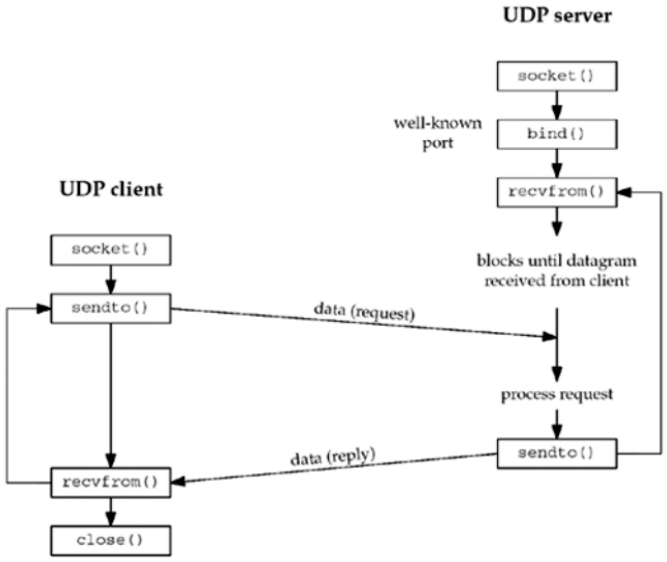
UNIT – 3

1. Illustrate the significance of socket functions for UDP TCP client/server with a neat block diagram.

Figure 8.1. Socket functions for UDP client/server.



- The Figure shows the function calls for a typical UDP client/server.
- The client does not establish a connection with the server. Instead, the client just sends a datagram to the server using the **sendto** function (described in the next section), which requires the address of the destination (the server) as a parameter.
- Similarly, the server does not accept a connection from a client. Instead, the server just calls the **recvfrom** function, which waits until data arrives from some client.
- **recvfrom** returns the protocol address of the client, along with the datagram, so the server can send a response to the correct client.
- Figure shows a timeline of the typical scenario that takes place for a UDP client/server exchange.

2.Explain the following functions of UDP socket:

- **recvfrom**
- **sendto**

These two functions are similar to the standard `read` and `write` functions, but three additional arguments are required.

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

```
ssize_t recvfrom(int sockfd, void *buff, size_t nbytes, int flags, struct sockaddr *
from, socklen_t *addrlen);
```

```
ssize_t sendto(int sockfd, const void *buff, size_t nbytes, int flags, const struct
sockaddr *to, socklen_t addrlen);
```

Both return: number of bytes read or written if OK, 1 on error

- The first three arguments, **sockfd**, **buff**, and **nbytes**, are identical to the first three arguments for **read** and **write**: descriptor, pointer to buffer to read into or write from, and number of bytes to read or write.
- Both functions return the length of the data that was read or written as the value of the function. In the typical use of **recvfrom**, with a datagram protocol, the return value is the amount of user data in the datagram received.

3. List and explain with a neat block diagram the steps associated with simple UDP echo client and server.

4. Develop the 'C' program to demonstrate the UDP echo server: main function

Figure 8.2. Simple echo client/server using UDP.

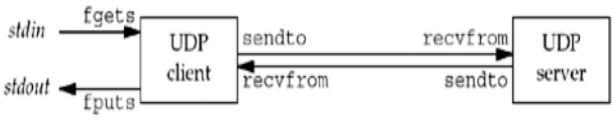


Figure 8.3 UDP echo server.

udpcliserv/udpserv01.c

```
 1 #include     "unp.h"

 2 int
 3 main(int argc, char **argv)
 4 {
 5     int     sockfd;
 6     struct sockaddr_in servaddr, cliaddr;

 7     sockfd = Socket(AF_INET, SOCK_DGRAM, 0);

 8     bzero(&servaddr, sizeof(servaddr));
 9     servaddr.sin_family = AF_INET;
10     servaddr.sin_addr.s_addr = htonl(INADDR_ANY);
11     servaddr.sin_port = htons(SERV_PORT);

12     Bind(sockfd, (SA *) &servaddr, sizeof(servaddr));

13     dg_echo(sockfd, (SA *) &cliaddr, sizeof(cliaddr));
14 }
```

Create UDP socket, bind server's well-known port

7 12 We create a UDP socket by specifying the second argument to `socket` as `SOCK_DGRAM` (a datagram socket in the IPv4 protocol). As with the TCP server example, the IPv4 address for the `bind` is specified as `INADDR_ANY` and the server's well-known port is the constant `SERV_PORT` from the `unp.h` header.

