# L04 Sockets

## Definition

- The point where a local application process attaches to the network
- Interface Between network and application
- Created by application

## Socket Working Process

- Being created
- Being connected to the network
- Changing messages
- Being closed

## Ports

Used to identify different applications(processes) in the same host

## Socket Implementation

### 1. Socket Family

- PF_INET
    - **INET** denotes the internet family. If u want to communicate with a remote host, u should use this.
    - An **INET** socket is bound to a specific IP address.
    - INET sockets sit at the top of a full TCP/IP stack, with traffic congestion algorithms, backoffs and the like to handle
- PF_UNIX
    - An **UNIX** socket is bound to a special file on our file system.
    - We use it as an a lightweight alternative to an `INET` socket via loopback, when u need communication between processes on the same host.
    - everything is designed to be local to the machine, so its code is much simpler and the communication is faster
- PF_PACKET
    - Used if u want to play with packets at the protocol level, if u are implementing ur own protocol
    - denotes direct access to the network interface (i.e., it bypasses the TCP/IP protocol stack)

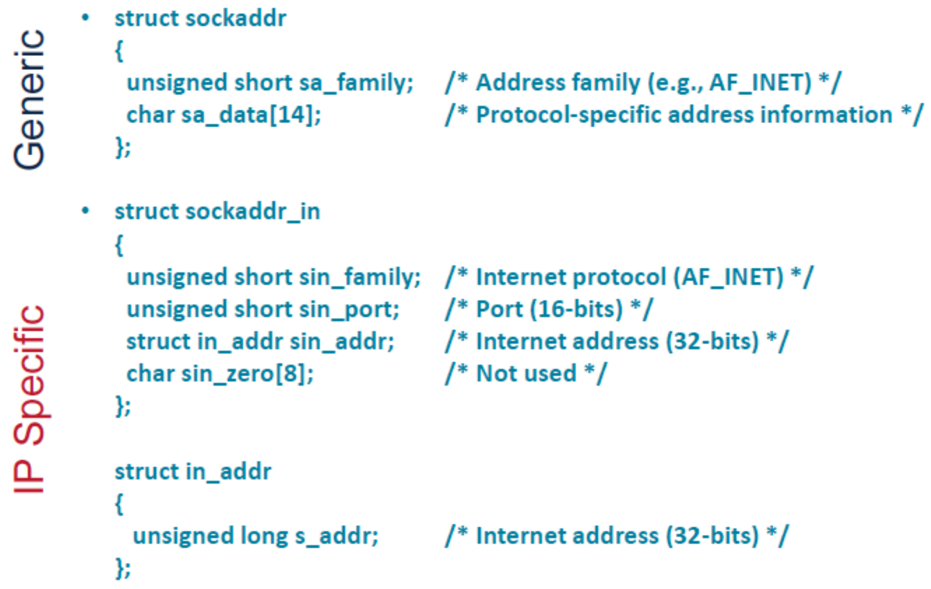
**Remark** AF_ and PF_ have the same values. And u can just use them alternatively, but AF_ seem to be more prevalent.

### 2. Socket Type

- SOCK_STREAM: denotes a byte stream
- SOCK_DGRAM: an alternative that denotes a message oriented service, such as that provided by UDP

**Remark** PF_INET and SOCK_STREAM impliy **TCP**

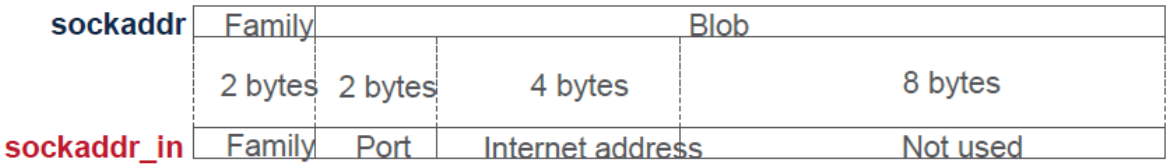
### 3. Socket in Code



```
• struct sockaddr
  {
   unsigned short sa_family;    /* Address family (e.g., AF_INET) */
   char sa_data[14];            /* Protocol-specific address information */
  };

• struct sockaddr_in
  {
   unsigned short sin_family;   /* Internet protocol (AF_INET) */
   unsigned short sin_port;     /* Port (16-bits) */
   struct in_addr sin_addr;     /* Internet address (32-bits) */
   char sin_zero[8];            /* Not used */
  };

  struct in_addr
  {
    unsigned long s_addr;       /* Internet address (32-bits) */
  };
```



