Network Protocols

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Elementary UDP Sockets

Outline

- Elementary UDP Sockets (Chapter 8)
  - Information to write a complete UDP client and server

Typical Scenario between UDP client/server

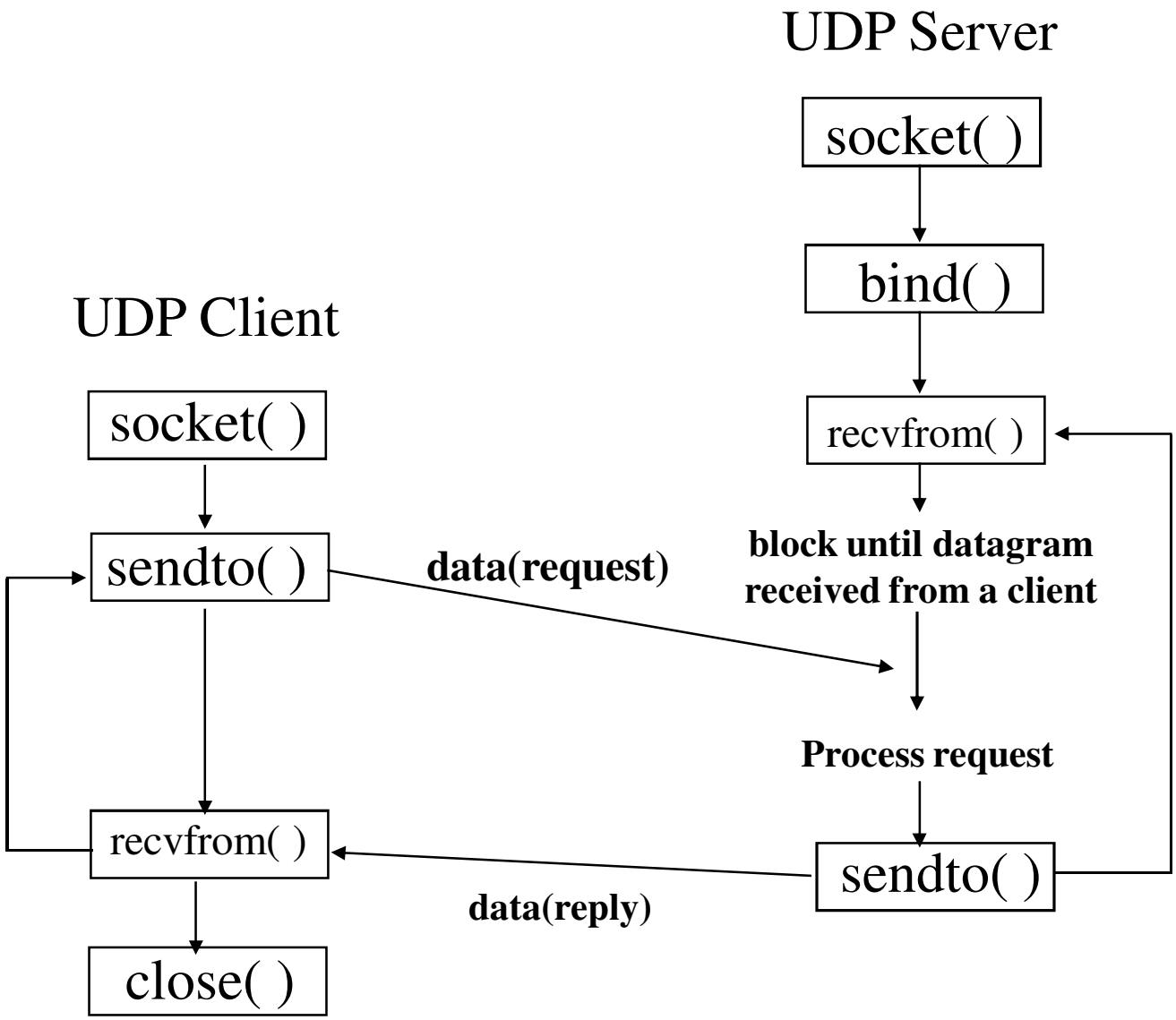
Typical UDP client

- Client does not establish a connection with the server
- Client sends a datagram to the server using **sendto** function

Typical UDP server

- Does not accept a connection from a client
- Server calls **recvfrom** function which waits until data arrives from some client

Socket functions for UDP client/server



recvfrom and **sendto** Function 1/2

```
#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
```

- Both return the amount of user data in the datagram received
- Writing a datagram of length 0 is acceptable (return value from recvfrom?)
- Closing a UDP connection does not make sense?

