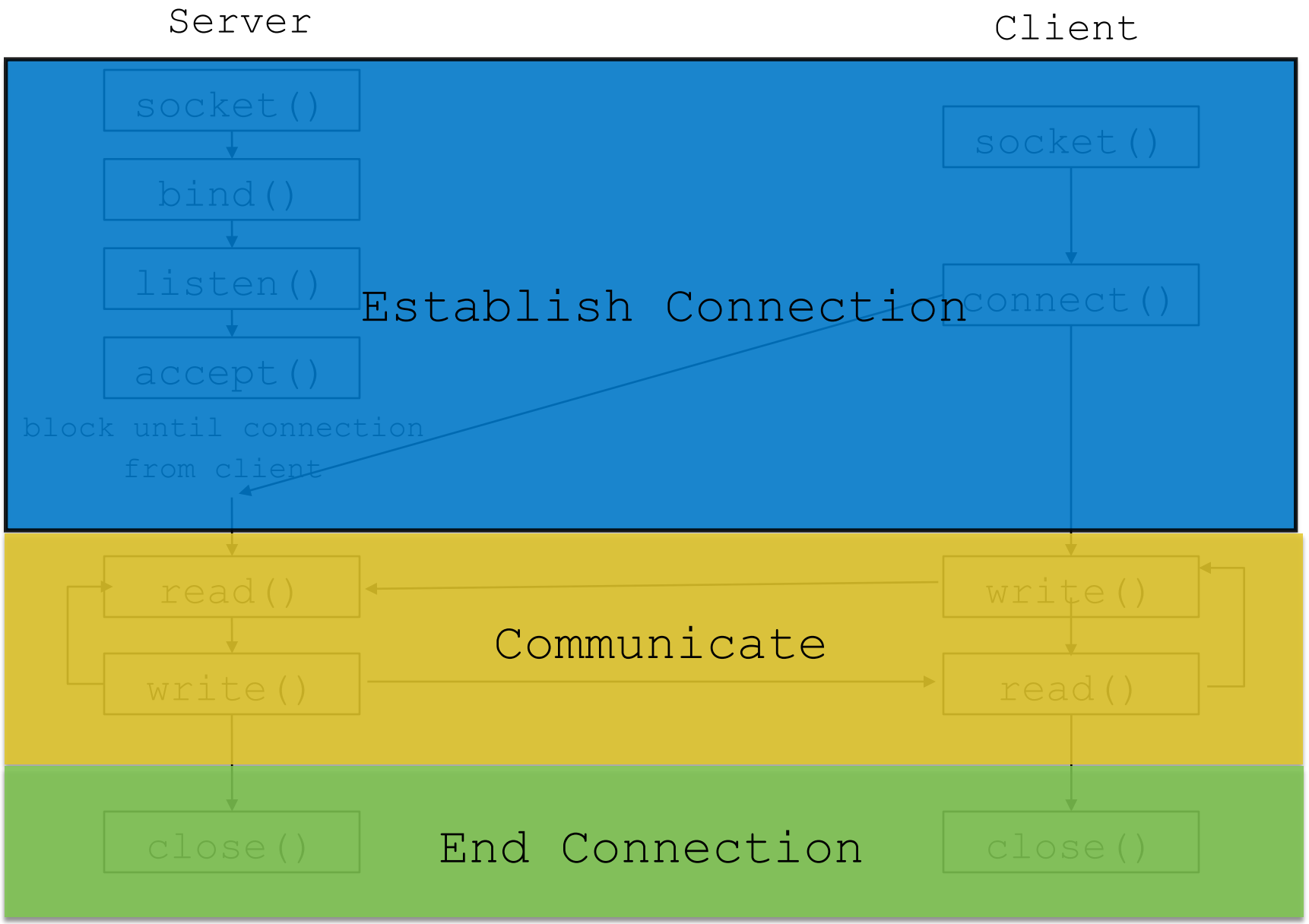
CSCB09: Software Tools and Systems Programming

Bianca Schroeder
bianca@cs.toronto.edu
IC 460

COURSE EVALUATIONS

We care what you think,

TELL US!


