EECS 489 - Winter 2024

Discussion 1

Assignment 1 is out!

- Due Date: Friday, January 26th @ 11:59 pm EDT
  - Autograder + Repos will be released soon, sorry for the delay!
- Start early and have fun!
- Make sure to fill out the GitHub info form ASAP when it is out!
  - This is your only way you will be able to submit to the autograder

Today

- Socket Programming
  - Stepping through functions
  - Walking through code example

Socket Programming: Introduction

- How does a server and a client communicate over the network?

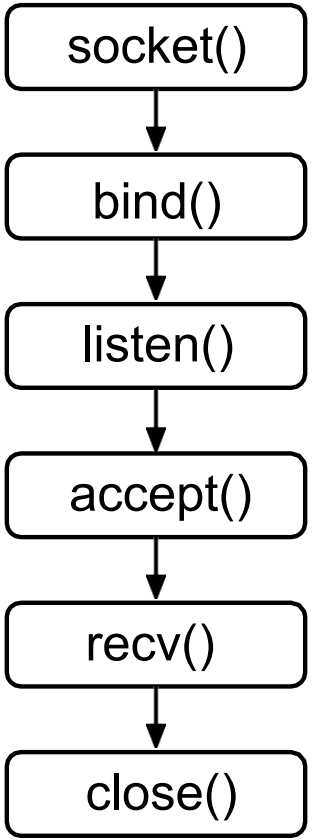
- Host (Server) ------ Network ------ Host (Client)

- Sockets will save the day!

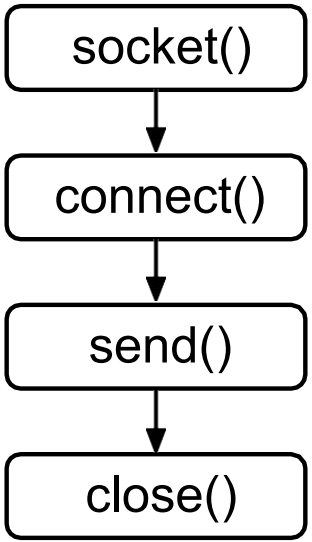
Socket Programming: Introduction

- What is a socket?
  - A socket is a communication endpoint at the hosts (applications) for communication flow
- Why do we use sockets?
  - A socket provides an API for exchanging data
    - Can be on different machines, or even the same machine! (Different processes)

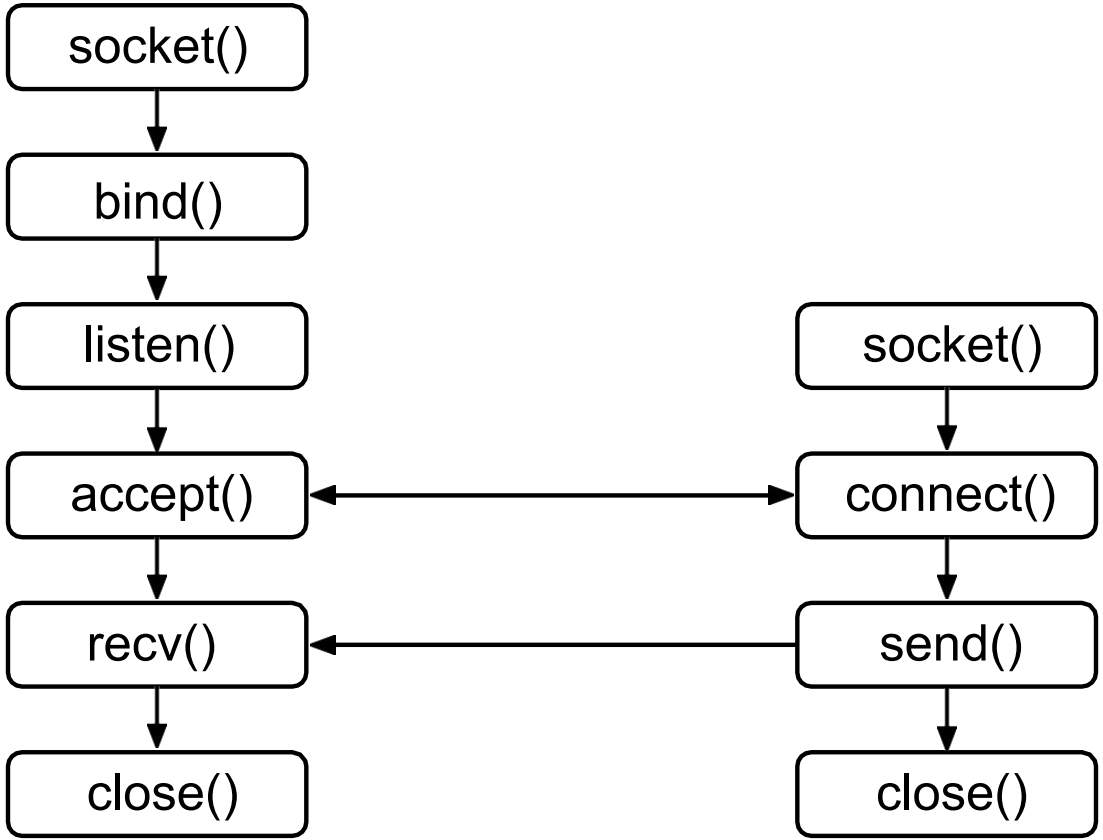
Socket Programming: Server Side



Socket Programming: Client Side



Socket Programming: Complete Flow



Socket Programming: socket()