UDP Echo server: **main**

```
//source code is udpcliserv/udpserv01.c
#include “unp.h”
int main(int argc, char **argv)
{
    int sockfd;
    struck sockaddr_in servaddr,cliaddr;

    sockfd=Socket(AF_INET,SOCK_DGRAM,0);

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

    bind(sockfd, (SA *) &servaddr,sizeof(servaddr));

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

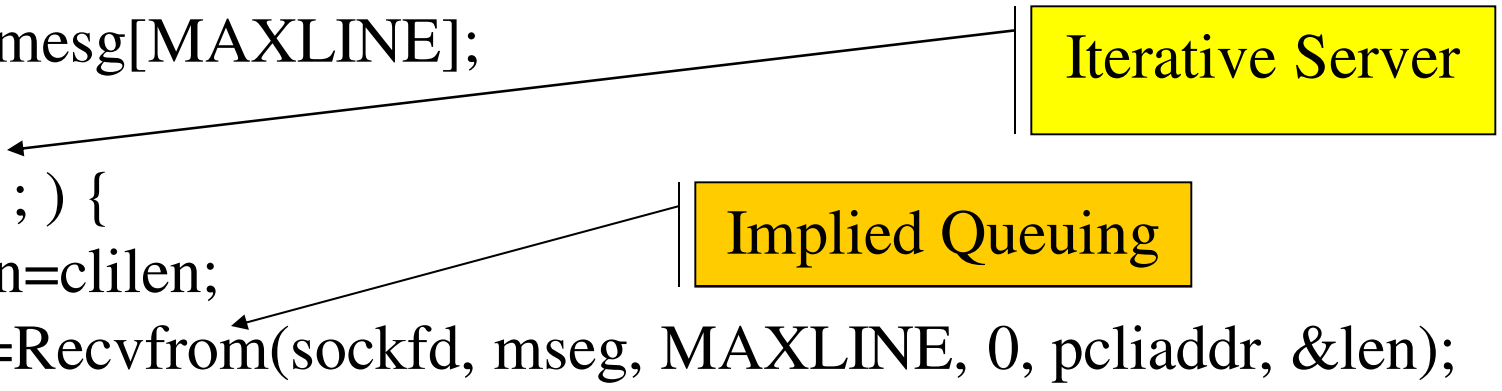
UDP Echo server: **dg_echo** function

//source code is /lib/dg_echo.c

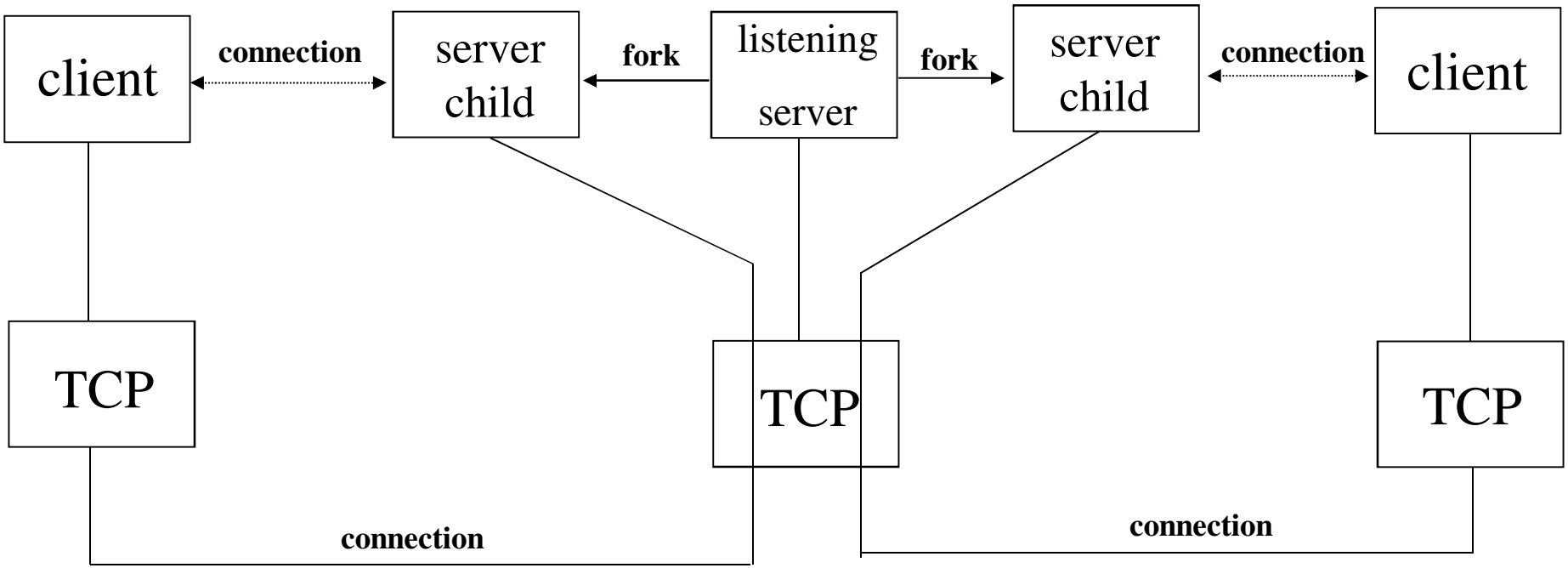
```
#include "unp.h"
void dg_echo(int sockfd, SA *pcliaddr, socklen_t clilen)
{
    int n;
    socklen_t len;
    char mesg[MAXLINE];

