli at socket 5 => serv: ping
serv => cli at socket 5 : pong
cli at socket 5 => serv: pang
serv => cli at socket 5 : pung. Protocol completed. Start chatting.

cli at socket 3 => serv: hello
serv => cli at socket 4, 5 : hello
cli at socket 4 => serv: hi
serv => cli at socket 3, 5: hi
.....

5) Modify your code in Problem 4) such that the server attaches the client’s name and age in the message. For this purpose, the server should ask name and age for each client and store them in cli[] array which is an array of client{} structure to store name and age of each client. cli[x] will remember the client information whose socket number is x.

```
struct client{
    char name[20];   // this client's name
    char age[5];        // this client's age as a string
```

```
};
......
struct client cli[50];   // max 50 clients

 cli   aaa=> serv: ping
 serv => cli aaa: pong
 cli   aaa=> serv: pang
 serv => cli aaa: pung. name?
 cli   aaa=> serv: aaa
 serv => cli aaa: age?
 cli aaa => serv: 19

 cli   bbb=> serv: ping
 serv => cli bbb: pong
 cli   bbb=> serv: pang
 serv => cli bbb: pung. name?
 cli   bbb=> serv: bbb
 serv => cli aaa: age?
 cli aaa => serv: 22

 cli   ccc=> serv: ping
 serv => cli ccc: pong
 cli   ccc=> serv: pang
 serv => cli ccc: pung. name?
 cli   ccc=> serv: ccc
 serv => cli aaa: age?
 cli aaa => serv: 21

 serv => cli aaa: start chatting
 serv => cli bbb: start chatting
 serv => cli bbb: start chatting
 cli aaa => serv: "hello there"
 serv=> cli bbb: "aaa 19 to bbb 22: hello there"
 serv=> cli ccc: "aaa 19 to ccc 21: hello there"
 cli bbb=> serv: "hi"
 serv => cli aaa: "bbb 22 to aaa 19: hi"
```

serv => cli ccc: "bbb 22 to ccc 21: hi"

6) Modify your code in Problem 5) such that the client can now specify which client it wants to chat with. Add "partner" to client{} strucure to remember the socket number of the chatting partner. The server should ask which partner the clients wants to talk with and remember the partner's socket number in the client{} structure. Assume if cli A points to cli B as a partner, cli B also points to cli A as a partner.

```
struct client{
    char name[20];   // this client's name
    char age[5];      // this client's age as a string
    int   partner;    // the socket number of the chatting partner of this client
};
```

cli  aaa=> serv: ping
serv => cli aaa: pong
cli  aaa=> serv: pang
serv => cli aaa: name?
cli  aaa=> serv: aaa

cli  bbb=> serv: ping
serv => cli bbb: pong
cli  bbb=> serv: pang
serv => cli bbb: name?
cli  bbb=> serv: bbb

cli  ccc=> serv: ping
serv => cli ccc: pong
cli  ccc=> serv: pang
serv => cli ccc: name?
cli  ccc=> serv: ccc

cli  ddd=> serv: ping
serv => cli ddd: pong
cli  ddd=> serv: pang
serv => cli ddd: name?
cli  ddd=> serv: ddd

serv=>cli aaa: chat partner?
cli aaa=>serv: bbb
serv=>cli bbb: chat partner?
cli bbb=>serv: aaa

serv=>cli ccc: chat partner?
cli ccc=>serv: ddd
serv=>cli ddd: chat partner?
cli ddd=>serv: ccc

serv => cli aaa: start chatting
serv => cli bbb: start chatting
serv => cli ccc: start chatting
serv => cli ddd: start chatting

cli aaa => serv: hello there
serv=> cli bbb: aaa to bbb: hello there
cli bbb=> serv: hi
serv => cli aaa: bbb to aaa: hi

cli ccc => serv: hear me
serv=> cli ddd: ccc to ddd: hear me
cli ddd=> serv: hi there
serv => cli ccc: ddd to ccc: hi there

7) Implement a chatting server. The state of the client during the protocol is as follows. At any moment multiple pair of clients should be able to talk at the same time.

state 1 : The server is expecting "hello" for this client. When "hello" arrives, the server sends "name?"

state 2 : The server is expecting client ID from this client. The server rembers this client's ID in cli[x].name, where x is the socket number of this client. The server asks "ready?".

state 3 : The server is expecting "yes" from this client. The server sends all client name whose state is greater than or equal to 3.

state 4 : The server is expecting the chatting partner's ID from this client. The server remembers partner socket number in cli[x].partner. Send "go" to the client.

state 5 : The client is now in chatting session. The server is expecting some chat message from this client. The server sends this message to cli[x].partner.

All client's initial state is 1.

cli eee => serv: hello
serv => cli eee: name?
cli eee=> serv: eee
serv => cli eee: ready?
cli eee => serv : yes
serv => cli eee: client list (aaa bbb ccc .....)
cli eee=> serv : bbb
serv => cli eee: go
.....
cli bbb => serv : yes
serv => cli bbb : client list (aaa bbb ccc eee ...)
cli bbb => serv : eee
serv => cli bbb : go

cli eee => serv : hi how are you
serv => cli bbb : hi how are you
cli bbb => serv : hi there
serv => cli eee : hi there
.....

8) Modify your chatting server in Problem 7 such that the server checks whether the client's name is in "login.txt" file. If yes, proceed as before; if not, ask the client's name again. If the client fails to give registered name for 5 times, the server should disconnect this client.