| | | | | |
|---|---|---|---|---|
| sockaddr | Family | Blob | | |
| | 2 bytes | 2 bytes | 4 bytes | 8 bytes |
| sockaddr_in | Family | Port | Internet address | Not used |

### 4. Helper Functions

- Printable String to IP address

  **int inet_pton()**

- Binary to printable string

  **const char * inet_ntop**

- convert the integer from host byte order to network byte order

  **uint16_t htons (uint16_t hostshort)**

- convert the integer from network byte order to host byte order

  **uint16_t ntohs (uint16_t netshort)**

- connect socket

  **int connect( int socket, const struct sockaddr *address, socklen_t address_len)**

  socket is the descriptor

- Sending data

  **ssize_t send(socket,buf,len,flags)**

  - return the number of bytes being copied to the OS kernel for transmission
  - blocking semantics of send

- Receiving Responses

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

  - Receives at least one byte
  - 0 is reserved when the other side closed the socket
  - Does not receive the same number of bytes that were sent via send
  - You have to keep reading from the socket until you've received all the bytes you need
  - returns the length of the message or datagram in bytes

- Bind (Only for server)

  **int bind( int sockfd , const struct sockaddr my_addr , socklen_t addrlen)**

  my_addr

  - struct sockaddr_in for IPv4
  - cast (struct sockaddr_in *) to (struct sockaddr)

  **Remark** Binding a socket means assigning an address and port number to the socket

- Listen(Only for server)

  **int listen( int sockfd , int backlog)**

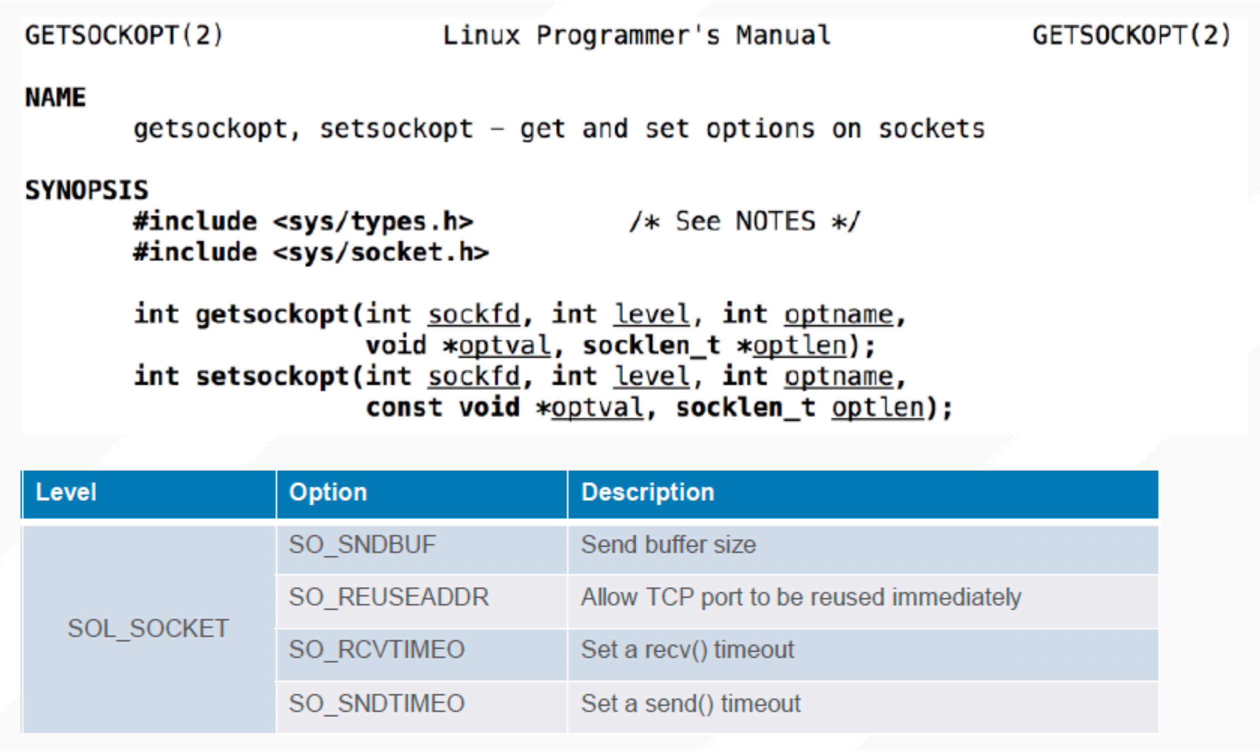
  **backlog** Number of pending connections to queue

