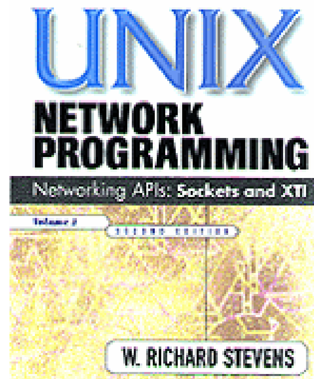
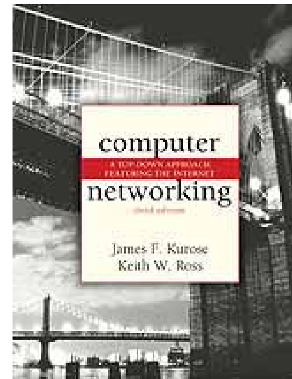
Socket Programming

2005/03/16

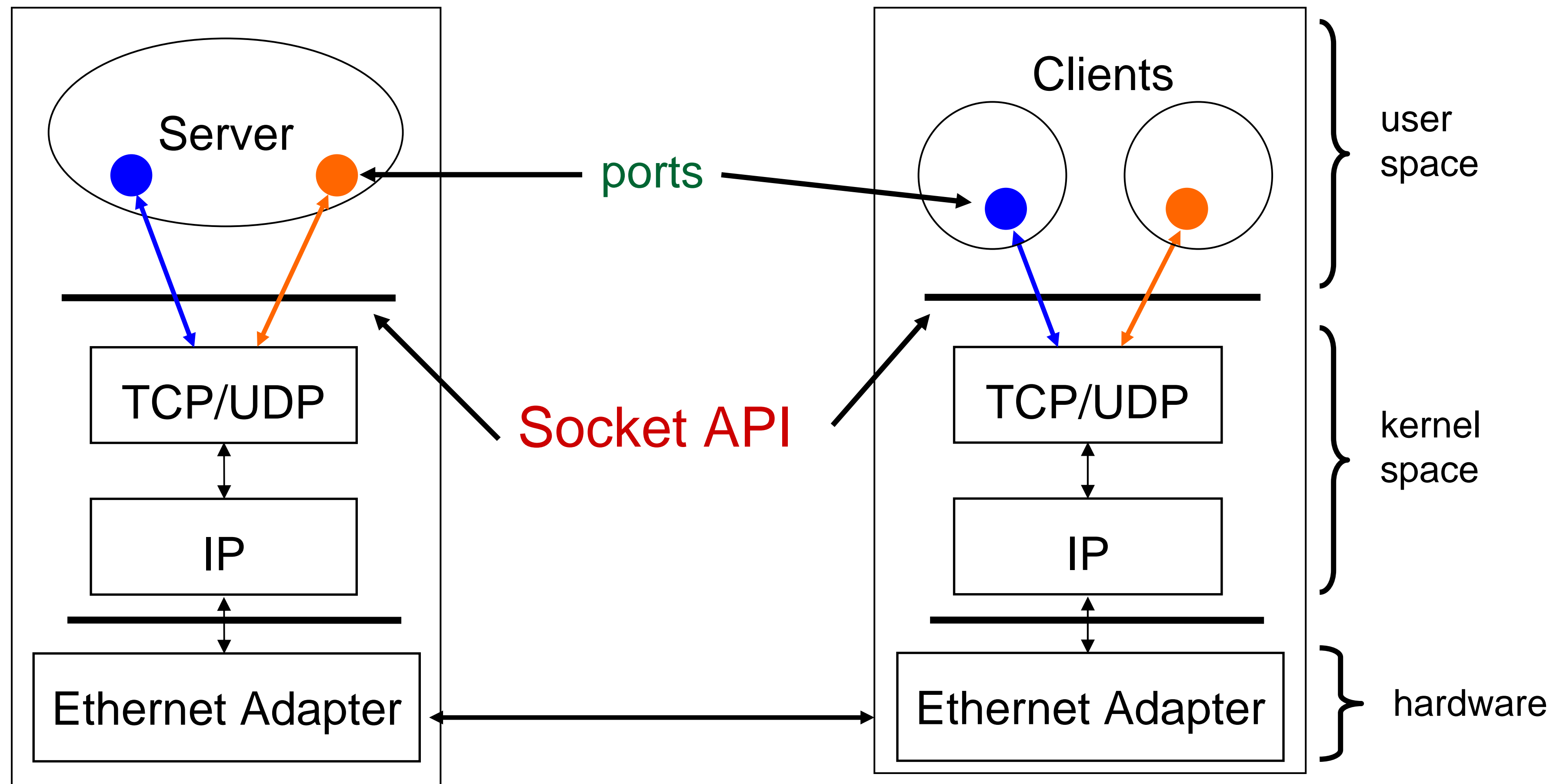
Reference

- W. Richard Stevens, “Unix Network Programming 2/e Volume 1” ,1998
- James F. Kurose and Keith W. Ross, "Computer Networks: A Top-Down Approach Featuring the Internet 3/e“, 2002.

