# COMS 3157: Advanced Programming
# Networking and Sockets

May 3, 2025

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1. What are the steps in order to send and recieve data from a client to a server?
2. Explain the each parameter in socket(int domain, int type, int protocol) (3 marks)
   (a) int domain
   (b) int type
   (c) int protocol
3. Syntax for establishing UDP/TCP sockets (2 marks)
   (a) What is the syntax to establish a UDP socket?
   (b) What is the syntax to establish a TCP socket?
4. What is the purpose of binding in networking (used in both UDP/TCP)?
5. Explain the parameters of bind(int sockfd, const struct sockaddr *my_addr, socklen_t addrlen) (1 mark)
   (a) int sockfd
   (b) struct *my_addr
   (c) socklen_t addrlen
6. Given that the `struct sockaddr` in the bind() method is designed to work for all networking connections i.e. outside of only just UDP and TCP, explain the significance of each field for `struct sockaddr` (1 mark)
   (a) sa_family_t sa_family
   (b) char sa_data[14]

```c
struct sockaddr {
    sa_family_t sa_family; // unsigned short
    char sa_data[14]; // blob
}
```

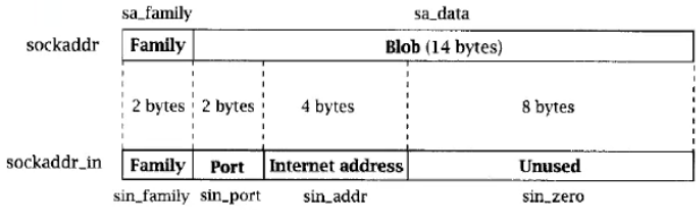
Listing 1: struct sockaddr

7. Below is the syntax for delcaring a struct that holds information for constructing an IPv4 address. How can we pass this in as an argument for the aforementioned bind() function? (1 mark)

```
struct sockaddr_in {
    sa_family_t sin_family;   // unsigned short, address family: AF_INET
    in_port_t sin_port;       // unsigned short, port in network byte order
    struct in_addr sin_addir; // internet address
    char sin_zero[8];         // not used}
```

Listing 2: IPv4 sockaddr_in struct

Hint below!




8. If I gave you an 32-bit integer with value 1, write the C code to determine if the value is stored as little-endian or big-endian format. The integer is stored in a variable named `x`. (1 mark)

9. Write C code to (2 marks)
   (a) convert little endian to big endian format for a short
   (b) convert big endian to little endian format for a short

10. State whether network byte order and host byte order use big or little endian. (2 marks)

11. State what the following functions are used for, and specify whether they will appear on server or client side code. (4 marks)
    (a) `ntohs()`
    (b) `htons()`
    (c) `ntohl()`
    (d) `htonl()`

12. What is the relationship between `htons()` and `noths()` in relation to big and little endianness? (1 mark)

13. What function should go in the blank and why? (2 marks)

```c
struct sockaddr_in server_addr;
server_addr.sin_family = AF_INET;
// Convert port to network byte order
server_addr.sin_port = __________;  // Port 8080
```

Listing 6: client side code

14. What function should go in the blank and why? (2 marks)

```c
uint32_t net_val;
recv(sock, &net_val, sizeof(net_val), 0);  // received 4-byte
    integer
uint32_t host_val = __________;
```

Listing 7: server side code

15. Do you need to use a byte order conversion here? (2 marks)

```c
uint32_t ip_host = inet_addr("192.168.0.1");  // host order
uint32_t ip_net = __________;
send(sock, &ip_net, sizeof(ip_net), 0);
```

Listing 8: client side code

16. You're writing server code that receives a 2-byte port number from a client (sent in network byte order). What function should you use?

```c
uint16_t port_net;
recv(sock, &port_net, sizeof(port_net), 0);
uint16_t port_host = __________;
```

Listing 9: server side code

17. What does `connect()` do and explain each parameter field in `connect()` (2 marks)

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

    (a) `sockfd`

    (b) `addr`

    (c) `addrlen`

18. What does `listen()` do and explain each parameter field in `listen()` (2 marks)

    `int listen(int sockfd, int backlog)`

    (a) sockfd

    (b) backlog

19. What does `accept()` do and explain each parameter field in `accept()` (2 marks)

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

(a) sockfd

(b) addr

(c) addrlen

20. What does `recv()` do and explain each parameter field in `recv()`? (2 marks)

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

(a) `sockfd`

(b) `buf`

(c) `len`

(d) `flags`

21. What does `listen()` do and explain each parameter field in `listen()` (2 marks)

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

(a) sockfd

(b) backlog

22. What does `select()` do and explain each parameter field (4 marks)

```
int select(int nfds, fd_set *readfds, fd_set *writefds, fd_set *exceptfds,
struct timeval *timeout)
```

(a) int nfds

(b) fd_set *readfds

(c) struct timeval *timeout

23. Why is `select()` considered a *destructive* function? (1 mark)

24. Write a complete C code block that performs the following steps in a TCP client:

    - Creates a socket using IPv4 and TCP.
    - Initializes a `sockaddr_in` struct with an IP address and port from `argv[1]` and `argv[2]`.
    - Connects the socket to the server.
    - Sends the message `argv[3]` to the server.
    - Receives a response into a buffer.

    Assume `BUFFSIZE` is predefined. You may use `inet_addr()`, `htons()`, `strlen()`, and standard system calls like `socket()`, `connect()`, `send()`, and `recv()`. Do not include the full `main()` function or headers.

25. Write a complete C code block that performs the following steps in a TCP server:

    - Creates a socket using IPv4 and TCP.
    - Binds the socket to port `argv[1]` on all local interfaces.
    - Listens for incoming client connections with a maximum pending queue.
    - Accepts a client connection.
    - Receives data into a buffer and echoes it back to the client.

    Assume `BUFFSIZE` and `MAXPENDING` are predefined. You may use system calls such as `socket()`, `bind()`, `listen()`, `accept()`, `recv()`, and `send()`, along with `htonl()`, `htons()`, and `memset()`. Do not include the full `main()` function or headers.

26. Write a C code block that uses `select()` to implement a concurrent TCP server. Your code should:

    - Loop through all file descriptors to check for incoming connections or data.
    - Accept new connections on the listening socket and add them to the active file descriptor set.
    - Handle input on already-connected sockets using a function `read_from_client(int fd)`.
    - Remove a socket from the set and close it if the client disconnects.

    Assume the sets `active_fd_set` and `read_fd_set` are already declared, and that `sock` is the listening socket. The function `read_from_client()` is already defined. Do not write the full `main()` function or include headers.