- Accept(Only for server)

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

Eg: int isock = sockfd , (struct sockaddr_in *) caddr , clen);

## Socket Options



```
GETSOCKOPT(2)               Linux Programmer's Manual              GETSOCKOPT(2)

NAME
       getsockopt, setsockopt - get and set options on sockets

SYNOPSIS
       #include <sys/types.h>          /* See NOTES */
       #include <sys/socket.h>

       int getsockopt(int sockfd, int level, int optname,
                      void *optval, socklen_t *optlen);
       int setsockopt(int sockfd, int level, int optname,
                      const void *optval, socklen_t optlen);
```

| Level | Option | Description |
|---|---|---|
| SOL_SOCKET | SO_SNDBUF | Send buffer size |
| | SO_REUSEADDR | Allow TCP port to be reused immediately |
| | SO_RCVTIMEO | Set a recv() timeout |
| | SO_SNDTIMEO | Set a send() timeout |

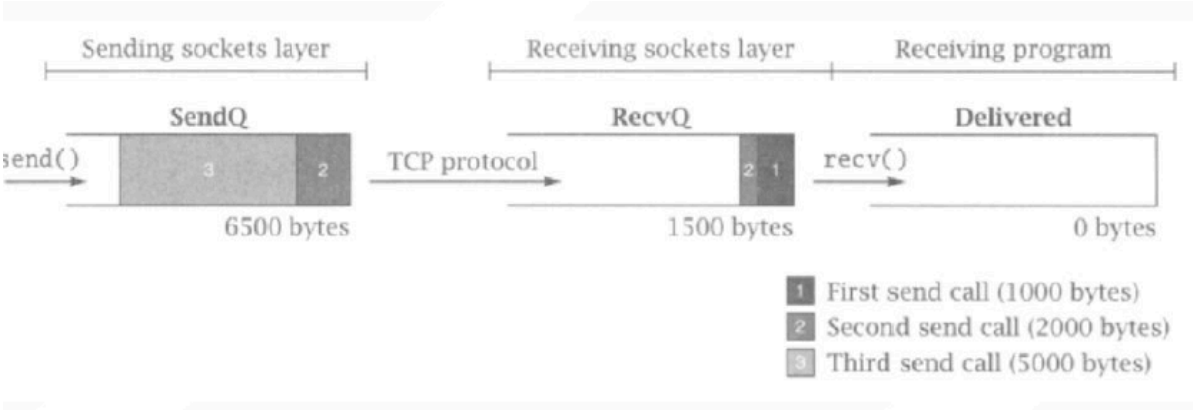
## Socket Internals

Suppose the following occasion:

