Linux socket Tutorial

If you are familiar with writing C programs on Linux or for Linux, jump to Step 3. Otherwise, you can learn how to install Linux in Step 1 and how to install C/C++ compiler and IDE (integrated development environment) in Step 2.

1. Install a virtual machine of Linux by following the instructions shown in:
   https://blog.xuite.net/yh96301/blog/432341564-VirtualBox+5.1%E5%AE%89%E8%A3%9DUbuntu+16.04
   Download ubuntu for 16.04 LTS
2. Compiler
   You can use terminal for programing(A) or you can download Visual Studio Code(B) for programing.

A. terminal

a. Use terminal to install gcc for compile: sudo apt install gcc

```
lighthan@lighthan-VirtualBox:~$ sudo apt install gcc
[sudo] password for lighthan:
正在讀取套件清單... 完成
正在重建相依關係
正在讀取狀態資料... 完成
下列的額外套件將被安裝：
  gcc-7 libasan4 libatomic1 libc-dev-bin libc6-dev libcilkrts5 libgcc-7-dev
  libitm1 liblsan0 libmpx2 libquadmath0 libtsan0 libubsan0 linux-libc-dev
  manpages-dev
建議套件：
  gcc-multilib make autoconf automake libtool flex bison gcc-doc
  gcc-7-multilib gcc-7-doc gcc-7-locales libgcc1-dbg libgomp1-dbg libitm1-dbg
  libatomic1-dbg libasan4-dbg liblsan0-dbg libtsan0-dbg libubsan0-dbg
  libcilkrts5-dbg libmpx2-dbg libquadmath0-dbg glibc-doc
下列【新】套件將會被安裝：
  gcc gcc-7 libasan4 libatomic1 libc-dev-bin libc6-dev libcilkrts5
  libgcc-7-dev libitm1 liblsan0 libmpx2 libquadmath0 libtsan0 libubsan0
  linux-libc-dev manpages-dev
升級 0 個，新安裝 16 個，移除 0 個，有 11 個未被升級。
需要下載 18.8 MB 的套件檔。
此操作完成之後，會多佔用 75.2 MB 的磁碟空間。
是否繼續進行 [Y/n]？ [Y/n] Y
```