13 The function `dg_echo` is called to perform server processing.

5. Develop the 'C' program to demonstrate the UDP echo server: dg_echo function

Figure 8.4 dg_echo function: echo lines on a datagram socket.

lib/dg_echo.c

```
 1 #include     "unp.h"

 2 void
 3 dg_echo(int sockfd, SA *pcliaddr, socklen_t clilen)
 4 {
 5     int     n;
 6     socklen_t len;
 7     char    mesg[MAXLINE];

 8     for ( ; ; ) {
 9         len = clilen;
10         n = Recvfrom(sockfd, mesg, MAXLINE, 0, pcliaddr, &len);

11         Sendto(sockfd, mesg, n, 0, pcliaddr, len);
12     }
13 }
```

8 12 This function is a simple loop that reads the next datagram arriving at the server's port using `recvfrom` and sends it back using `sendto`.

Next, this function provides an *iterative server*, not a concurrent server as we had with TCP. There is no call to `fork`, so a single server process handles any and all clients. In general, most TCP servers are concurrent and most UDP servers are iterative.

6. Develop the 'C' program to demonstrate the UDP echo client: main function

Figure 8.7 UDP echo client.

udpcliserv/udpcli01.c

```
 1 #include     "unp.h"

 2 int
 3 main(int argc, char **argv)
 4 {
 5     int     sockfd;
 6     struct sockaddr_in servaddr;

 7     if(argc != 2)
 8        err_quit("usage: udpcli <IPaddress>");

 9     bzero(&servaddr, sizeof(servaddr));
10     servaddr.sin_family = AF_INET;
11     servaddr.sin_port = htons(SERV_PORT);
12     Inet_pton(AF_INET, argv[1], &servaddr.sin_addr);

13     sockfd = Socket(AF_INET, SOCK_DGRAM, 0);

14     dg_cli(stdin, sockfd, (SA *) &servaddr, sizeof(servaddr));

15     exit(0);
16 }
```

9 12 An IPv4 socket address structure is filled in with the IP address and port number of the server. This structure will be passed to `dg_cli`, specifying where to send datagrams.

13 14 A UDP socket is created and the function `dg_cli` is called.

7. Develop the 'C' program to demonstrate the UDP echo client: dg_cli function

Figure 8.8 `dg_cli` function: client processing loop.

lib/dg_cli.c

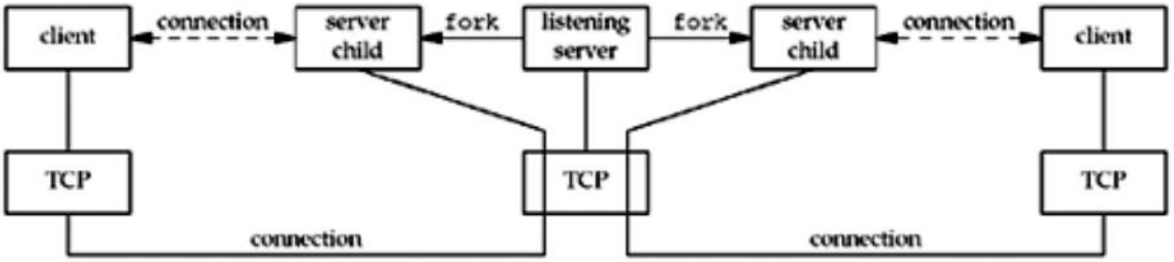
```
 1 #include     "unp.h"

 2 void
 3 dg_cli(FILE *fp, int sockfd, const SA *pservaddr, socklen_t servlen)
 4 {
 5     int     n;
 6     char    sendline[MAXLINE], recvline[MAXLINE + 1];

 7     while (Fgets(sendline, MAXLINE, fp) != NULL) {

 8         Sendto(sockfd, sendline, strlen(sendline), 0, pservaddr, servlen);

 9         n = Recvfrom(sockfd, recvline, MAXLINE, 0, NULL, NULL);

10         recvline[n] = 0;        /* null terminate */
11         Fputs(recvline, stdout);
12     }
13 }
```

7 12 There are four steps in the client processing loop: read a line from standard input using `fgets`, send the line to the server using `sendto`, read back the server's echo using `recvfrom`, and print the echoed line to standard output using `fputs`.

