

```
#include<stdio.h>
#include<string.h>
#include<sys/socket.h>
#include<sys/types.h>
#include<netinet/in.h>
#include<arpa/inet.h>
#include<fcntl.h>
#include<stdlib.h>

main(int argc, char * argv[])
{
    int n;
    int sock_fd;
    int i,j,k;
    int row_1, row_2, col_1, col_2;
    struct sockaddr_in servaddr, cliaddr;
    int len = sizeof(cliaddr);
    int matrix_1[10][10], matrix_2[10][10], matrix_product[10][10];
    int size[2][2];
    if(argc != 2)
    {
        fprintf(stderr, "Usage: ./server port\n");
        exit(1);
    }

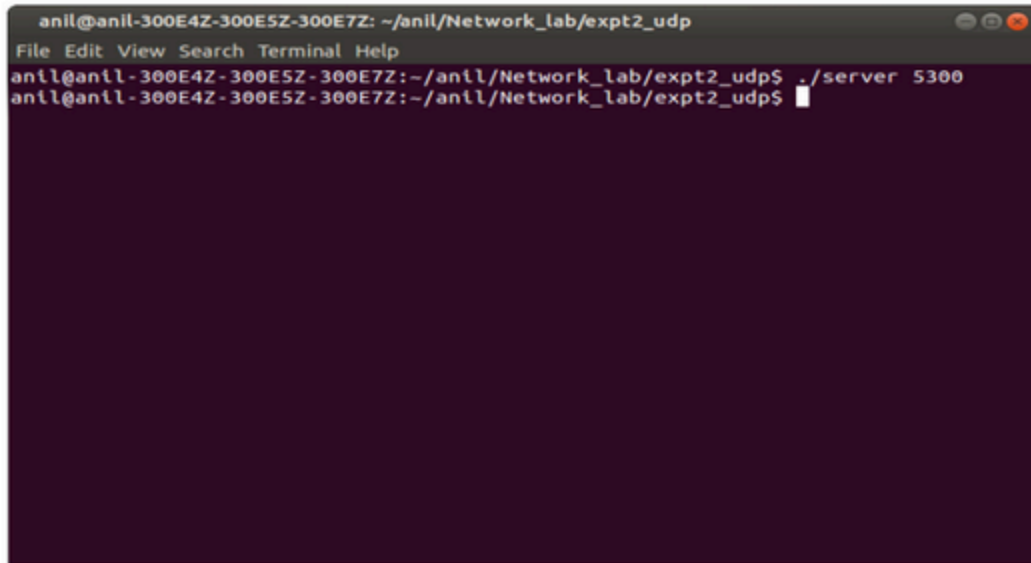
    if((sock_fd = socket(AF_INET, SOCK_DGRAM, 0)) < 0)
    {
        printf("Cannot create socket\n");
        exit(1);
    }
    bzero((char*)&servaddr, sizeof(servaddr));
    servaddr.sin_family = AF_INET;
    servaddr.sin_port = htons(atoi(argv[1]));
    servaddr.sin_addr.s_addr = htonl(INADDR_ANY);
    if(bind(sock_fd, (struct sockaddr*)&servaddr, sizeof(servaddr)) < 0)
    {
        perror("bind failed:");
        exit(1);
    }
    // MATRICES RECEIVE
```

```
if((n = recvfrom(sock_fd, size, sizeof(size), 0, (struct sockaddr *)&cliaddr, &len)) == -1)
{
    perror("size not received:");
    exit(1);
}
// RECEIVE MATRIX 1
if((n = recvfrom(sock_fd, matrix_1, sizeof(matrix_1), 0, (struct sockaddr *)&cliaddr, &len)) ==
-1)
{
    perror("matrix 1 not received:");
    exit(1);
}
// RECEIVE MATRIX 2
if((n = recvfrom(sock_fd, matrix_2, sizeof(matrix_2), 0, (struct sockaddr *)&cliaddr, &len)) ==
-1)
{
    perror("matrix 2 not received:");
    exit(1);
}
row_1 = size[0][0];
col_1 = size[0][1];
row_2 = size[1][0];
col_2 = size[1][1];
for (i=0; i < row_1 ; i++)
for (j=0; j < col_2; j++)
{
    matrix_product[i][j] = 0;
}
for(i=0; i< row_1 ; i++)
for(j=0; j< col_2 ; j++)
for (k=0; k < col_1; k++)
{
    matrix_product[i][j] += matrix_1[i][k]*matrix_2[k][j];
}
n = sendto(sock_fd, matrix_product, sizeof(matrix_product),0, (struct sockaddr*)&cliaddr,
sizeof(cliaddr));
if( n < 0)
{
    perror("error in matrix product sending");
    exit(1);
}
```

```
}  
close(sock_fd);  
}
```