Server
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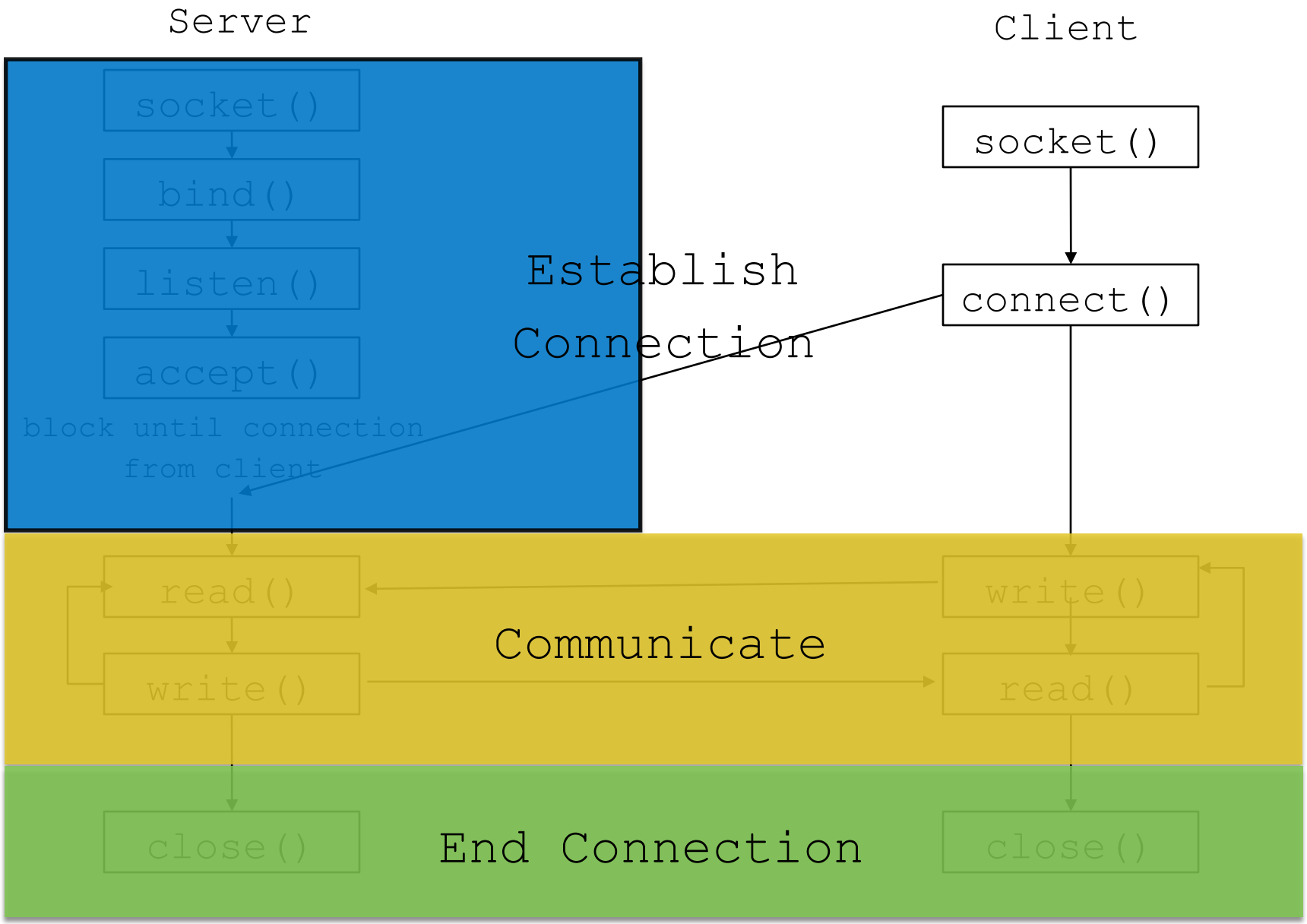
