



CS3516 B10

Help Session 1

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CS3516 — TCP/IP Socket Programming





Outline

- Project 1 Overview
- Unix Network Programming
 - TCP Client
 - TCP Server
- Processing commands
- How to find help and other tips.



CS4514 Project1

- Your programs should compile and work on ccc.wpi.edu computers, which are running Linux.
- Programs should be written in **C** or **C++**.
- If your program is developed on another platform or machine, you should **test** the software on **ccc** before turning in the assignment.
- Make sure you have the correct **#include** in your program.



Project 1 missions (in handout)

- **The Client:**

1. Reading a command from a script file or from console.
2. Sending the command to the server.
3. Receiving and displaying the information from the server.
4. Writing the results to the log file *LClient.log*.



Project 1 missions (in handout)

- **Server:**

1. Processing the command from the client and return the result to the client.
2. Maintaining the records to keep the location information.
3. Writing the complete database to the file *LDatabase.txt* when the server received the “quit EOF” command.



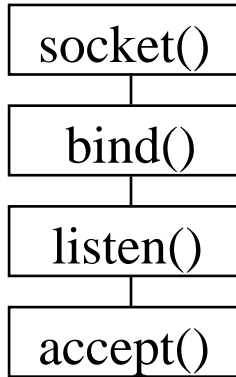
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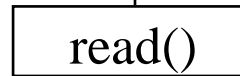


Server

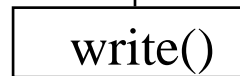
(connection-oriented protocol)



blocks until connection
from client

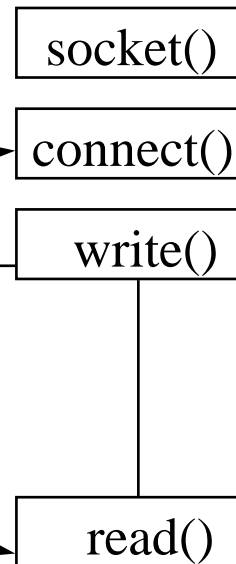


process request



Socket system calls for connection-oriented protocol (TCP)

Client



connection establishment

data (request)

data (reply)



What Do We Need?

- Data communication between two hosts on the Internet require the five components :
{protocol, local-addr, local-process, remote-addr, remote-process}
- The different system calls for sockets provides values for one or more of these components.

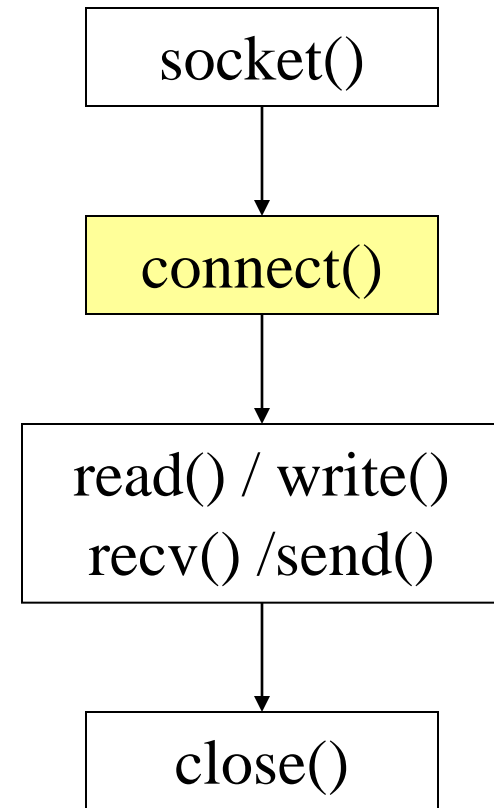
What Do We Need?

- The socket system call just fills in one element of the five-tuple we've looked at - the protocol. The remaining are filled in by the other calls as shown in the figure.

	<i>protocol</i>	<i>local_addr,</i> <i>local_process</i>	<i>remote_addr,</i> <i>remote_process</i>
Connection-oriented Server (TCP)	socket()	bind()	accept()
Connection-oriented Client (TCP)	socket()	connect()	
Connectionless Server (UDP)	socket()	bind()	recvfrom()
Connectionless Client (UDP)	socket()	<i>bind()</i>	sendto()

TCP Connection (Client)

- **Connection Oriented**
 - Specify transport address once at connection
- **Use File Operations**
 - `read() / write()`
 - or
 - `recv() / send()`
- **Reliable Protocol**



Example: TCP Client

```
int sd;  
struct hostent *hp;  
struct sockaddr_in server;
```

```
/* prepare a socket */
```

```
if ( (sd = socket( AF_INET, SOCK_STREAM, 0 )) < 0 ) {  
    perror( strerror(errno) );  
    exit(-1);  
}
```

AF_INET address family sockets can be either connection-oriented (type SOCK_STREAM) or they can be connectionless (type SOCK_DGRAM). Connection-oriented AF_INET sockets use TCP as the transport protocol. Connectionless AF_INET sockets use UDP as the transport protocol.