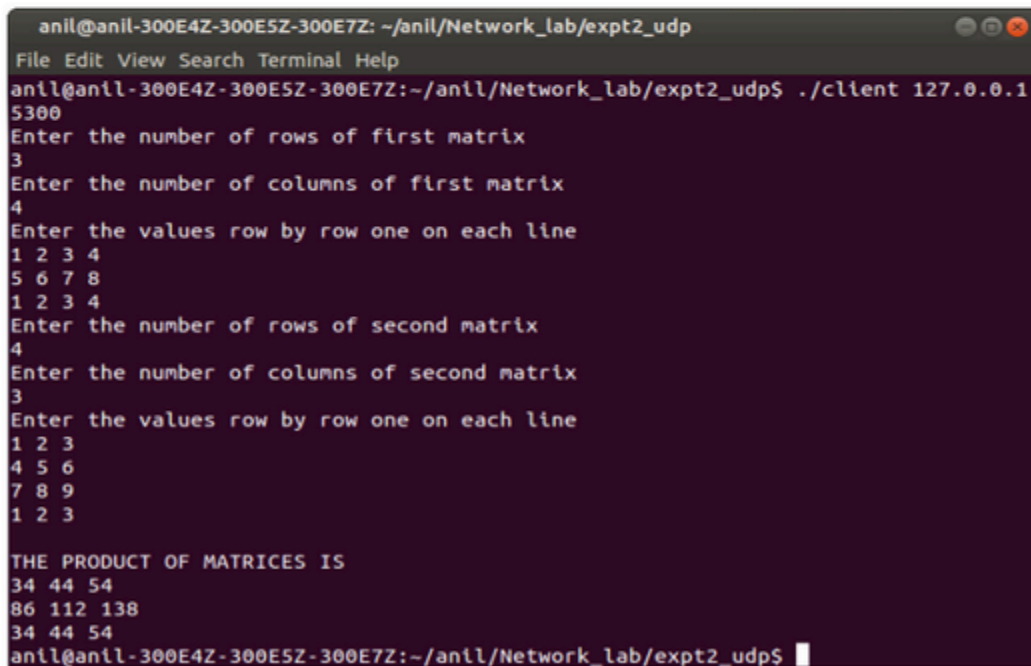
### Output

#### Server



```
anil@anil-300E4Z-300E5Z-300E7Z: ~/anil/Network_lab/expt2_udp  
File Edit View Search Terminal Help  
anil@anil-300E4Z-300E5Z-300E7Z:~/anil/Network_lab/expt2_udp$ ./server 5300  
anil@anil-300E4Z-300E5Z-300E7Z:~/anil/Network_lab/expt2_udp$
```

#### Client



```
anil@anil-300E4Z-300E5Z-300E7Z: ~/anil/Network_lab/expt2_udp  
File Edit View Search Terminal Help  
anil@anil-300E4Z-300E5Z-300E7Z:~/anil/Network_lab/expt2_udp$ ./client 127.0.0.1 5300  
Enter the number of rows of first matrix  
3  
Enter the number of columns of first matrix  
4  
Enter the values row by row one on each line  
1 2 3 4  
5 6 7 8  
1 2 3 4  
Enter the number of rows of second matrix  
4  
Enter the number of columns of second matrix  
3  
Enter the values row by row one on each line  
1 2 3  
4 5 6  
7 8 9  
1 2 3  
  
THE PRODUCT OF MATRICES IS  
34 44 54  
86 112 138  
34 44 54  
anil@anil-300E4Z-300E5Z-300E7Z:~/anil/Network_lab/expt2_udp$
```