End Connection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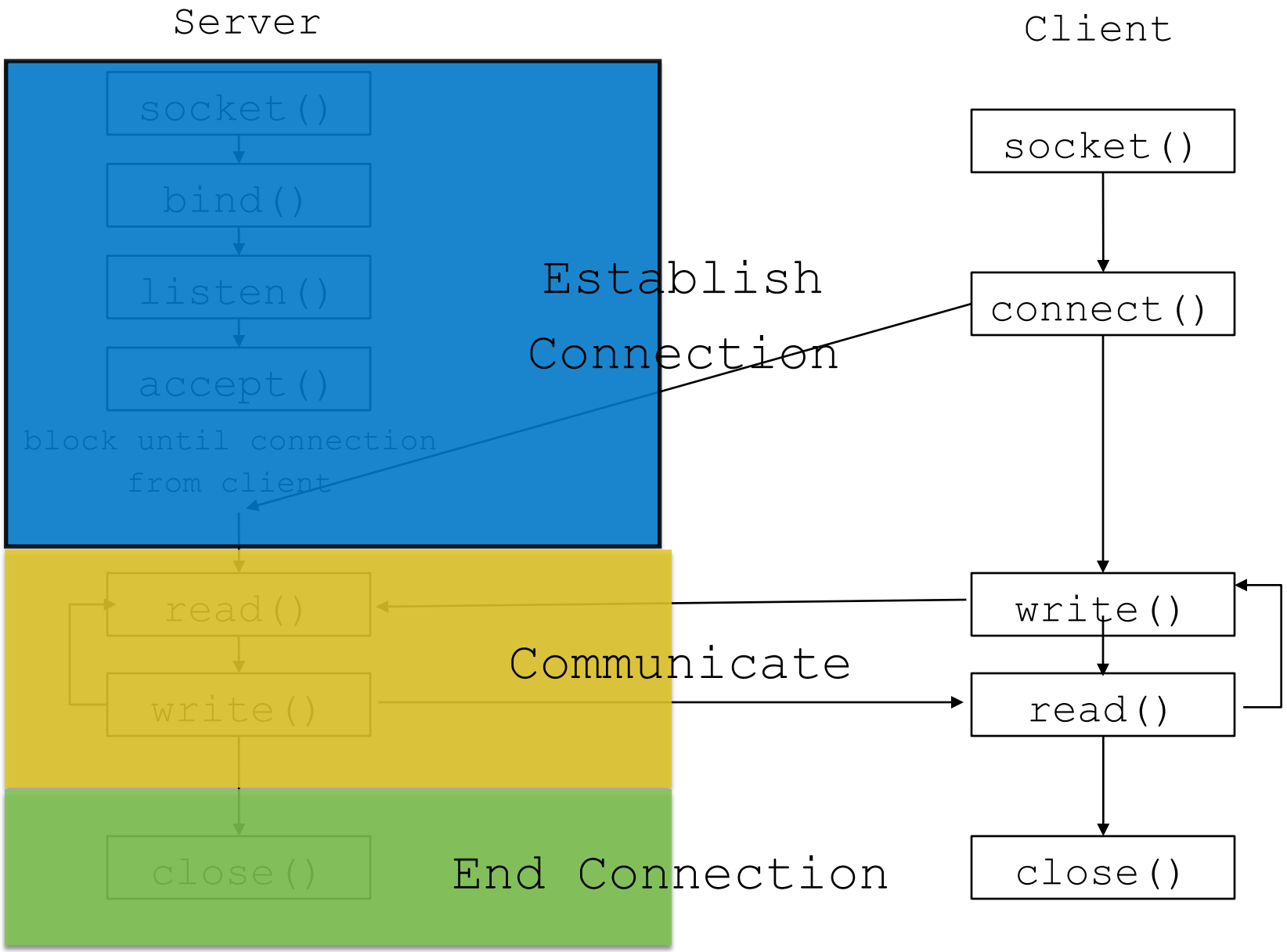
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