    for( ; ; ) {
        len=clilen;
        n=Recvfrom(sockfd, mseg, MAXLINE, 0, pcliaddr, &len);

        sendto(sockfd, mesg, n, 0, pcliaddr, len);
    }
}
```

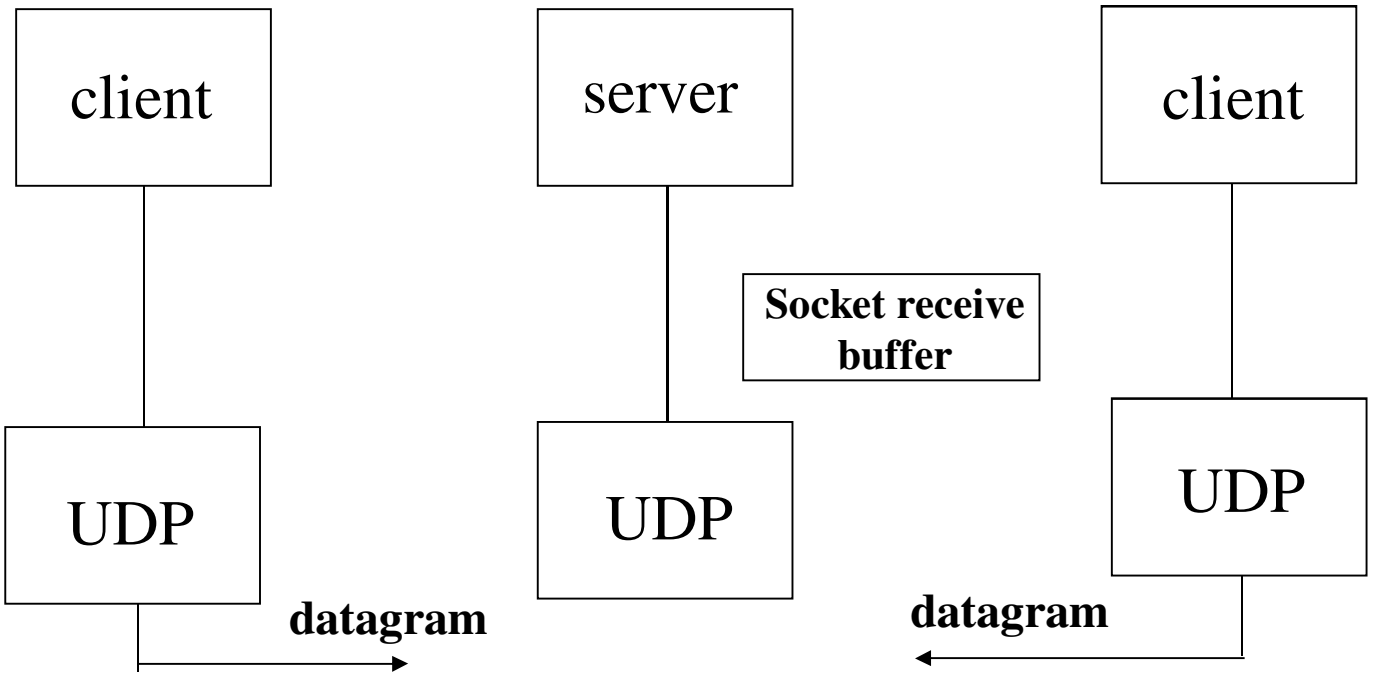


TCP versus UDP server 1/2



Summary of TCP client-server with two clients.

TCP versus UDP server 2/2



Summary of UDP client-server with two clients.

UDP Echo Client: **main**

//source code is udpcliserv/udpcli01.c