## Experiment 5

**Simulate sliding window flow control protocols. (Stop and Wait, Go back N, Selective Repeat ARQ protocols)**

### sliding window flow control protocols

Flow control deals with problem that sender transmits frames faster than receiver can accept, and solution is to limit sender into sending no faster than receiver can handle Consider the simplex case: data is transmitted in one direction (Note although data frames are transmitted in one direction, frames are going in both directions, i.e. link is duplex) Stop and wait: sender sends one data frame, waits for acknowledgement (ACK) from receiver before proceeding to transmit next frame This simple flow control will break down if ACK gets lost or errors occur → sender may wait for ACK that never arrives

#### Go-back-n ARQ

The basic idea of go-back-n error control is: If frame  $i$  is damaged, receiver requests retransmission

of all frames starting from frame  $i$

Notice that all possible cases of damaged frame and ACK / NAK must be taken into account

In selective-reject ARQ error control, the only frames retransmitted are those receive a NAK or which time out

### 1. Stop and Wait

Server.c

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

```
#include <time.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <sys/socket.h>
#include <unistd.h>
#include <arpa/inet.h>
typedef struct packet{
char data[1024];
}Packet;
typedef struct frame{
int frame_kind; //ACK:0, SEQ:1 FIN:2
int sq_no;
int ack;
Packet packet;
}Frame;
int main(int argc, char** argv){
if (argc != 2){
printf("Usage: %s <port>", argv[0]);
exit(0);
}
int port = atoi(argv[1]);
int sockfd;
struct sockaddr_in serverAddr, newAddr;
char buffer[1024];
socklen_t addr_size;
int frame_id=0;
Frame frame_recv;
Frame frame_send;
sockfd = socket(AF_INET, SOCK_DGRAM, 0);
memset(&serverAddr, '\0', sizeof(serverAddr));
serverAddr.sin_family = AF_INET;
serverAddr.sin_port = htons(port);
serverAddr.sin_addr.s_addr = inet_addr("127.0.0.1");
bind(sockfd, (struct sockaddr*)&serverAddr, sizeof(serverAddr));
addr_size = sizeof(newAddr);
while(1){
int f_recv_size = recvfrom(sockfd, &frame_recv, sizeof(Frame), 0, (struct
sockaddr*)&newAddr, &addr_size);
if (f_recv_size > 0 && frame_recv.frame_kind == 1 && frame_recv.sq_no ==
frame_id){
```

```
printf("[+]Frame Received: %s\n", frame_recv.packet.data);
frame_send.sq_no = 0;
frame_send.frame_kind = 0;
frame_send.ack = frame_recv.sq_no + 1;
sendto(sockfd, &frame_send, sizeof(frame_send), 0, (struct
sockaddr*)&newAddr, addr_size);
printf("[+]Ack Send\n");
}else{
printf("[+]Frame Not Received\n");
}
frame_id++;
}
close(sockfd);
return 0;
}
```

### **client.c**

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <arpa/inet.h>
#include <sys/socket.h>
typedef struct packet{
char data[1024];
}Packet;
typedef struct frame{
int frame_kind; //ACK:0, SEQ:1 FIN:2
int sq_no;
int ack;
Packet packet;

}Frame;
int main(int argc, char **argv){
if (argc != 2){
printf("Usage: %s <port>", argv[0]);
exit(0);
}
int port = atoi(argv[1]);
```

```
int sockfd;
struct sockaddr_in serverAddr;
char buffer[1024];
socklen_t addr_size;
int frame_id = 0;
Frame frame_send;
Frame frame_recv;
int ack_recv = 1;
sockfd = socket(AF_INET, SOCK_DGRAM, 0);
memset(&serverAddr, '\0', sizeof(serverAddr));
serverAddr.sin_family = AF_INET;
serverAddr.sin_port = htons(port);
serverAddr.sin_addr.s_addr = inet_addr("127.0.0.1");
while(1){
    if(ack_recv == 1){
        frame_send.sq_no = frame_id;
        frame_send.frame_kind = 1;
        frame_send.ack = 0;
        printf("Enter Data: ");
        scanf("%s", buffer);
        strcpy(frame_send.packet.data, buffer);
        sendto(sockfd, &frame_send, sizeof(Frame), 0, (struct
        sockaddr*)&serverAddr, sizeof(serverAddr));
        printf("[+]Frame Send\n");
    }
    int addr_size = sizeof(serverAddr);
    int f_recv_size = recvfrom(sockfd, &frame_recv, sizeof(frame_recv), 0, (struct
    sockaddr*)&serverAddr, &addr_size);
    if( f_recv_size > 0 && frame_recv.sq_no == 0 && frame_recv.ack ==
    frame_id+1){
        printf("[+]Ack Received\n");
        ack_recv = 1;
    }else{
        printf("[-]Ack Not Received\n");
        ack_recv = 0;
    }
    frame_id++;
}
close(sockfd);
return 0;
```

}

## OUTPUT

