```
#include <stdio.h>      /* for printf() and fprintf() */
#include <sys/socket.h> /* for socket(), connect(), send(), and recv() */
#include <arpa/inet.h>  /* for sockaddr_in and inet_addr() */
#include <stdlib.h>     /* for atoi() */
#include <string.h>     /* for memset() */
#include <unistd.h>     /* for close() */

#define RCVBUFSIZE 32   /* Size of receive buffer */

void DieWithError(char *errorMessage);  /* Error handling function */

int main(int argc, char *argv[])
{
  /* local declarations */ …
  /* command line processing */ …
  /* socket creation */ …
  /* connection establishment */ …
  /* socket sending */ …
  /* socket receiving */ …

    printf("\n");    /* Print a final linefeed */

    close(sock);
    exit(0);
}
```

DieWithError is implemented in a separate source file.

Note the client pattern: socket creation, connection establishment, {send, receive}*, close

Declarations

```
    int sock;                        /* Socket descriptor */
    struct sockaddr_in echoServAddr; /* Echo server address */
    unsigned short echoServPort;     /* Echo server port */
    char *servIP;                    /* Server IP address (dotted quad)
*/
    char *echoString;                /* String to send to echo server */
    char echoBuffer[RCVBUFSIZE];     /* Buffer for echo string */
    unsigned int echoStringLen;      /* Length of string to echo */
    int bytesRcvd, totalBytesRcvd;   /* Bytes read in single recv()
                                        and total bytes read */
```

Socket descriptor is a file descriptor (in Unix); In Winsock a similar role is played by a socket “handle”

Struct sockaddr_in is the structure containing internet addresses; other address families use different sockaddr structures

servIP is a character string containing an address such as “199.237.73.84”

Command Line Processing

```
    if ((argc < 3) || (argc > 4))
       /* Test for correct number of arguments */
    {
       fprintf(stderr, "Usage: %s <Server IP> <Echo Word> [<Echo \
Port>]\n", argv[0]);
       exit(1);
    }

    servIP = argv[1];   /* First arg: server IP address (dotted quad) */
    echoString = argv[2];         /* Second arg: string to echo */

    if (argc == 4)
        echoServPort = atoi(argv[3]); /* Use given port, if any */
    else
        echoServPort = 7;
        /* 7 is the well-known port for the echo service */
```

Note use of default port if none is provided on the command line. Our machines don't have an echo server running so this is not a useful feature.

As a rule I don't like the practice of writing then and else clauses without surrounding braces. I find such code to be error-prone.

Socket Creation

```
/* Create a reliable, stream socket using TCP */
if ((sock = socket(PF_INET, SOCK_STREAM, IPPROTO_TCP)) < 0)
  DieWithError("socket() failed");

/* Construct the server address structure */
memset(&echoServAddr, 0, sizeof(echoServAddr));
       /* Zero out structure */

echoServAddr.sin_family      = AF_INET;
       /* Internet address family */

echoServAddr.sin_addr.s_addr = inet_addr(servIP);
       /* Server IP address */

echoServAddr.sin_port = htons(echoServPort);
       /* Server port */
```

A socket descriptor is created with a call to socket()

inet_addr() converts a dotted quad string to the internal representation of a network address

htons(), pronounced "host to network short", converts a 2byte internal representation to network byte order. Values in a struct sockaddr_in are in network byte order. Similar functions ntohs, htonl, and ntohl all exist. The "L" variants operate on 4 byte quantities.

Establishing the connection

```
/* Establish the connection to the echo server */
if (connect(sock, (struct sockaddr *) &echoServAddr,
            sizeof(echoServAddr)) < 0)
  DieWithError("connect() failed");
```

connect() carries out the initial handshake of the protocol for setting up a TCP connection. Note cast of a (struct sockaddr_in *) value to (struct sockaddr *) and the passing of an explicit length for the structure.

Socket Sending

```
    echoStringLen = strlen(echoString);    /* Determine input length */

    /* Send the string to the server */
    if (send(sock, echoString, echoStringLen, 0) != echoStringLen)
        DieWithError("send() sent a different number of bytes than \
expected");
```

Note that an explicit length is passed to send – it does not treat its first argument as a null-terminated string because send is used for sending binary data. The 4th argument, 0 here, is a set of flags. Note also the expectation here that send will return the length of the provided data.

Socket Receiving

```
/* Receive the same string back from the server */
totalBytesRcvd = 0;
printf("Received: ");        /* Setup to print the echoed string */
while (totalBytesRcvd < echoStringLen)
{
  /* Receive up to the buffer size (minus 1 to leave space for
     a null terminator) bytes from the sender */
  if ((bytesRcvd = recv(sock, echoBuffer, RCVBUFSIZE - 1, 0)) <= 0)
     DieWithError("recv() failed or connection closed prematurely");
    totalBytesRcvd += bytesRcvd;   /* Keep tally of total bytes */
    echoBuffer[bytesRcvd] = '\0';  /* Terminate the string! */
    printf(echoBuffer);            /* Print the echo buffer */
}
```

Again, the 4th argument to recv(), here 0, contains flags. We'll talk more about those later. Here we are prepared to receive the data piecemeal, hence the loop surrounding recv().