```
#include “unp.h”
int main(int argc, char **argv)
{
   int sockfd;
  struct sockaddr_in servaddr;

  if (argc != 2)
    err_quit( “usage : udpcli <Ipaddress>”);

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

  sockfd = Socket(AF_INET, SOCK_DGRAM, 0);

  dg_cli(stdin, sockfd, (SA *) &servaddr, sizeof(servaddr);
  exit(0);
}
```

UDP Echo Client: **dg_cli** function

```
//source code is lib/dg_cli.c
#include “unp.h”
void  dg_cli(FILE *fp, int sockfd, const SA *pservaddr, socklen_t servlen)
{
    int n;
    char sendline[MAXLINE], recvline[MAXLINE+1];

    while(Fgets(sendline, MAXLINE, fp) != NULL)  {
        sendto(sockfd, sendline, strlen(sendline), 0, pservaddr, servlen);

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

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

Did not assign an ephemeral port to UDP Socket?

First time sendto is called

Lost Datagrams

- If the client datagram arrives at the server but the server's reply is lost, the client will *block forever* in its call to *recvfrom.*

- *The only way to prevent this is to place a timeout on the recvfrom*

- *Timeout not the entire solution*
  - Do not know whether client datagram never made it to server
  - Or, Server reply never made it back

- Will fix later

Verifying Received Response 1/3

//Need to return IP address and port of who sent back reply

//source code in udpcliserv/dgcliaddr.c

```
#include "unp.h"
void dg_cli(FILE *fp, int sock, const SA *pseraddr, socklen_t servlen)
{
    int n;
    char sendline[MAXLINE], recvline[MAXLINE];
    socklen_t len;
    struct sockaddr  *preply_addr;
    preply_addr = Malloc(servlen);

    while(Fgets(sendline, MAXLINE, fp) ! = NULL) {
            Sendto(sockfd,sendline, strlen(sendline), 0, pservaddr, servlen);
            len = servlen;
            n = Recvfrom(sockfdm, recvline, MAXLINE, 0, preply_addr,&len);
/* continued in next slide */
```

Verifying Received Response 2/3

//Need to return IP address and port of who sent back reply

//source code in udpcliserv/dgcliaddr.c

```
if(len != servlen || memcmp(pservaddr, preply_addr, len) != 0) {
        printf("reply from %s  (ignore)\n",
                Sock_ntop(preply_addr, len);
        continue;
    }
    recvline[n] = 0;      /*NULL terminate */
    Fputs(recvline, stdout);
  }
}
```

//program can fail if server is multi-homed (The server has not bound an IP address to its socket, the kernel chooses the source address for the IP datagram outgoing from the server)

Verifying Received Response 3/3

- Program can fail if server is multi-homed (The server has not bound an IP address to its socket, the kernel chooses the source address for the IP datagram outgoing from the server)
- Can this be solved otherwise?
  - Verify respondent's host name by looking up its name from DNS (will see later how to do that)
  - Other solution
    - ✓Create a socket for every IP address configured on host
    - ✓Bind IP address to socket
    - ✓Wait for any of these sockets to become readable
    - ✓Reply from this socket

Server not Running

•Client blocks forever in the call to **recvfrom**.

• ICMP error "port unreachable" is an asynchronous error

•Error caused by **sendto** but **sendto** returns successfully (only means there was room for resulting IP datagram on interface output queue). ICMP error returned later → *asynchronous error*

• ***The basic rule is that asynchronous errors are not returned for UDP sockets unless the socket has been connected***