b. Use vim to start programming: sudo apt install vim

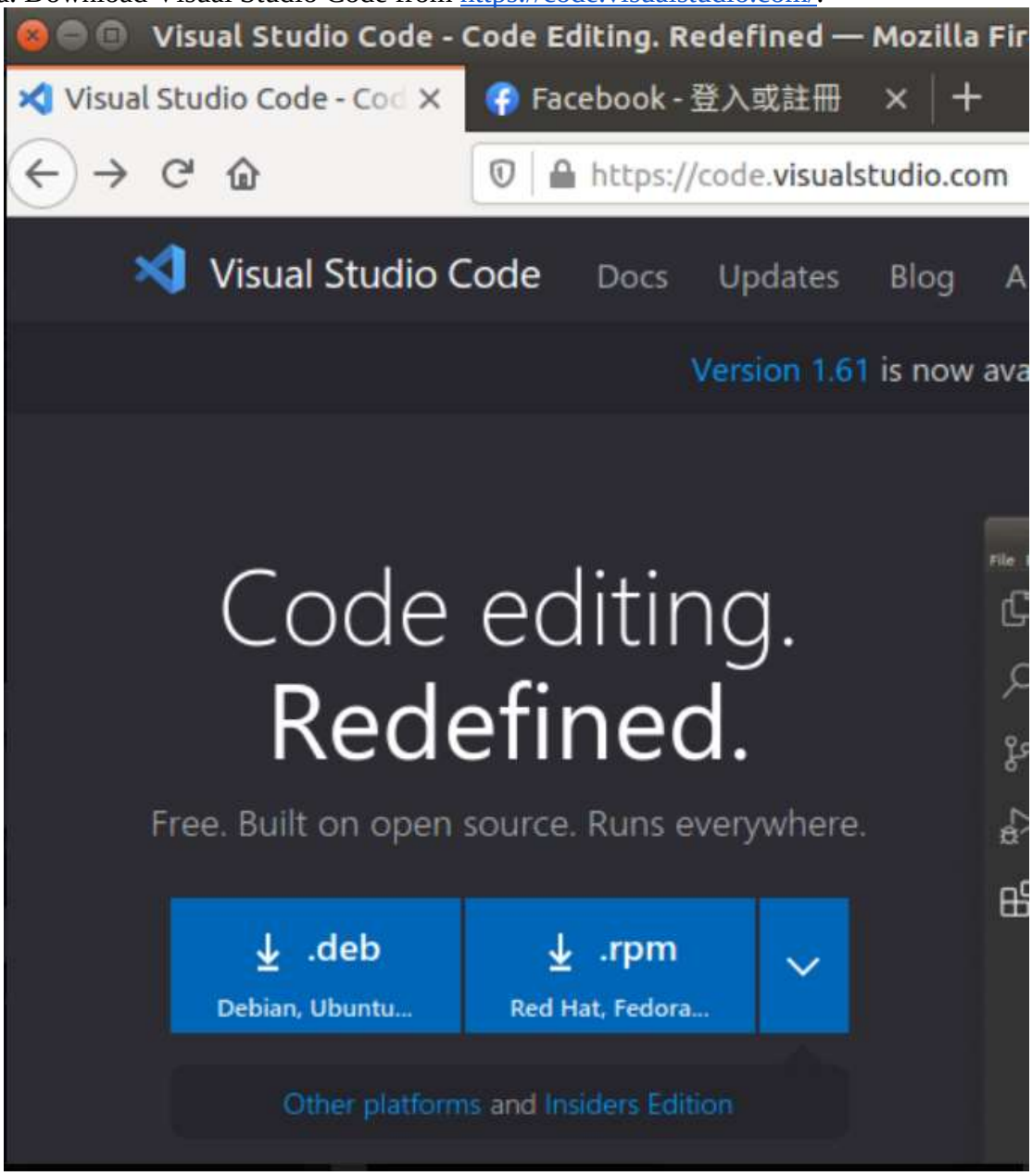
```
lighthan@lighthan-VirtualBox:~$ sudo apt install vim
[sudo] password for lighthan:
正在讀取套件清單... 完成
正在重建相依關係
正在讀取狀態資料... 完成
下列的額外套件將被安裝：
  vim-common vim-runtime vim-tiny
建議套件：
  ctags vim-doc vim-scripts indent
下列【新】套件將會被安裝：
  vim vim-runtime
下列套件將會被升級：
  vim-common vim-tiny
升級 2 個，新安裝 2 個，移除 0 個，有 9 個未被升級。
需要下載 6,589 kB/7,136 kB 的套件檔。
此操作完成之後，會多佔用 32.0 MB 的磁碟空間。
是否繼續進行 [Y/n]？ [Y/n] Y
```

c. Learn how to use vim, start from title ”9.2 vi 的使用”
   http://linux.vbird.org/linux_basic/0310vi.php