```

11111 Welcome to Linux Server 11111
Last login: Tue Jun 21 20:04:53 2022 from 192.168.99.215
p1920@administrator-rusa:~$ cd unni/CN/
p1920@administrator-rusa:~/unni/CN$ atom
p1920@administrator-rusa:~/unni/CN$ gcc slide_window.c
p1920@administrator-rusa:~/unni/CN$ ./a.out
Enter window size: 000
Enter number of frames to transmit: 2
Enter 2 frames: 12
qw
With sliding window protocol the frames will be sent in the following manner (assuming no corruption of frames)
After sending 600 frames at each stage sender waits for acknowledgement sent by the receiver
12 .609933392
Acknowledgement of above frames sent is received by sender
p1920@administrator-rusa:~/unni/CN$ ./a.out
Enter window size: 3
Enter number of frames to transmit: 5
Enter 5 frames: 12 5 89 4 0
With sliding window protocol the frames will be sent in the following manner (assuming no corruption of frames)
After sending 3 frames at each stage sender waits for acknowledgement sent by the receiver
12 5 89
Acknowledgement of above frames sent is received by sender
4 0
Acknowledgement of above frames sent is received by sender
p1920@administrator-rusa:~/unni/CN$

```

## 2. Go\_Back ARQ

## Reciver.c

```

#include<stdio.h>
#include<sys/types.h>
#include<sys/socket.h>
#include<netinet/in.h>
#include<string.h>
#include<time.h>
#include<stdlib.h>
#include<ctype.h>
#include<arpa/inet.h>
#define W 5
#define P1 50
#define P2 10
char a[10];
char b[10];
void alpha9(int);
int main()
{
    struct sockaddr_in ser,cli;
    int s,n,sock,i,j,c=1,f;

```



```
unsigned int s1;
s=socket(AF_INET,SOCK_STREAM,0);
ser.sin_family=AF_INET;
ser.sin_port=6500;
ser.sin_addr.s_addr=inet_addr("127.0.0.1");
bind(s,(struct sockaddr *)&ser, sizeof(ser));
listen(s,1);
n=sizeof(cli);
sock=accept(s,(struct sockaddr *)&cli, &n);
printf("\nTCP Connection Established.\n");
s1=(unsigned int) time(NULL);
srand(s1);
strcpy(b,"Time Out ");
recv(sock,a,sizeof(a),0);
f=atoi(a);
while(1)
{
for(i=0;i<W;i++)
{
recv(sock,a,sizeof(a),0);
if(strcmp(a,b)==0)
{
break;
}
}
i=0;
while(i<W)
{
j=rand()%P1;
if(j<P2)
{
send(sock,b,sizeof(b),0);
break;
}
else
{
alpha9(c);
if(c<=f)
{
printf("\nFrame %s Received ",a);
```

```
send(sock,a,sizeof(a),0);
}
else
{
break;
}
c++;
}
if(c>f)
{
break;
}
i++;
}
}
close(sock);
close(s);
return 0;
}
void alpha9(int z)
{
int k,i=0,j,g;
k=z;
while(k>0)
{
i++;
k=k/10;
}
g=i;
i--;
while(z>0)
{
k=z%10;
a[i]=k+48;
i--;
z=z/10;
}
a[g]='\0';
}
```

**Client.c**