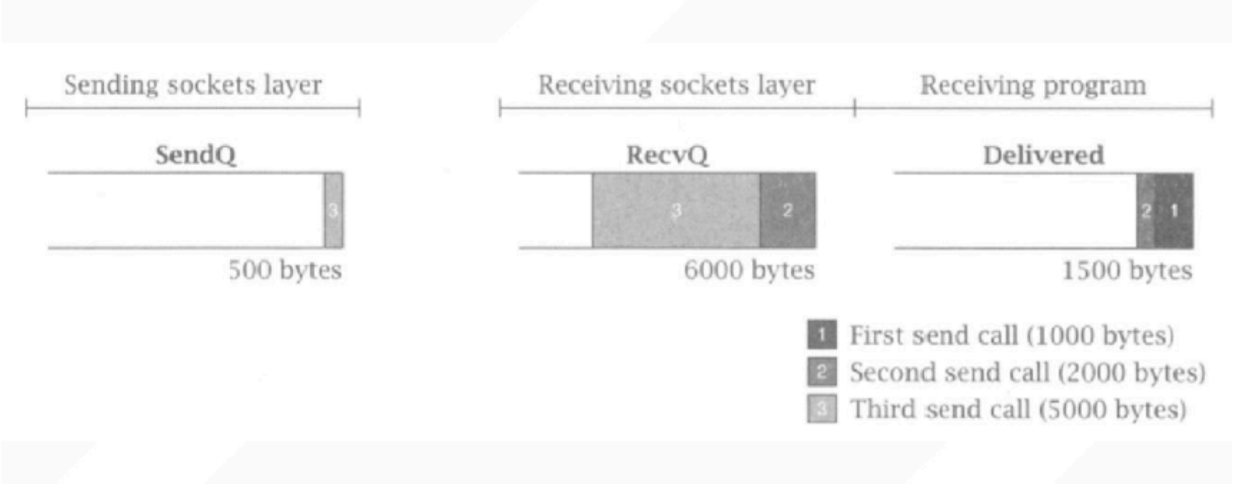
1. rv = connect(s, ...);
2. rv = send(s, buffer0, 1000, 0);
3. rv = send(s, buffer1, 2000, 0);
4. rv = send(s, buffer2, 5000, 0);

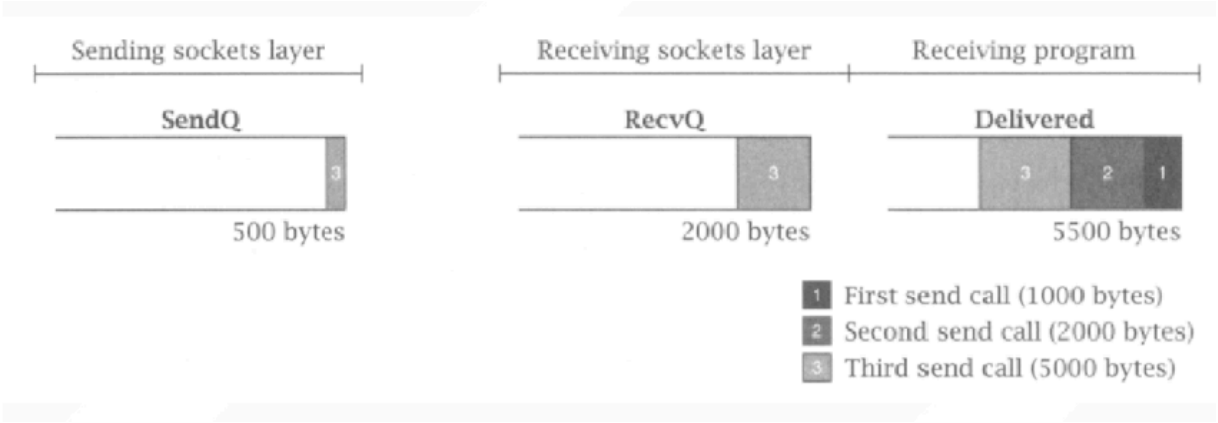
5. close(s);

At first, we are sending smoothly.



But then something strange happens.

