Elementary UDP Sockets

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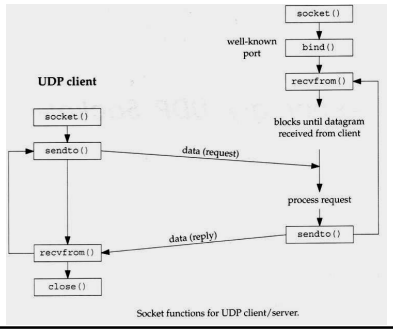
Introduction

- UDP is
  - Connectionless
  - Unreliable
  - datagram protocol
- Some popular applications are built using UDP
  - DNS(the Domain Name System)
  - NFS(the Network File System)
  - SNMP(Simple Network Management Protocol)

Structure of UDP client-server program

- Client does not establish a connection to the server
  - client just sends a datagram to the server using sendto() function.
- similarly, server does not accept a connection from client.
  - It instead simply calls recvfrom() function which waits for data to arrive.

Structure of UDP client-server program



Socket functions for UDP client/server.

sendto and recvfrom functions

#include <sys/socket.h>

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

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

- Both return: number of bytes read or written if OK, -1 on error
- First three arguments, sockfd, buff, and nbytes, are identical to the first three arguments for read and write calls.

sendto and recvfrom functions

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

- flags: set this to 0 for simple UDP programs.
- to: socket address structure containing the protocol address (IP address and port #) of where data is to be sent.
- addrlen: Size of socket address structure (integer value argument)

sendto and recvfrom functions

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

- flags: set this to 0 for simple UDP programs.
- from: socket address structure that is filled in by recvfrom with the protocol address (IP address and port #) of where data came from
- *addrlen: pointer to integer value. (Value-result argument).

- If the from argument is a null pointer, then the corresponding length argument (addrlen) must also be a null pointer. I.e., we are not interested in knowing who sent us data.
- Final two arguments to sendto are similar to the final two arguments to connect.

sendto and recvfrom functions

- Writing a datagram of length 0 is OK.
  - In the case of UDP
    - This results in an **IP datagram** containing an IP header (20 bytes IPv4), an 8 byte **UDP header** and no data.
- This means return value of 0 from recvfrom is OK for a datagram protocol.
  - It does not mean that peer has closed the connection (as happens in case of TCP).
  - UDP is connectionless. No meaning of closing the connection.

Echo client-server application (UDP)

- Implement UDP protocol based Echo client-server application

echoUDPServer.c

```
#include <sys/types.h>
#include <sys/socket.h>
#include <stdio.h>
#include <netinet/in.h>
#define MAXLINESIZE 100
#define SERV_PORT 8000

int main(int argc, char** argv)
{
    int sockfd;
    struct sockaddr_in servaddr, cliaddr;
    int n;
    socklen_t len;
    char mesg [MAXLINESIZE];
```

echoUDPServer.c

```
/*Create socket*/
sockfd = socket(AF_INET,SOCK_DGRAM,0);

/*Initialize socket address structure*/
bzero(&servaddr,sizeof(servaddr));

servaddr.sin_family = AF_INET;
servaddr.sin_addr.s_addr = htonl(INADDR_ANY);
servaddr.sin_port = htons(SERV_PORT);

/*bind socket address to the socket*/
bind(sockfd,(struct sockaddr*)&servaddr,sizeof(servaddr));
```

echoUDPServer.c

```
    for(; ; ) {
        len=sizeof(cliaddr);
        /*wait for datagram to arrive, receive a datagram*/
        n=recvfrom(sockfd,mesg,MAXLINESIZE,0,(struct
sockaddr*)&cliaddr,&len);
        /*send back the datagram to the client from which it arrived*/
        sendto(sockfd,mesg,n,0,(struct sockaddr*)&cliaddr,len);
    }
}
```

echoUDPClient.c

```
#include <sys/types.h>
#include <sys/socket.h>
#include <stdio.h>
#include <netinet/in.h>
#define MAXLINE 100
#define SERV_PORT 8000

int main(int argc, char** argv)
{
    int sockfd;
    struct sockaddr_in servaddr;
    int n;
    char sendline[MAXLINE],recvline[MAXLINE];
```

echoUDPClient.c

```
if(argc!=2){
        fprintf(stderr,"Usage: %s IP-Address\n",argv[0]);
        exit(-1);
}
/*Initialize socket address structure*/
bzero(&servaddr,sizeof(servaddr));
servaddr.sin_family = AF_INET;

if(inet_pton(AF_INET,argv[1], &servaddr.sin_addr)<0)
        fprintf(stderr,"Error in inet_pton");

servaddr.sin_port = htons(SERV_PORT);
```

echoUDPClient.c

```
    /*Create socket*/
    sockfd = socket (AF_INET,SOCK_DGRAM,0);
    while(fgets(sendline,MAXLINE,stdin)!=NULL)
    {
        /*Send the message to the server*/
        sendto(sockfd,sendline,strlen(sendline),0,(struct
sockaddr*)&servaddr,sizeof(servaddr));
        /*wait for response and receive the response*/
        n = recvfrom(sockfd,recvline,MAXLINE,0,NULL,NULL);
        recvline[n] = 0;
        /*Display what the server sent in reply*/
        fputs(recvline,stdout);
    }
}
```

Echo client-server application (UDP)

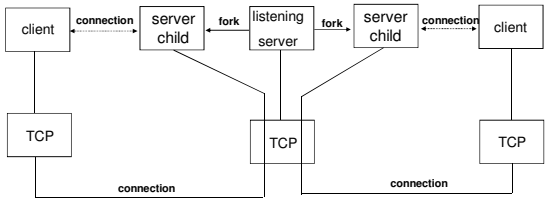
- Compile echoTCPServer.c and echoTCPClient.c using gcc.
- First run the server.
- Run clients and test.

Comparing TCP and UDP based programs

- Generally, TCP servers are concurrent and UDP servers are iterative.
- In our UDP Server program, we have not used fork.
- Each UDP socket has a receive buffer.
  - If multiple datagrams arrive for the socket, they are kept in socket receive buffer. (I.e., implied queueing takes place).
  - The socket receive buffer has limited size. It can be changed using SO_RCVBUF socket option. (See later).
  - When the process calls recvfrom, the next datagram from the buffer is taken in a FIFO order and is delivered to the process.

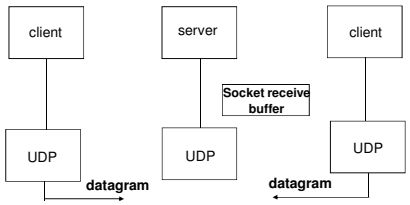
Comparing TCP and UDP based programs

- TCP client server with two clients



Comparing TCP and UDP based programs

- UDP client-server with two clients.



UDP Client

- At which time, the ephemeral port for the UDP socket is selected by the kernel?
  - In case of TCP, during **connect** function an ephemeral port is selected by the kernel for TCP client application.
  - In case of UDP, during first time call to sendto, the ephemeral port is chosen by the kernel for the socket.