Notice that the call to recvfrom specifies a null pointer as the fifth and sixth arguments. This tells the kernel that we are not interested in knowing who sent the reply.

8. Outline the summary of TCP client/server with two clients.

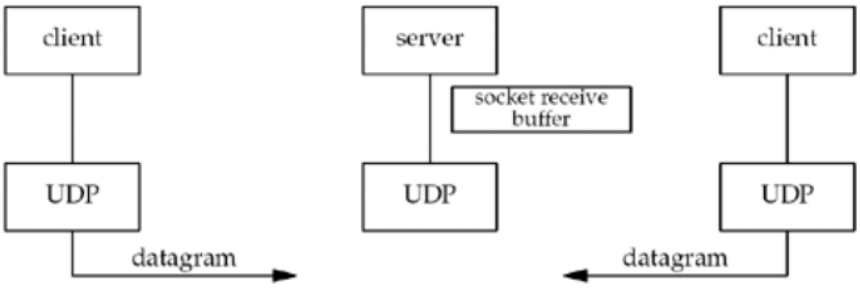
Figure 8.5. Summary of TCP client/server with two clients.



There are two connected sockets and each of the two connected sockets on the server host has its own socket receive buffer.

9. Outline the summary of UDP client/server with two clients.

Figure 8.6. Summary of UDP client/server with two clients.



There is only one server process and it has a single socket on which it receives all arriving datagrams and sends all responses. That socket has a receive buffer into which all arriving datagrams are placed.

10. Develop the 'C' program for dg_cli function that verifies returned socket address.

Figure 8.8 `dg_cli` function: client processing loop.

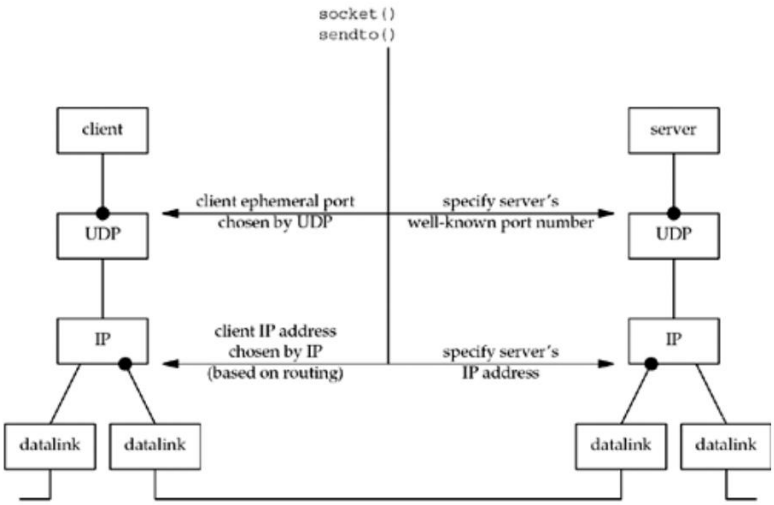
lib/dg_cli.c

```
 1 #include     "unp.h"

 2 void
 3 dg_cli(FILE *fp, int sockfd, const SA *pservaddr, socklen_t servlen)
 4 {
 5     int     n;
 6     char    sendline[MAXLINE], recvline[MAXLINE + 1];

 7     while (Fgets(sendline, MAXLINE, fp) != NULL) {

 8         Sendto(sockfd, sendline, strlen(sendline), 0, pservaddr, servlen);

 9         n = Recvfrom(sockfd, recvline, MAXLINE, 0, NULL, NULL);

10         recvline[n] = 0;        /* null terminate */
11         Fputs(recvline, stdout);
12     }
13 }
```

7 12 There are four steps in the client processing loop: read a line from standard input using `fgets`, send the line to the server using `sendto`, read back the server's echo using `recvfrom`, and print the echoed line to standard output using `fputs`.