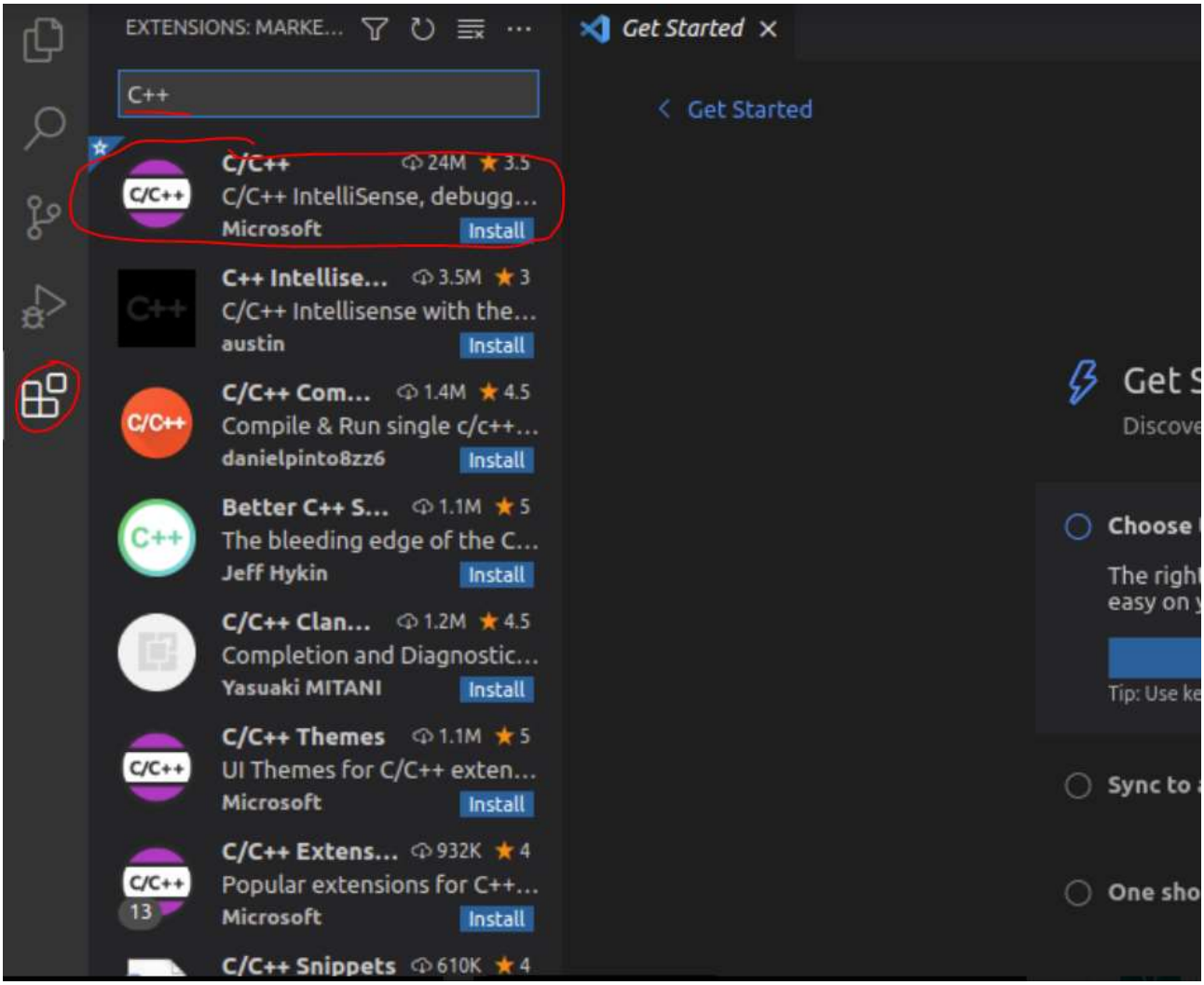
d. How to compile and run your code
   https://blog.gtwang.org/programming/gcc-comipler-basic-tutorial-examples/

B. Visual Studio Code

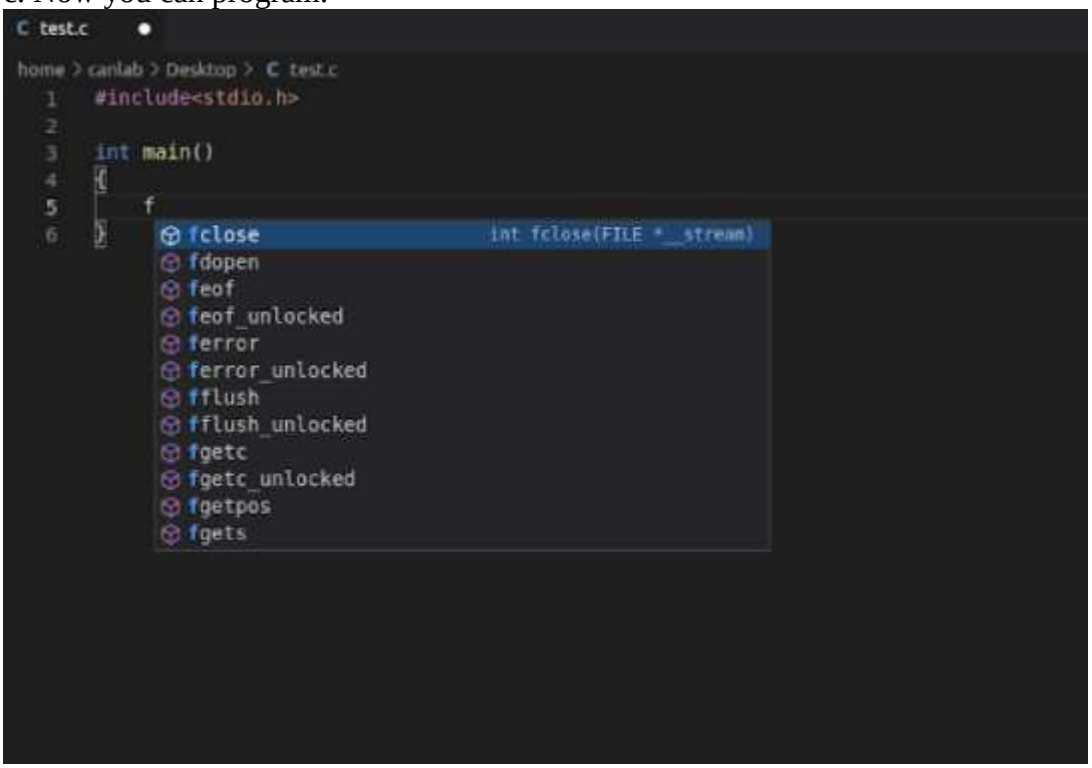
a. Download Visual Studio Code from https://code.visualstudio.com/.