```
#include<stdio.h>
#include<sys/types.h>
#include<sys/socket.h>
#include<netinet/in.h>
#include<string.h>
#include<time.h>
#include<stdlib.h>
#include<ctype.h>
#include<arpa/inet.h>
#define W 5
#define P1 50
#define P2 10
char a[10];
char b[10];
void alpha9(int);
int main()
{
    struct sockaddr_in ser,cli;
    int s,n,sock,i,j,c=1,f;
    unsigned int s1;
    s=socket(AF_INET,SOCK_STREAM,0);
    ser.sin_family=AF_INET;
    ser.sin_port=6500;
    ser.sin_addr.s_addr=inet_addr("127.0.0.1");
    bind(s,(struct sockaddr *)&ser, sizeof(ser));
    listen(s,1);
    n=sizeof(cli);
    sock=accept(s,(struct sockaddr *)&cli, &n);
    printf("\nTCP Connection Established.\n");
    s1=(unsigned int) time(NULL);
    srand(s1);
    strcpy(b,"Time Out ");
    recv(sock,a,sizeof(a),0);
    f=atoi(a);
    while(1)
    {
        for(i=0;i<W;i++)
        {
```

```
recv(sock,a,sizeof(a),0);
if(strcmp(a,b)==0)
{
break;
}
}
i=0;
while(i<W)
{
j=rand()%P1;
if(j<P2)
{
send(sock,b,sizeof(b),0);
break;
}
else
{
alpha9(c);
if(c<=f)
{
printf("\nFrame %s Received ",a);
send(sock,a,sizeof(a),0);
}
else
{
break;
}
c++;
}
}
if(c>f)
{
break;
}
i++;
}
}
close(sock);
close(s);
return 0;
}
```

```

void alpha9(int z)
{
int k,i=0,j,g;
k=z;
while(k>0)
{
i++;
k=k/10;
}
g=i;
i--;
while(z>0)
{
k=z%10;
a[i]=k+48;
i--;
z=z/10;
}
a[g]='\0';
}

```

```

Wed 06:55
p1920@administrator-rusa: ~/unnt/CN
File Edit View Search Terminal Help
The packet number 1 is not received
resending packet 1
The recieved packet is 0
All packets sent successfully
p1920@administrator-rusa: ~/unnt/CN$ ./a.out
1.Selective repeat ARQ
2.Goback ARQ
3.exit
Enter your choice:2
Enter the no. of packets to be sent:2
Floating point exception (core dumped)
p1920@administrator-rusa: ~/unnt/CN$ ./a.out
1.Selective repeat ARQ
2.Goback ARQ
3.exit
Enter your choice:2
Enter the no. of packets to be sent:3
Enter data for packets[1]2
Enter data for packets[2]1
Enter data for packets[3]5
The packet number 1 is not received
2 resending from packet 1
Received data of packet 1 is 2
Received data of packet 2 is 1
Received data of packet 3 is 5
all packets sent successfully
p1920@administrator-rusa: ~/unnt/CN$

```

### 3. Selective repeat ARQ

Reciver.c

```
#include<stdio.h>
#include<sys/types.h>
#include<sys/socket.h>
#include<netinet/in.h>
#include<string.h>
#include<time.h>
#include<stdlib.h>
#include<ctype.h>
#include<arpa/inet.h>
#define W 5
#define P1 50
#define P2 10
char a[10];
char b[10];
void alpha9(int);
void alp(int);
int main()
{
    struct sockaddr_in ser,cli;
    int s,n,sock,i,j,c=1,f;
    unsigned int s1;
    s=socket(AF_INET,SOCK_STREAM,0);
    ser.sin_family=AF_INET;
    ser.sin_port=6500;
    ser.sin_addr.s_addr=inet_addr("127.0.0.1");
    bind(s,(struct sockaddr *) &ser, sizeof(ser));
    listen(s,1);
    n=sizeof(cli);
    sock=accept(s,(struct sockaddr *)&cli, &n);
    printf("\nTCP Connection Established.\n");
    s1=(unsigned int) time(NULL);
    srand(s1);
    strcpy(b,"Time Out ");
    recv(sock,a,sizeof(a),0);
    f=atoi(a);
    while(1)
    {
        for(i=0;i<W;i++)
        {
```