11. Outline the summary of UDP client/server from client's perspective with a neat block diagram.

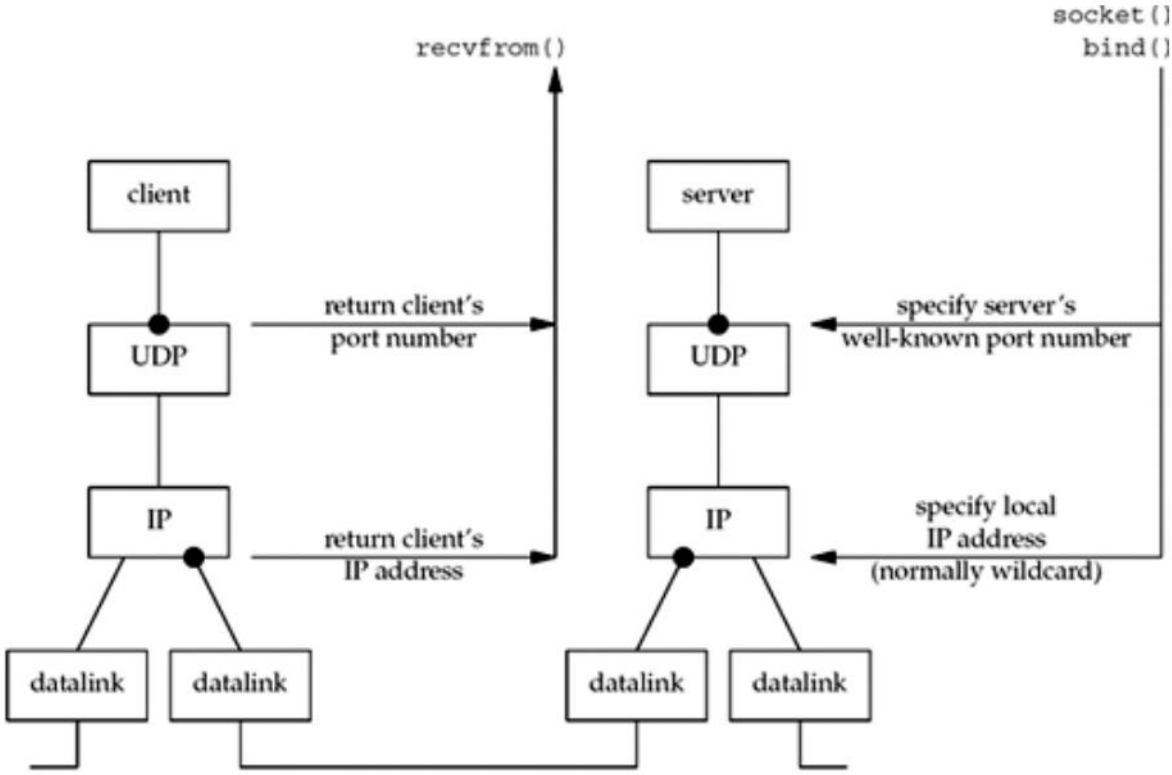
Figure 8.11. Summary of UDP client/server from client's perspective.



- The client must specify the server's IP address and port number for the call to **sendto**. Normally, the client's IP address and port are chosen automatically by the kernel, although we mentioned that the client can call **bind** if it so chooses.
- If these two values for the client are chosen by the kernel, we also mentioned that the client's ephemeral port is chosen once, on the first **sendto**, and then it never changes.
- The client's IP address, however, can change for every UDP datagram that the client sends, assuming the client does not bind a specific IP address to the socket.
- The reason is shown in Figure : If the client host is multihomed, the client could alternate between two destinations, one going out the datalink on the left, and the other going out the datalink on the right.
- What happens if the client **binds** an IP address to its socket, but the kernel decides that an outgoing datagram must be sent out some other datalink? In this case the IP datagram will contain a source IP address that is different from the IP address of the outgoing datalink

12. Outline the summary of UDP client/server from server's perspective with a neat block diagram.

Figure 8.12. Summary of UDP client/server from server's perspective.



There are at least four pieces of information that a server might want to know from an arriving IP datagram: **the source IP address**, **destination IP address**, **source port number**, and **destination port number.** Figure 8.13 shows the function calls that return this information for a TCP server and a UDP server.

Figure 8.13. Information available to server from arriving IP datagram.