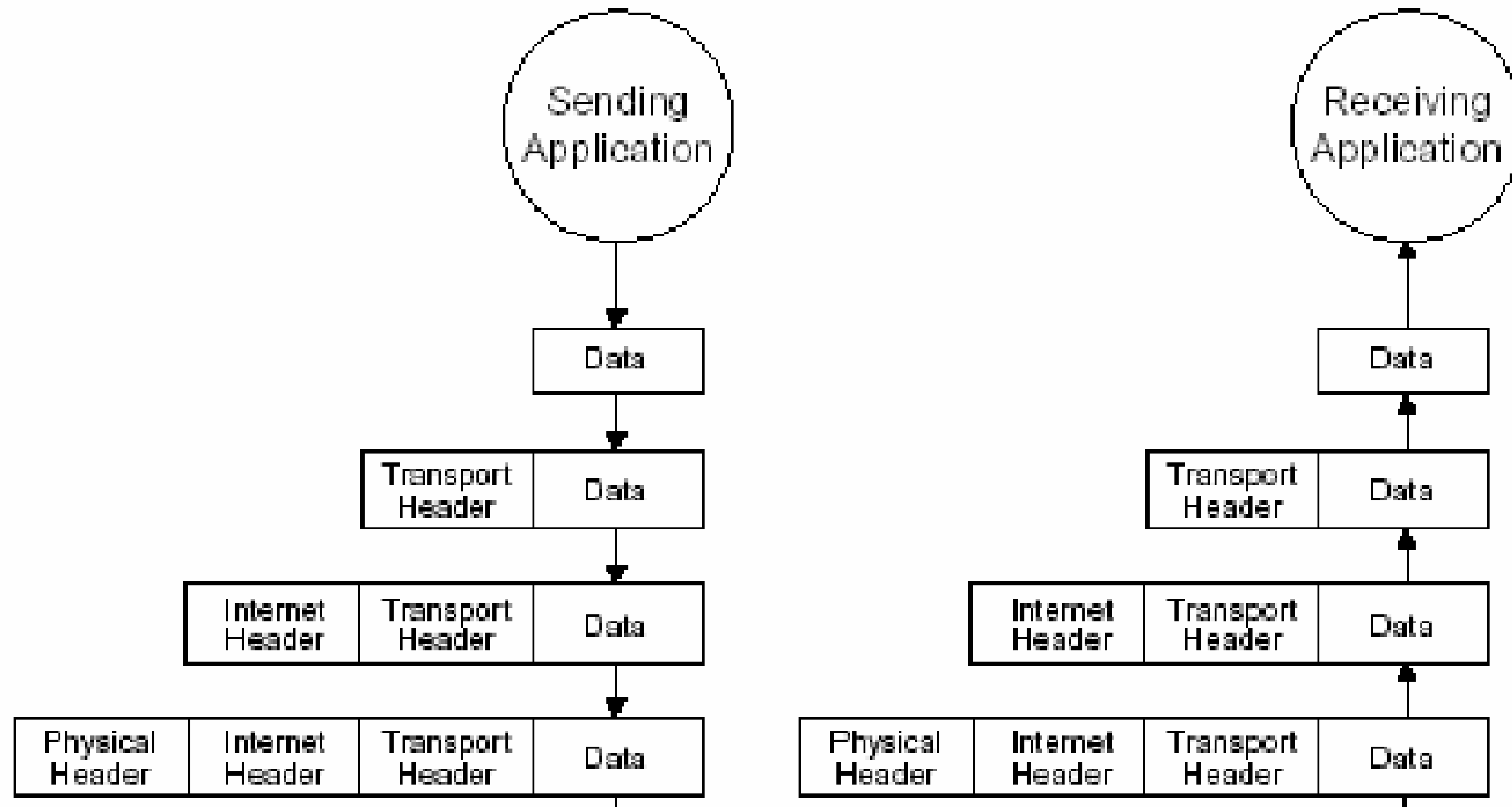




Server & Client

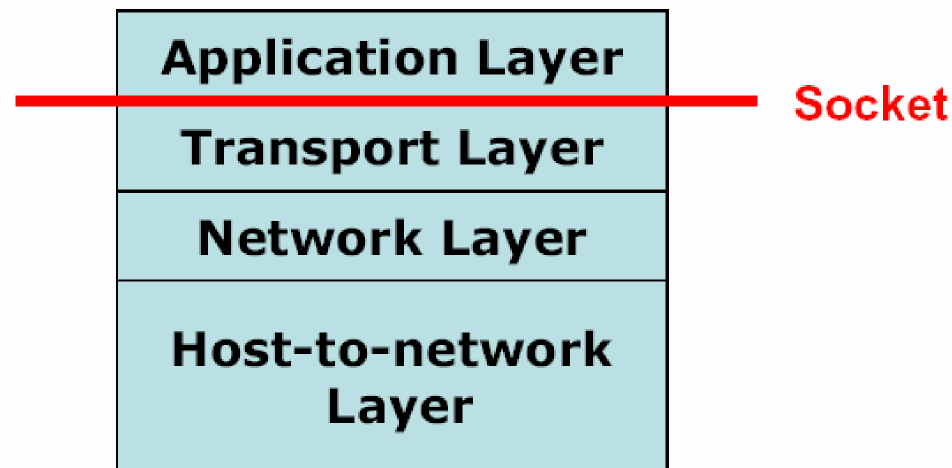


Server & Client



What is Socket?