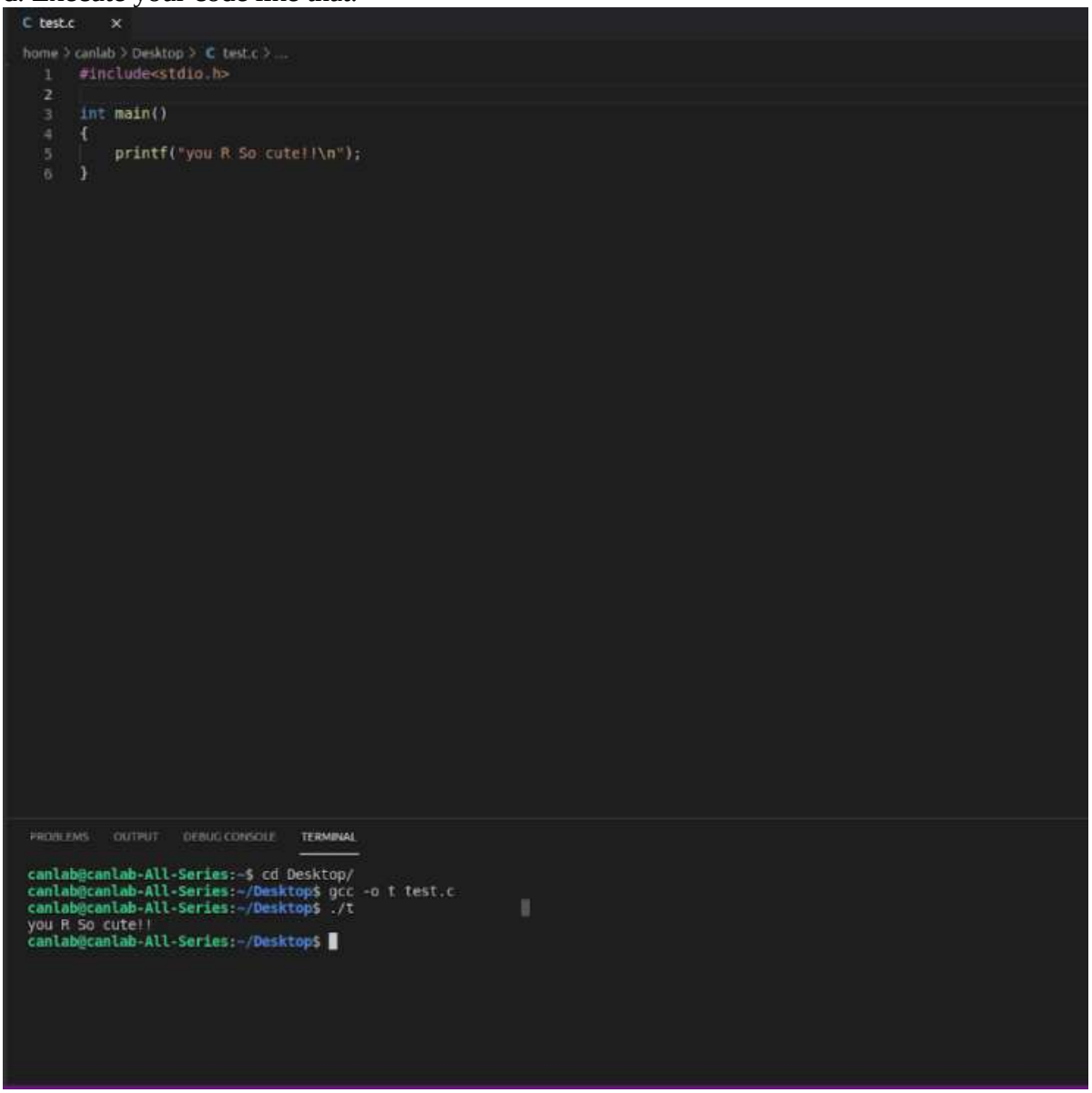
b. Search C++ extension and install it.