From client's IP datagram	TCP server	UDP server
Source IP address	`accept`	`recvfrom`
Source port number	`accept`	`recvfrom`
Destination IP address	`getsockname`	`recvmsg`
Destination port number	`getsockname`	`getsockname`

13. Develop the 'C' program to demonstrate the UDP dg_cli function that calls connect.

Figure 8.17 dg_cli function that calls connect.

udpcliserv/dgcliconnect.c

```
 1 #include     "unp.h"

 2 void
 3 dg_cli(FILE *fp, int sockfd, const SA *pservaddr, socklen_t servlen)
 4 {
 5     int     n;
 6     char    sendline[MAXLINE], recvline[MAXLINE + 1];

 7     Connect(sockfd, (SA *) pservaddr, servlen);

 8     while (Fgets(sendline, MAXLINE, fp) != NULL) {

 9         Write(sockfd, sendline, strlen(sendline));

10         n = Read(sockfd, recvline, MAXLINE);

11         recvline[n] = 0;        /* null terminate */
12         Fputs(recvline, stdout);
13     }
14 }
```

14. Develop the 'C' program to demonstrate the UDP dg_cli function that writes a fixed number of datagrams to the server.

Figure 8.19 dg_cli function that writes a fixed number of datagrams to the server.

udpcliserv/dgcliloop1.c

```
 1 #include     "unp.h"

 2 #define NDG      2000          /*  datagrams to send */
 3 #define DGLEN    1400          /*  length of each datagram */

 4 void
 5 dg_cli(FILE *fp, int sockfd, const SA *pservaddr, socklen_t servlen)
 6 {
 7     int     i;
 8     char    sendline[DGLEN];

 9     for (i = 0; i < NDG; i++) {
10         Sendto(sockfd, sendline, DGLEN, 0, pservaddr, servlen);
11     }
12 }
```

15. Develop the 'C' program to demonstrate the UDP dg_echo function that counts received datagrams.

Figure 8.20 dg_echo function that counts received datagrams.

udpcliserv/dgecholoop1.c

```
 1 #include     "unp.h"

 2 static void recvfrom_int(int);
 3 static int count;

 4 void
 5 dg_echo(int sockfd, SA *pcliaddr, socklen_t clilen)
 6 {
 7     socklen_t len;
 8     char    mesg[MAXLINE];

 9     Signal(SIGINT, recvfrom_int);

10     for ( ; ; ) {
11         len = clilen;
12         Recvfrom(sockfd, mesg, MAXLINE, 0, pcliaddr, &len);

13         count++;
14     }
15 }

16 static void
17 recvfrom_int(int signo)
18 {
19     printf("\nreceived %d datagrams\n", count);
20     exit(0);
21 }
```

16. Develop the 'C' program to demonstrate the UDP dg_echo function that increases the size of the socket receive queue.

Figure 8.22 dg_echo function that increases the size of the socket receive queue.

udpcliserv/dgecholoop2.c

```
 1 #include    "unp.h"

 2 static void recvfrom_int(int);
 3 static int count;

 4 void
 5 dg_echo(int sockfd, SA *pcliaddr, socklen_t clilen)
 6 {
 7     int     n;
 8     socklen_t len;
 9     char    mesg[MAXLINE];

10     Signal(SIGINT, recvfrom_int);

11     n = 220 * 1024;
12     Setsockopt(sockfd, SOL_SOCKET, SO_RCVBUF, &n, sizeof(n));

13     for ( ; ; ) {
14         len = clilen;
15         Recvfrom(sockfd, mesg, MAXLINE, 0, pcliaddr, &len);

16         count++;
17     }
18 }

19 static void
20 recvfrom_int(int signo)
21 {
22     printf("\nreceived %d datagrams\n", count);


23     exit(0);
24 }
```

17. Develop the 'C' program for UDP that uses connect to determine outgoing interface.

Figure 8.23 UDP program that uses `connect` to determine outgoing interface.

udpcliserv/udpcli09.c

```
 1 #include     "unp.h"

 2 int
 3 main(int argc, char **argv)
 4 {
 5     int     sockfd;
 6     socklen_t len;
 7     struct sockaddr_in cliaddr, servaddr;

 8     if (argc != 2)
 9         err_quit("usage: udpcli <IPaddress>");

10     sockfd = Socket(AF_INET, SOCK_DGRAM, 0);

11     bzero(&servaddr, sizeof(servaddr));
12     servaddr.sin_family = AF_INET;
13     servaddr.sin_port = htons(SERV_PORT);
14     Inet_pton(AF_INET, argv[1], &servaddr.sin_addr);

15     Connect(sockfd, (SA *) &servaddr, sizeof(servaddr));

16     len = sizeof(cliaddr);
17     Getsockname(sockfd, (SA *) &cliaddr, &len);
18     printf("local address %s\n", Sock_ntop((SA *) &cliaddr, len));

19     exit(0);
20 }
```

18. Make use of select function for TCP and UDP Echo server.