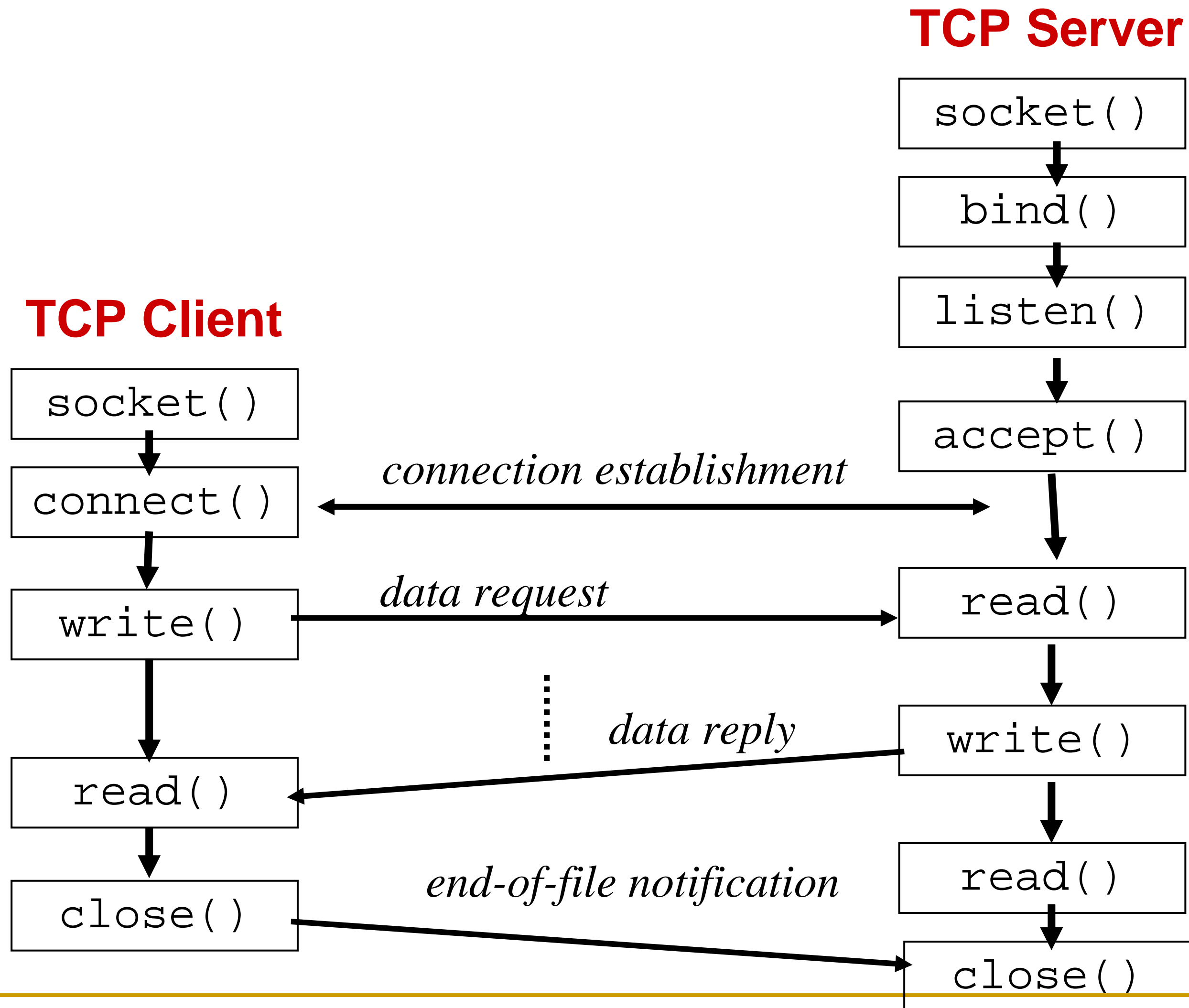
- Service access point of TCP/IP protocol stacks
- Socket is an interface between Application layer and Transport layer



What is Socket?

- A socket is a file descriptor that lets an application read/write data from/to the network
- Once configured the application can
  - pass data to the socket for network transmission
  - receive data from the socket (transmitted through the network by some other host)

TCP Client & Server



socket()

- int s = socket(domain, type, protocol);
  - s: socket descriptor
  - domain: integer, communication domain
    - e.g., AF_INET (IPv4 protocol) – typically used
  - type: communication type
    - SOCK_STREAM: reliable, 2-way, connection-based service (TCP)
    - SOCK_DGRAM: unreliable, connectionless (UDP)
  - protocol: specifies protocol (see file /etc/protocols for a list of options) - usually set to 0

socket()

- Ex.

```
int s;                  /* socket descriptor */

if((s = socket(AF_INET, SOCK_STREAM, 0)) < 0) {
        perror("socket");
        exit(1);
}
```

bind()

- int status = bind(sockid, &addrport, size);
  - status: error status, = -1 if bind failed
  - sockid: integer, socket descriptor
  - addrport: struct sockaddr, the (IP) address and port of the machine (address usually set to INADDR_ANY – chooses a local address)
  - size: the size (in bytes) of the addrport structure

bind()

- Ex.

```
int s;                          /* socket descriptor */
struct sockaddr_in srv;         /* used by bind() */

/* create the socket */

srv.sin_family = AF_INET; /* use the Internet addr family */

srv.sin_port = htons(8888); /* bind socket ‘fd’ to port 8888*/

/* bind: a client may connect to any of my addresses */
srv.sin_addr.s_addr = htonl(INADDR_ANY);

if(bind(s, (struct sockaddr*) &srv, sizeof(srv)) < 0) {
       perror("bind"); exit(1);
}
```

listen()