```
recv(sock,a,sizeof(a),0);
if(strcmp(a,b)==0)
{
break;
}
}
i=0;
while(i<W)
{
L:
j=rand()%P1;
if(j<P2)
{
alp(c);
send(sock,b,sizeof(b),0);
goto L;
}
else
{
alpha9(c);
if(c<=f)
{
printf("\nFrame %s Received ",a);
send(sock,a,sizeof(a),0);
}
else
{
break;
}
c++;
}
if(c>f)
{
break;
}
i++;
}
}
close(sock);
close(s);
```

```
return 0;
}
void alpha9(int z)
{
int k,i=0,j,g;
k=z;
while(k>0)
{
i++;
k=k/10;
}
g=i;
i--;
while(z>0)
{
k=z%10;
a[i]=k+48;
i--;
z=z/10;
}
a[g]='\0';
}
void alp(int z)
{
int k,i=1,j,g;
k=z;
b[0]='N';
while(k>0)
{
i++;
k=k/10;
}
g=i;
i--;
while(z>0)
{
k=z%10;
b[i]=k+48;
i--;
z=z/10;
}
```



```
}  
b[g]='\0';  
}
```

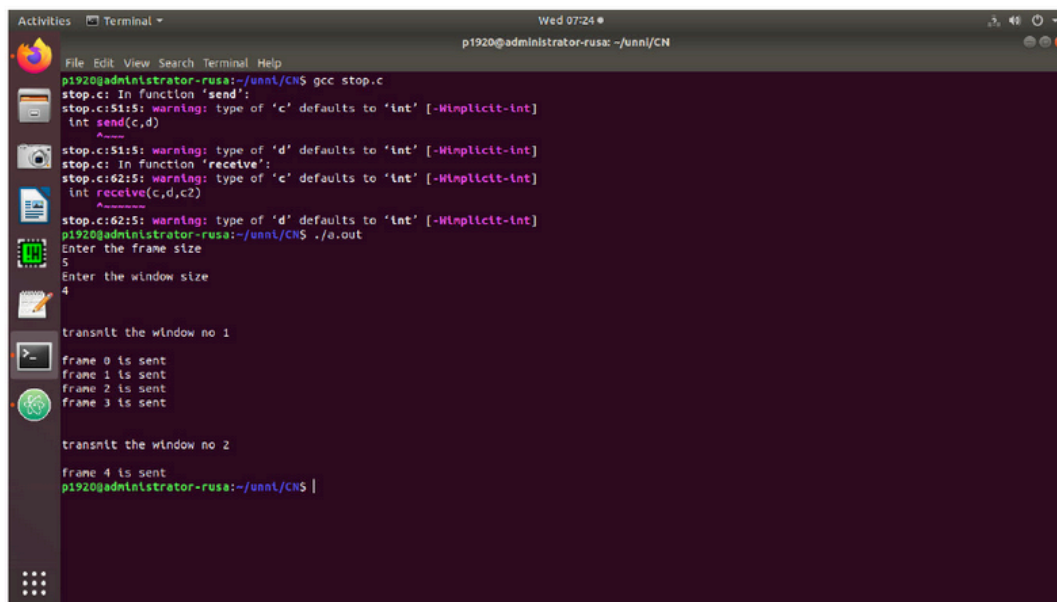
### **Client.c**

```
#include<stdio.h>  
#include<sys/types.h>  
#include<sys/socket.h>  
#include<netinet/in.h>  
#include<string.h>  
#include<time.h>  
#include<stdlib.h>  
#include<ctype.h>  
#define W 5  
char a[10];  
char b[10];  
void alpha9(int);  
int con();  
int main()  
{  
    int s,f,wl,c=1,x,i=0,j,n,p=0,e=0;  
    struct sockaddr_in ser;  
    s=socket(AF_INET,SOCK_STREAM,0);  
    ser.sin_family=AF_INET;  
    ser.sin_port=6500;  
    ser.sin_addr.s_addr=inet_addr("127.0.0.1");  
    connect(s,(struct sockaddr *) &ser, sizeof(ser));  
    printf("\nTCP Connection Established.\n");  
    printf("\nEnter the number of Frames: ");  
    scanf("%d",&f);  
    alpha9(f);  
    send(s,a,sizeof(a),0);  
    strcpy(b,"Time Out ");  
    while(1)  
    {  
        for(i=0;i<W;i++)  
        {  
            alpha9(c);  
            send(s,a,sizeof(a),0);
```