Example: TCP Client (Continued)

```
/* prepare server address */
```

```
bzero( (char*)&server, sizeof(server) );
```

```
server.sin_family = AF_INET;
```

```
server.sin_port = htons( SERVER_PORT );
```

```
if ( (hp = gethostbyname(SERVER_NAME)) == NULL) {
```

```
    perror( strerror(errno) );
```

```
    exit(-1);
```

```
}
```

```
bcopy( hp->h_addr, (char*)&server.sin_addr, hp->h_length);
```

Example: TCP Client (Continued)

```
/* connect to the server */
```

```
if (connect( sd, (struct sockaddr*) &server, sizeof(server) ) < 0 ) {  
    perror( strerror(errno) );  
    exit(-1);  
}
```

```
/* send/receive data */
```

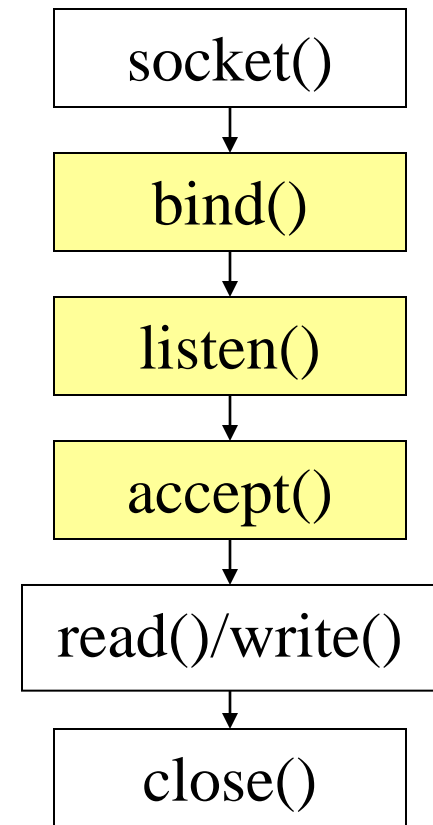
```
while (1) {  
    read/write();  
}
```

```
/* close socket */
```

```
close( sd );
```

TCP Connection (Server)

- Bind transport address to socket
- Listen to the socket
- Accept connection on a new socket





Example: TCP Server

```
int sd, nsd;
struct sockaddr_in server; /* /usr/include/netinet/in.h */

sd = socket( AF_INET, SOCK_STREAM, 0 );

bzero( (char*)&server, sizeof(server) );

server.sin_family = AF_INET;
server.sin_port = htons( YOUR_SERVER_PORT );
server.sin_addr.s_addr = htonl( INADDR_ANY );
```



Example: TCP Server (Continued)

```
bind( sd, (struct sockaddr*) &server, sizeof(server) );
```

```
listen( sd, backlog );
```

```
unsigned int cltsize=sizeof(client);
```

```
while (1) {
```

```
    nsd = accept( sd, (struct sockaddr *) &client, &cltsize );
```

```
    read()/write();
```

```
    close( nsd );
```

```
}
```

```
close( sd );
```




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Processing commands

- Each command triggers a communication conversion, between client and server. Then, we have
 - login
 - add
 - remove
 - quit
 - *list* (attn: this one is different from above commands, most complex one).



Commands

- In the *login*, *add*, *remove*, and *quit* commands:

The server only returns one message to the client.

- In the *list command*, the server could return multiple messages to the client.

“Each entry, which meets the search condition, is sent as a separate TCP message back to the Client.”



Login Command

- Login Command Format.
login name
- Login Command Handling
 - For The Client: When the Client reads a **login** command, the client establishes a TCP connection to the Server.
 - For The Server: When the Server receives a “**login name**”, it replies “**Hello, name!**” to the client.



Add Command

- Add Command Format:

add id_number first_name last_name location

Notes:

- *first_name*, *last_name*, and *location* are nonblank ASCII string. For example:
Tony Smith 12_Institute_rd_worcester
 - *id_number* is 9 digital number similar to SSN number.
(example: 321654987)
- For the Client:
reads and sends the *add* command to the server,
and displays the result returned from server.

Add Command (cont'd)

- For the Server:

When the server gets the **Add** command, it will

- add the four items as an entry into the location database in the proper location, and return a successful message to client.
- If a duplicate *id_number* is received, the server sends an error message back to the client.
- If the command's parameter is not valid, the server returns an Error message to the client.