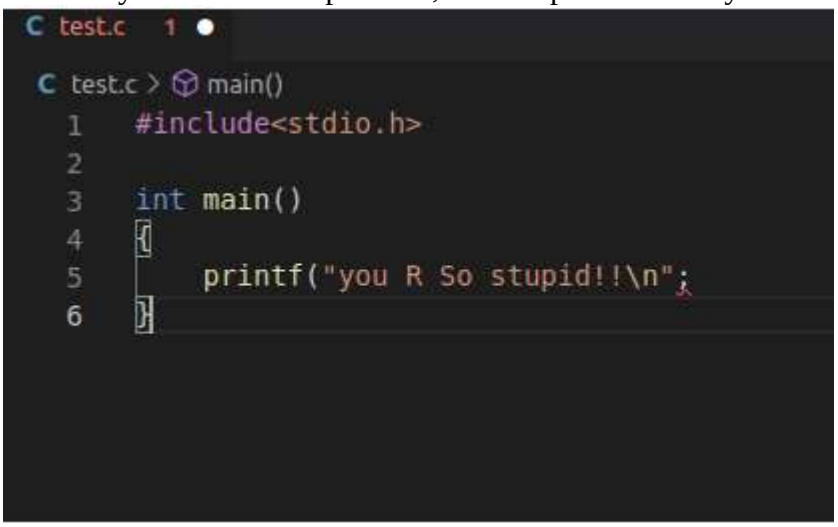
c. Now you can program.



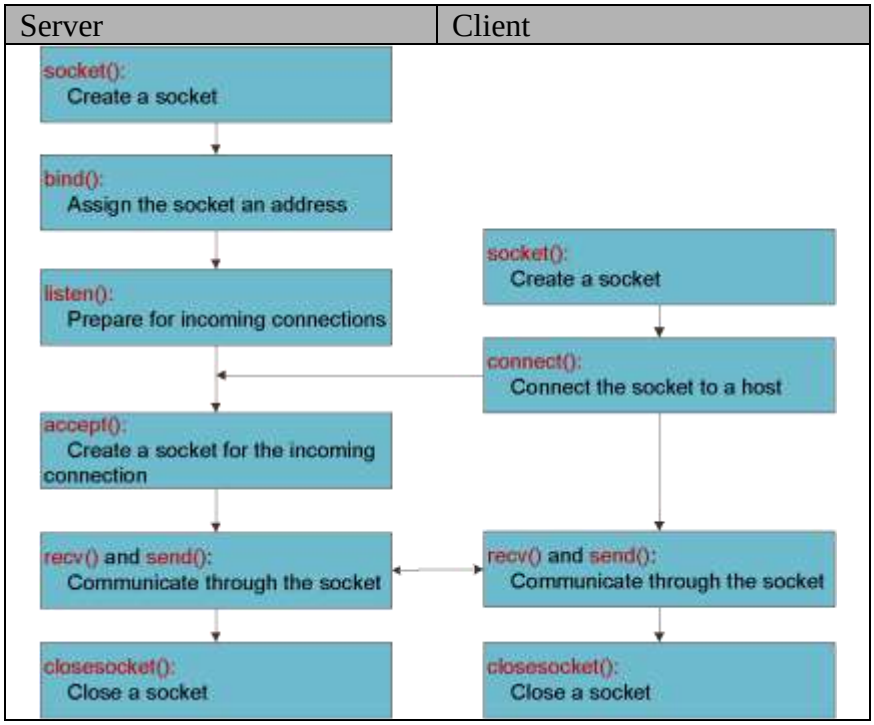
d. Execute your code like that.