```
if(c<=f)
{
printf("\nFrame %d Sent",c);
c++;
}
}
i=0;
wl=W;
while(i<W)
{
recv(s,a,sizeof(a),0);
p=atoi(a);
if(a[0]=='N')
{
e=con();
if(e<f)
{
printf("\nNAK %d",e);
printf("\nFrame %d sent",e);
i--;
}
}
else
{
if(p<=f)
{
printf("\nFrame %s Acknowledged",a);
wl--;
}
else
{
break;
}
}
if(p>f)
{
break;
}
i++;
}
```

```
if(wl==0 && c>f)
{
send(s,b,sizeof(b),0);
break;
}
else
{
c=c-wl;
wl=W;
}
}
close(s);
return 0;
}
void alpha9(int z)
{
int k,i=0,j,g;
k=z;
while(k>0)
{
i++;
k=k/10;
}
g=i;
i--;
while(z>0)
{
k=z%10;
a[i]=k+48;
i--;
z=z/10;
}
a[g]='\0';
}
int con()
{
char k[9];
int i=1;
while(a[i]!='\0')
{
```

```
k[i-1]=a[i];  
i++;  
}  
k[i-1]='\0';  
i=atoi(k);  
return i;  
}
```



```
Activities Terminal Wed 07:24 p1920@administrator-rusa: ~/unnt/CN  
File Edit View Search Terminal Help  
p1920@administrator-rusa:~/unnt/CN$ gcc stop.c  
stop.c: In function 'send':  
stop.c:51:5: warning: type of 'c' defaults to 'int' [-Wimplicit-int]  
    int send(c,d)  
    ^~~~~~  
stop.c:51:5: warning: type of 'd' defaults to 'int' [-Wimplicit-int]  
stop.c: In function 'receive':  
stop.c:62:5: warning: type of 'c' defaults to 'int' [-Wimplicit-int]  
    int receive(c,d,c2)  
    ^~~~~~  
stop.c:62:5: warning: type of 'd' defaults to 'int' [-Wimplicit-int]  
p1920@administrator-rusa:~/unnt/CN$ ./a.out  
Enter the frame size  
5  
Enter the window size  
4  
  
transmit the window no 1  
  
frame 0 is sent  
frame 1 is sent  
frame 2 is sent  
frame 3 is sent  
  
transmit the window no 2  
  
frame 4 is sent  
p1920@administrator-rusa:~/unnt/CN$ |
```

## Experiment 6

### **Implement and simulate algorithm for Distance Vector Routing protocol**

**Aim:** To implement and simulate algorithm for Distance vector routing protocol

**Description:**

This algorithm is iterative, and distributed. Each node receives information from its directly attached neighbors, performs some calculations and results to its neighboring nodes. This process of updating the information goes on until there is no exchange of information between neighbors.

**Algorithm:**

(adapted from Computer Networking – A top down approach by Kurose and Rose)

Bellman Ford algorithm is applied.

Let  $dx(y)$  be the cost of the least cost path from node  $x$  to node  $y$ . Then Bellman Ford equation states that

$$dx(y) = \min\{ c(x,v) + dv(y) \}$$

$v$

where  $v$  is a neighbour of node  $x$ .  $dv(y)$  is the cost of the least cost path from  $v$  to  $y$ .  $c(x,v)$  is the cost from  $x$  to neighbour  $v$ . The least cost path has a value equal to minimum of  $c(x,v) + dv(y)$  over all its neighbours  $v$ . The solution of Bellman Ford equation provides entries in node  $x$ 's forwarding table.

Distance vector (DV) algorithm

At each node  $x$

Initialization:

for all destinations  $y$  in  $N$ :

$$D_x(y) = c(x,y) \text{ /* if } y \text{ is not a neighbour of } x, \text{ then } c(x,y) = \infty \text{ */}$$

```
for each neighbour w,  
send distance vector  $D_x = \{ D_x(y): y \text{ in } N \}$  to w  
loop:  
for each y in N:  
 $D_x(y) = \min \{ c(x,v) + D_v(y) \}$ 
```