For example,

Add 12033_000 Tony Smith worcester MA

→ returns "an invalid add command".



Remove Command

- Remove command format

remove id_number

example: “remove 123456789” is a valid command.

- For the Client,
sends the **remove** command to the server,
and displays the result returned from
server.

Remove command (cont'd)

- For the Server,

When the server receives **remove** command, the server searches the database for a match on *id_number*.

- If the *id_number* entry **exists** in the database for a person, that entry is removed from the location database and a **success** message that contains the first and last name of the person removed is sent back to the Client.
- If there is **not a match** in the database, the server does not modify the database and sends an appropriate **error** message back to the Client.



Quit Command

- Quit Command format:

quit [EOF]

For example, *quit* and *quit EOF* are valid commands.

- For the Client

- sends the quit command to the server, and when the client received the response message from the server, the client knows the connection will be closed.
- If **EOF** is specified, the client will close the log file, and terminate.



Quit Command (Cont'd)

- For the Server,
 - When server received **quit** command, it sends a response back to the Client indicating that the connection will be closed. The server returns to wait for a new connection triggered by a subsequent login request.
 - If **quit EOF** is received, the Server additionally writes out the complete database to the file *LDatabase.txt* and then terminates.

List Command

- List Command format

list start finish

Notes: start/finish are two *capital letters*

Examples:

- **list**

Find all the entries.

- **list A B**

Find the entries, whose *last_name* is greater than or equal to A but smaller than or equal to B.

- **list A A**

Find the entries whose *last_name* starts with A.

- **list B A**

Invalid Command. (Assume *Start* less than or equal to *Finish*)



List Command (cont'd)

- **For the Client:**

Sends the command to the server, and displays the response messages from the server.

- **For the Server:**

When it receives the list command:

- sends all location entries satisfying the list limits.
- sends “no such records” if there are no entries satisfying the list request.
- sends “invalid command” if the list command is in illegal format.
 - example, *list Z A*, or *list A*)



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Some Useful System Calls

- ***gethostbyname***: map hostname to IP addr
`struct hostent *gethostbyname(char *name)`
- ***getservbyname***: look up service name given
`struct servent *getservbyname(const char *servname,
const char *protocol)`
- ***gethostname***: get own hostname
`int gethostname(char *name, size_t len)`

Others Tips

- Include files

```
#include <sys/types.h>
```

```
#include <netinet/in.h>
```

```
#include <netdb.h>
```

```
#include <signal.h>
```

```
#include <fcntl.h>
```

```
#include <sys/time.h>
```

```
#include <memory.h>
```

```
#include <sys/socket.h>
```

```
#include <arpa/inet.h>
```

```
#include <unistd.h>
```

```
#include <stdio.h>
```

```
#include <errno.h>
```

```
#include <stdlib.h>
```

```
#include <string.h>
```

- Programming tips

- Always check the return value for each function call.
- Consult the UNIX on-line manual pages ("[man](#)") for a complete description.

- Internet: Beej's Guide to Network Programming

<http://www.ecst.csuchico.edu/~beej/guide/net/>



Server Database

There are many possible data structure choices for implementing the server data base. Two of them are:

- **Linked list:**

Easy to add/remove an entry.

- **Array:**

The simplest data structure.

Sorting in Database

- The server's database is sorted ascending by *last_name*.

For example, (based on a linked list)





Case insensitive string comparison

- The case insensitive string compare functions in Linux.
 - `int strcasecmp(const char *s1, const char *s2);`
 - `int strncasecmp(const char *s1, const char *s2, size_t n);`
 - Their usage is similar to `strcmp()` function.
- An Alternative method.

Storing the information in upper case letters in server's database. (Smith → SMITH)

HELP

- Bring printouts to office hours.
- Email questions to Prof.+TAs (cs3516-ta "at" cs.wpi.edu), but do NOT expect immediate results, better to attend office hours.
 - My Office Hours: Wed, 6-8pm; Fri, 1-3pm
 - Lei (Kevin) Cao's Office Hours: Sun, 6-8pm; Mon, 4-6pm
- We do have a class mailing list that could be used as a last resort.



Questions?

More Tips: file and stdio

- In Linux, a device could be treated as a file.

For example, the standard input device could be handled as a file.

```
/* fgets() will read a line from the keyboard. */  
    fp=stdin;  
    fgets(buffer, buffer_len, fp);
```

```
/* next fgets() will read a line from the file named  
   "script.txt". */  
    fp=fopen("script.txt", "r");  
    fgets(buffer, buffer_len, fp);
```

References

- *Beej's Guide to Network Programming*
- *The GNU C Library*
- *IBM iSeries Information Center*
- *The Open Group Base Specifications*
- *Wikipedia*