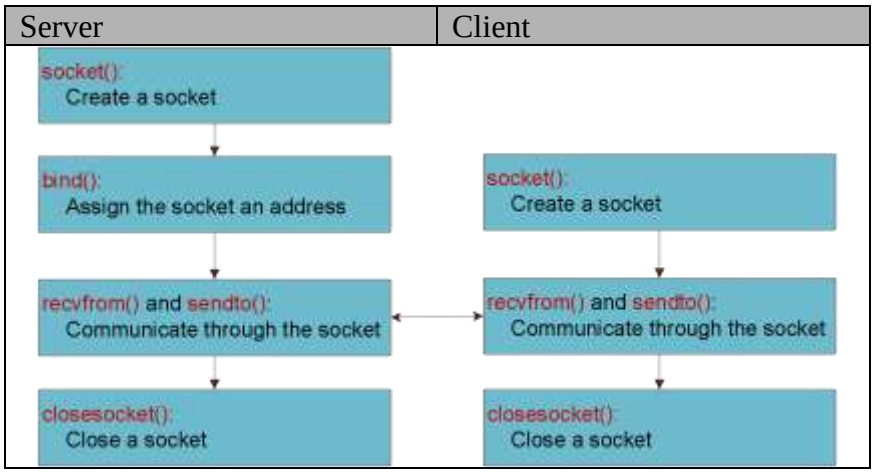
e. When your code has a problem, the compiler will tell you where you might be wrong.



3. Socket programming
   a. TCP flow chart



   b. UDP flow chart



c. Data structure of address

Structure	Usage

struct sockaddr_in {
sa_family_t sin_family;
in_port_t sin_port;
struct in_addr sin_addr;
};
	sin_family = AF_INET;
	sin_port = htons(8080);
	sin_addr.s_addr = INADDR_ANY; (for server)

*htons(unsign short port): host to network byte order for unsign short (16 bits)
*Use domain name instead of IP as the address

- struct sockaddr_in serverAddress
- struct hostent *h = gethostbyname(hostName)
- memcpy(&serverAddress.sin_addr, h->h_addr_list[0], h->h_length)

d. Functions

socket(AF_INET, SOCK_STREAM, 0) Create a TCP socket (SOCK_STREAM) or UDP socket (SOCK_DGRAM)
bind(server_fd, (struct sockaddr *)&address, sizeof(address)) Assign serverSocket serverAddress
listen(server_fd, 3) Prepare for incoming connections (maximum 3 connections)
accept(server_fd, (struct sockaddr *)&address,(socklen_t*)&addrlen)) Create a socket for the incoming connection, and the address of the target host is stored in address
send(new_socket , hello , strlen(hello) , 0) Send buf(hello) of size len (TCP socket)
read(new_socket , buffer, 1024) read data of maximum size 1024, and store the data in buffer (TCP socket)
sendto(sockfd, (const char *)hello, strlen(hello),MSG_CONFIRM, (const struct sockaddr *) &cliaddr,len); Send buf of size len to client (UDP socket)
recvfrom(sockfd, (char *)buffer, MAXLINE,MSG_WAITALL, (struct sockaddr *) &cliaddr,&len); Receive data of maximum size MAXLINE, and store the data in buffer (UDP socket)

4. Examples
   a. TCP echo server and client

TCP echo server

```
// Server side C/C++ program to demonstrate Socket programming
#include <unistd.h>
#include <stdio.h>
#include <sys/socket.h>
#include <stdlib.h>
#include <netinet/in.h>
#include <string.h>
#define PORT 8080
int main(int argc, char const *argv[])
{
    int server_fd, new_socket, valread;
    struct sockaddr_in address;
    int opt = 1;
    int addrlen = sizeof(address);
    char buffer[1024] = {0};
    char *hello = "Hello from server";

    // Creating socket file descriptor
    if ((server_fd = socket(AF_INET, SOCK_STREAM, 0)) == 0)
    {
        perror("socket failed");
        exit(EXIT_FAILURE);
    }
    // Forcefully attaching socket to the port 8080
    if (setsockopt(server_fd, SOL_SOCKET, SO_REUSEADDR | SO_REUSEPORT,&opt,
sizeof(opt)))
    {
        perror("setsockopt");
        exit(EXIT_FAILURE);
    }
    address.sin_family = AF_INET;
    address.sin_addr.s_addr = INADDR_ANY;
    address.sin_port = htons( PORT );
    // Forcefully attaching socket to the port 8080
    if (bind(server_fd, (struct sockaddr *)&address, sizeof(address))<0)
    {
        perror("bind failed");
        exit(EXIT_FAILURE);
    }
    if (listen(server_fd, 3) < 0)
    {
        perror("listen");
        exit(EXIT_FAILURE);
    }
    if ((new_socket = accept(server_fd, (struct sockaddr *)&address,(socklen_t*)&addrlen))<0)
    {
        perror("accept");
        exit(EXIT_FAILURE);
    }
    valread = read( new_socket , buffer, 1024);
    printf("%s\n",buffer );
    send(new_socket , hello , strlen(hello) , 0 );
    printf("Hello message sent\n");
    return 0;
}
```