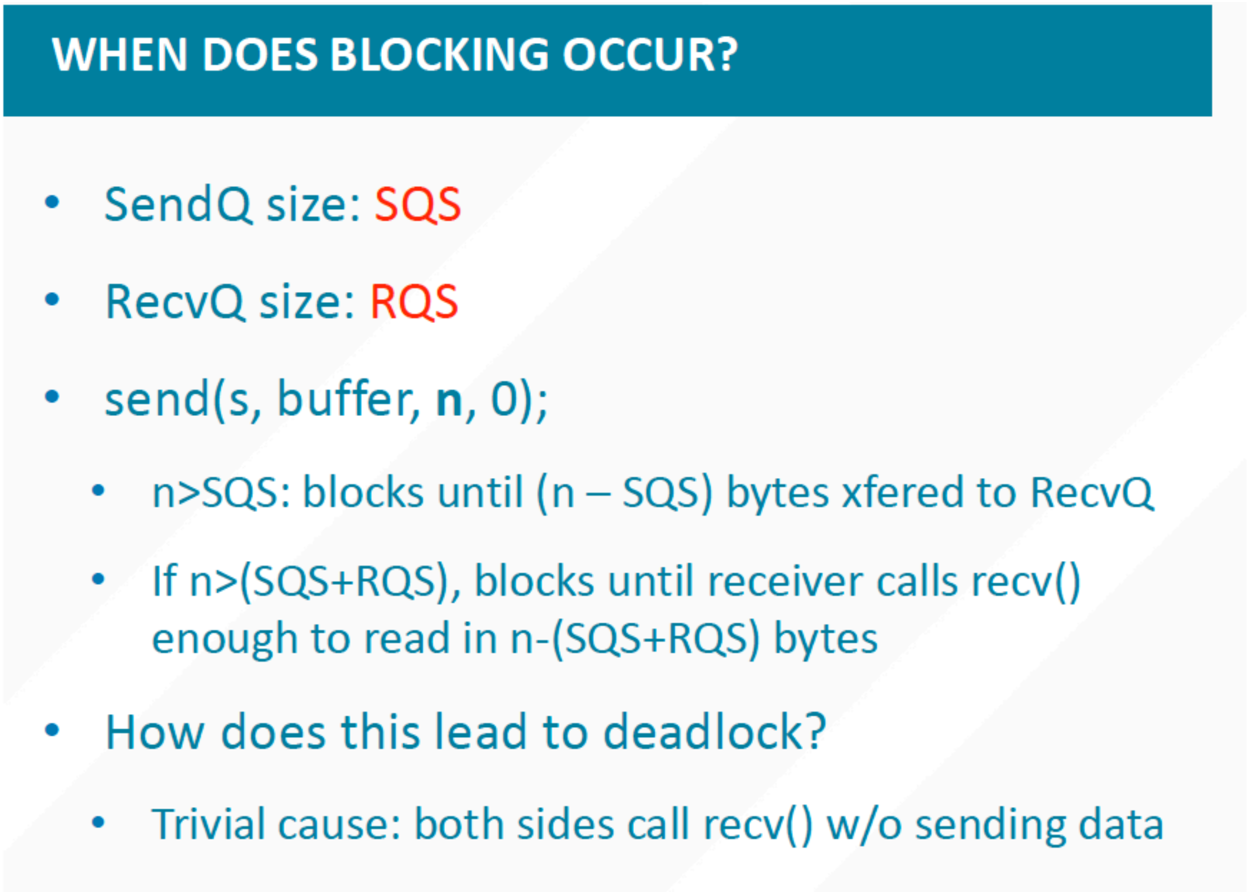




Our sending process seems to be blocked....But why?

Preventing Deadlock!!

Like we just mentioned when we were learning how to send a message with a socket, it is blocked while sending.



## WHEN DOES BLOCKING OCCUR?

- SendQ size: SQS
- RecvQ size: RQS
- send(s, buffer, **n**, 0);
  - n>SQS: blocks until (n – SQS) bytes xfered to RecvQ
  - If n>(SQS+RQS), blocks until receiver calls recv() enough to read in n-(SQS+RQS) bytes
- How does this lead to deadlock?
  - Trivial cause: both sides call recv() w/o sending data

This is a link I found regardidng this topic. U might found it useful.