- int status = listen(sock, queuelen);
  - status: 0 if listening, -1 if error
  - sock: integer, socket descriptor
  - queuelen: integer, # of active participants that can "wait" for a connection
  - listen is **non-blocking**: returns immediately

listen()

- Ex.

```
int s;                          /* socket descriptor */
struct sockaddr_in srv;         /* used by bind() */

/* 1) create the socket */
/* 2) bind the socket to a port */

if(listen(s, 5) < 0) {
        perror("listen");
        exit(1);
}
```

accept()

- int s = accept(sock, &name, &namelen);
  - s: integer, the new socket (used for data-transfer)
  - sock: integer, the orig. socket (being listened on)
  - name: struct sockaddr, address of the active participant
  - namelen: sizeof(name): value/result parameter
    - must be set appropriately before call
    - adjusted by OS upon return
  - accept is **blocking**: waits for connection before returning

accept()

- Ex.

```
int s;                                  /* socket descriptor */
struct sockaddr_in srv;                /* used by bind() */
struct sockaddr_in cli;                /* used by accept() */
int newfd;                             /* returned by accept() */
int cli_len = sizeof(cli); /* used by accept() */

/* 1) create the socket */
/* 2) bind the socket to a port */
/* 3) listen on the socket */

newfd = accept(s, (struct sockaddr*) &cli, &cli_len);
if(newfd < 0) {
        perror("accept");    exit(1);
}
```

connect()

- int status = connect(sock, &name, namelen);
  - status: 0 if successful connect, -1 otherwise
  - sock: integer, socket to be used in connection
  - name: struct sockaddr: address of passive participant
  - namelen: integer, sizeof(name)
- connect is **blocking**

connect()

- Ex.

```
int s;                                  /* socket descriptor */
struct sockaddr_in srv;                 /* used by connect() */

/* create the socket */

/* connect: use the Internet address family */
srv.sin_family = AF_INET;

/* connect: socket ‘s’ to port 8888 */
srv.sin_port = htons(8888);

/* connect: connect to IP Address “140.112.1.1” */
srv.sin_addr.s_addr = inet_addr(“140.112.1.1”);

if(connect(s, (struct sockaddr*) &srv, sizeof(srv)) < 0) {
        perror(”connect"); exit(1);
}
```

read()

- Ex.

```
int s;                                  /* socket descriptor */
char buf[512];                          /* used by read() */
int nbytes;                            /* used by read() */

/* 1) create the socket */
/* 2) bind the socket to a port */
/* 3) listen on the socket */
/* 4) accept the incoming connection */

if((nbytes = read(s, buf, sizeof(buf))) < 0) {
        perror("read"); exit(1);
}
```

- ***read* blocks waiting for data from the client but does not guarantee that sizeof(buf) is read**

write()

- Ex.

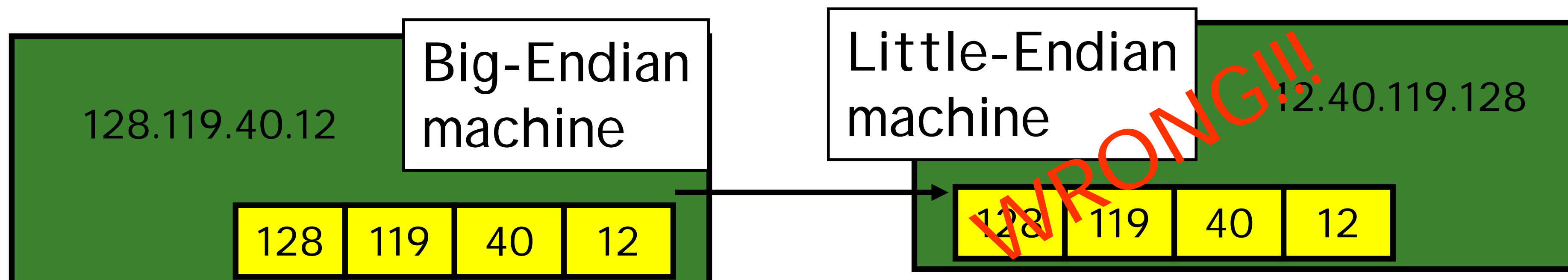
```
int s;                            /* socket descriptor */
char buf[512];                    /* used by write() */
int nbytes;                       /* used by write() */

/* 1) create the socket */
/* 2) bind the socket to a port */
/* 3) listen on the socket */
/* 4) accept the incoming connection */

if((nbytes = write(s, buf, sizeof(buf))) < 0) {
      perror("write");
      exit(1);
}
```