TCP echo client

```
// Client side C/C++ program to demonstrate Socket programming
#include <stdio.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <unistd.h>
#include <string.h>
#define PORT 8080

int main(int argc, char const *argv[])
{
    int sock = 0, valread;
    struct sockaddr_in serv_addr;
    char *hello = "Hello from client";
    char buffer[1024] = {0};
    if ((sock = socket(AF_INET, SOCK_STREAM, 0)) < 0)
    {
        printf("\n Socket creation error \n");
        return -1;
    }

    serv_addr.sin_family = AF_INET;
    serv_addr.sin_port = htons(PORT);

    // Convert IPv4 and IPv6 addresses from text to binary form
    if(inet_pton(AF_INET, "127.0.0.1", &serv_addr.sin_addr)<=0)
    {
        printf("\nInvalid address/ Address not supported \n");
        return -1;
    }

    if (connect(sock, (struct sockaddr *)&serv_addr, sizeof(serv_addr)) < 0)
    {
        printf("\nConnection Failed \n");
        return -1;
    }
    send(sock , hello , strlen(hello) , 0 );
    printf("Hello message sent\n");
    valread = read( sock , buffer, 1024);
    printf("%s\n",buffer );
    return 0;
}
```

b. UDP echo server and client

UDP echo server

```
// Server side implementation of UDP client-server model
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>

#define PORT   8080
#define MAXLINE 1024

// Driver code
int main() {
    int sockfd;
    char buffer[MAXLINE];
    char *hello = "Hello from server";
    struct sockaddr_in servaddr, cliaddr;

    // Creating socket file descriptor
    if ( (sockfd = socket(AF_INET, SOCK_DGRAM, 0)) < 0 ) {
        perror("socket creation failed");
        exit(EXIT_FAILURE);
    }

    memset(&servaddr, 0, sizeof(servaddr));
    memset(&cliaddr, 0, sizeof(cliaddr));

    // Filling server information
    servaddr.sin_family    = AF_INET; // IPv4
    servaddr.sin_addr.s_addr = INADDR_ANY;
    servaddr.sin_port = htons(PORT);

    // Bind the socket with the server address
    if ( bind(sockfd, (const struct sockaddr *)&servaddr,sizeof(servaddr)) < 0 )
    {
        perror("bind failed");
        exit(EXIT_FAILURE);
    }

    int len, n;

    len = sizeof(cliaddr);  //len is value/resuslt

    n = recvfrom(sockfd, (char *)buffer, MAXLINE,MSG_WAITALL, ( struct sockaddr *) &cliaddr,&len);
    buffer[n] = '\0';
    printf("Client : %s\n", buffer);
    sendto(sockfd, (const char *)hello, strlen(hello),MSG_CONFIRM, (const struct sockaddr *)
&cliaddr,len);
    printf("Hello message sent.\n");

    return 0;
}
```

UDP echo client

```
// Client side implementation of UDP client-server model
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>

#define PORT    8080
#define MAXLINE 1024

// Driver code
int main() {
    int sockfd;
    char buffer[MAXLINE];
    char *hello = "Hello from client";
    struct sockaddr_in      servaddr;

    // Creating socket file descriptor
    if ( (sockfd = socket(AF_INET, SOCK_DGRAM, 0)) < 0 ) {
        perror("socket creation failed");
        exit(EXIT_FAILURE);
    }

    memset(&servaddr, 0, sizeof(servaddr));

    // Filling server information
    servaddr.sin_family = AF_INET;
    servaddr.sin_port = htons(PORT);
    servaddr.sin_addr.s_addr = INADDR_ANY;

    int n, len;

    sendto(sockfd, (const char *)hello, strlen(hello),MSG_CONFIRM, (const struct sockaddr *)
&servaddr, sizeof(servaddr));
    printf("Hello message sent.\n");

    n = recvfrom(sockfd, (char *)buffer, MAXLINE,  MSG_WAITALL, (struct sockaddr *) &servaddr,
&len);
    buffer[n] = '\0';
    printf("Server : %s\n", buffer);

    close(sockfd);
    return 0;
}
```