connect function with UDP

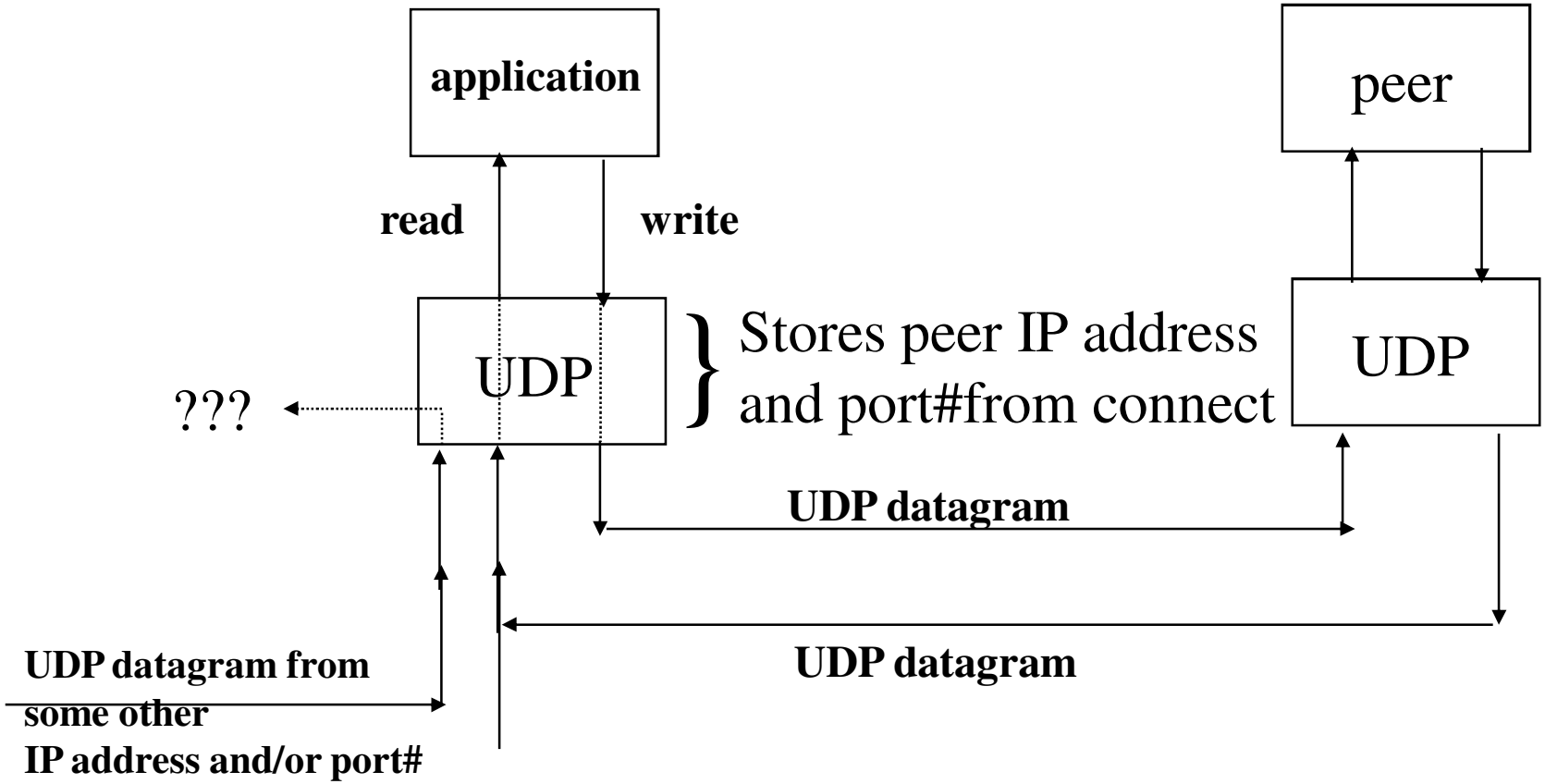
- This does not result in anything like a TCP connection: *there is no three-way handshake*. Instead, the kernel records the IP address and port number of the peer and returns immediately to calling process
- With a connected UDP socket, three things change:

  1. We can no longer specify the destination IP address and port for an output operation. That is, we do not use **sendto** but use **write** or **send** instead. (Can use **sendto** but fifth argument is null, and sixth is zero)

  2. We do not use **recvfrom** but **read** or **recv** instead. Only datagrams returned by the kernel for an input operation on a connected UDP socket are those arriving from protocol address specified in **connect**

  3. Asynchronous errors are returned to the process for a connected UDP socket

connect function with UDP



When an application calls **sendto** on an unconnected UDP socket, Berkeley-derived kernels temporarily connect the socket, send the datagram, and then unconnect the socket (see discussion on page 255)

UDP Echo Client: **dg_cli** revisited

```
//source code is udpcliserv/dgcliconnect.c
#include "unp.h"
void  dg_cli(FILE *fp, int sockfd, const SA *pservaddr, socklen_t servlen)
{
     int n;
     char sendline[MAXLINE], recvline[MAXLINE+1];

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

    while(Fgets(sendline, MAXLINE, fp) != NULL)  {
         Write(sockfd, sendline, strlen(sendline));

         n = Read(sockfd, recvline, MAXLINE);

         recvline[n] = 0;    /* null terminate */
         Fputs(recvline,stdout);
     }
} //ICMP error received after attempting to send the first datagram to server
```