Address & Port Byte Ordering

- Address and port are stored as integers
  - Problem:
  - different machines / OS's use different word orderings
    - little-endian: lower bytes first
    - big-endian: higher bytes first
  - these machines may communicate with one another over the network



Byte Ordering Solution

- htons(): “Host to Network Short”
- htonl(): “Host to Network Long”
- ntohs(): “Network to Host Short”
- ntohl(): “Network to Host Long”

Other Useful Function

- void bzero(void *dest, size_tnbytes);
- void bcopy(const void *src, void *dest, size_tnbytes);
- int bcmp(const void *ptr1, const void *ptr2, size_tnbytes);
- void *memset(void *dest, intc, size_tnbytes);
- void *memcpy(void *dest, const void *src, size_tnbytes);
- int memcmp(const void *ptr1, const void *ptr2, size_tnbytes);

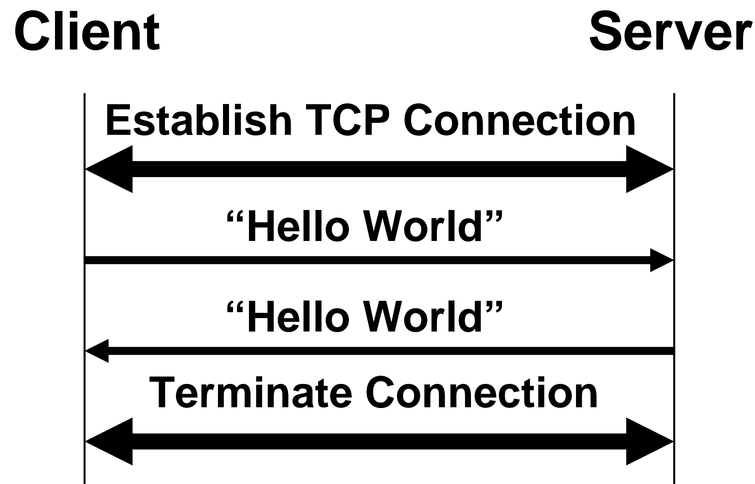
Other Useful Function

- int gethostname(char *name, int len)
- struct hostent * gethostbyaddr(char *addr, int len, int type):
- in_addr_t inet_addr(const char *cp)
- char * inet_ntoa(const struct in_addr in)

- Make sure to #include the header files, check it yourself !!

HW1:Echo Server & Client

- Your job is to implement an Echo Server which will send back whatever it receives
- You also have to write a program which will send message to the Echo Server



HW1:Echo Server & Client

- Echo Server execution format

```
EchoServer server_port
```

  - While someone connects to the server, server should output some information

```
Client_IP[140.112.30.1]
Client_Port[54321]
Message_Received[Hello World]
Message_Sendback[Hello World]
```

- Client execution format

```
EchoClient server_ip server_port message
```

HW1:Echo Server & Client

- Your program must be gcc 3.3.1 compatible
- Name your program in this way
  - b91902xxx_s.cc for Echo Server
  - b91902xxx_c.cc for Client
- Make your program as a tarball

```
tar zcvf b91902xxx_hw1.tar.gz b91902xxx_s.cc b91902xxx_c.cc
```

- Email the tarball to network_hw@voip.csie.ntu.edu.tw
  - Subject:[network hw1]b91902xxx name
- Due after two weeks (3/30 PM2:20)