- Creates a socket
- Returns a file descriptor that is used to refer to the socket object created
- sockfd = socket(AF_INET, SOCK_STREAM, IPPROTO_TCP);

```
int socket(int domain, int type, int protocol);
```

Socket Programming: bind()

- Binds an address (unique local name) to a socket
  - Sockets are unnamed when initially created
  - Returns 0 if successful, or -1 if error
- bind(sockfd, (struct sockaddr *) &addr, sizeof(addr));

```
int bind(int sockfd, const struct sockaddr *addr,
         socklen_t addrlen);
```

- NOTE: Do not put `using namespace std;` to avoid having issues with C++'s std::bind function

Socket Programming: socket addr

- Server:
  - `struct sockaddr_in addr;`
  - `memset(&addr, 0, sizeof(addr));`
  - `addr.sin_family = AF_INET;`
  - `addr.sin_addr.s_addr = INADDR_ANY;`
  - `addr.sin_port = htons(port);`
- Client:
  - `struct hostent* host = gethostbyname(hostname); // server hostname`
  - `struct sockaddr_in addr;`
  - `addr.sin_family = AF_INET;`
  - `memcpy(&(addr->sin_addr), host->h_addr, host->h_length);`
  - `addr.sin_port = htons(server_port);`

Quick Aside: Byte Order

- Internet: Big Endian
- Host: Machine Dependent

- Refresher: Represent the hex value **b34f**
  - Big Endian: **b34f**
  - Little Endian: **4fb3**

Function	Description
`htons()`	`h`ost `to` `n`etwork `s`hort
`htonl()`	`h`ost `to` `n`etwork `l`ong
`ntohs()`	`n`etwork `to` `h`ost `s`hort
`ntohl()`	`n`etwork `to` `h`ost `l`ong

Socket Programming: listen()

- Listens for connections on a socket
  - Takes in max number of pending connections allowed (backlog)
  - Returns 0 upon successful completion, or -1 if error
- listen(sockfd, 10);

```
int listen(int sockfd, int backlog);
```

Socket Programming: connect()

- Initiate a connection on a socket
  - Returns 0 if successful, or -1 if error
- socklen_t addr_len = sizeof(addr);
- connect(sockfd, (struct sockaddr *) &addr, &addr_len);

```
int connect(int sockfd, const struct sockaddr *addr,
            socklen_t addrlen);
```

Socket Programming: accept()

- Accepts a connection on a socket
  - Returns the file descriptor of the accepted socket, or -1 if error
- socklen_t addr_len = sizeof(addr);
- int connectfd = accept(sockfd, (struct sockaddr *) addr, &addr_len);

```
int accept(int sockfd, struct sockaddr *addr, socklen_t *addrlen);
```

Socket Programming: send()

- Sends a message on a socket
  - Returns the number of bytes read in, or -1 if error
- bytes_sent = send(connectfd, buffer, len, 0);
  - Last part is a flag, look at manual pages for different ones

```
ssize_t send(int sockfd, const void *buf, size_t len, int flags);
```

Socket Programming: recv()

- Receive a message from a socket
  - Returns the number of bytes read in, or -1 if error
- bytes_recv = recv(connectfd, buffer, len, MSG_WAITALL);
  - Last part is a flag, look at manual pages for different ones

```
ssize_t recv(int sockfd, void *buf, size_t len, int flags);
```

Socket Programming: Resources

- Beej's Guide to Network Programming
- Discussion Socket Example (from EECS 482)
- Open Group Docs
  - Page for socket (can lookup functions, too)
- Linux manual pages
  - `man socket`

Useful Libraries

```
#include <arpa/inet.h>        // htons(), ntohs()
#include <netdb.h>      // gethostbyname(), struct hostent
#include <netinet/in.h>       // struct sockaddr_in
#include <stdio.h>       // perror(), fprintf()
#include <string.h>      // memcpy()
#include <sys/socket.h>       // getsockname()
#include <unistd.h>       // stderr
#include <time.h>       //time(&time_t)
```

Wrap-Up

- Thanks for coming!
- Make sure to start Assignment 1 soon!
- Any last questions?