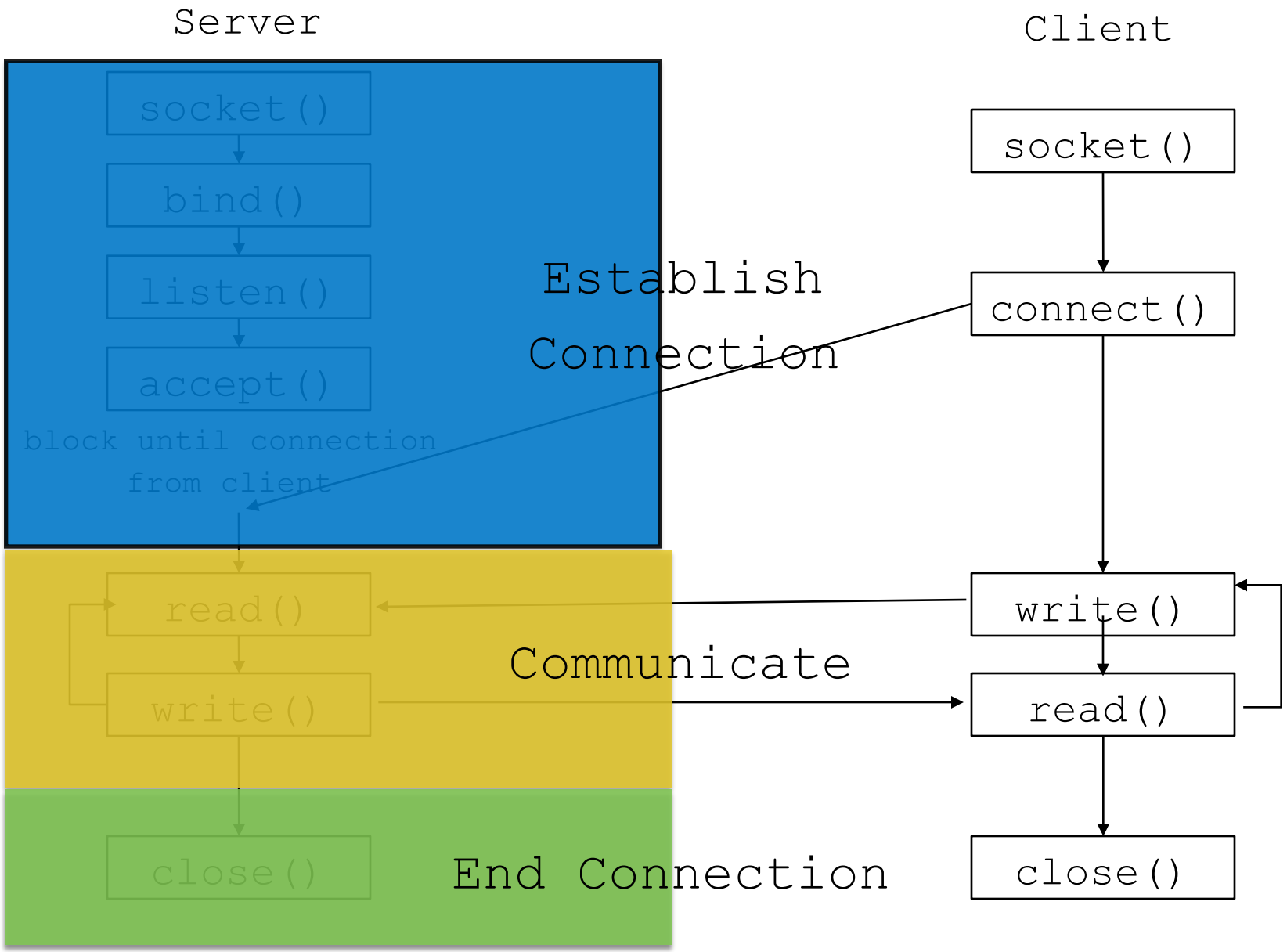
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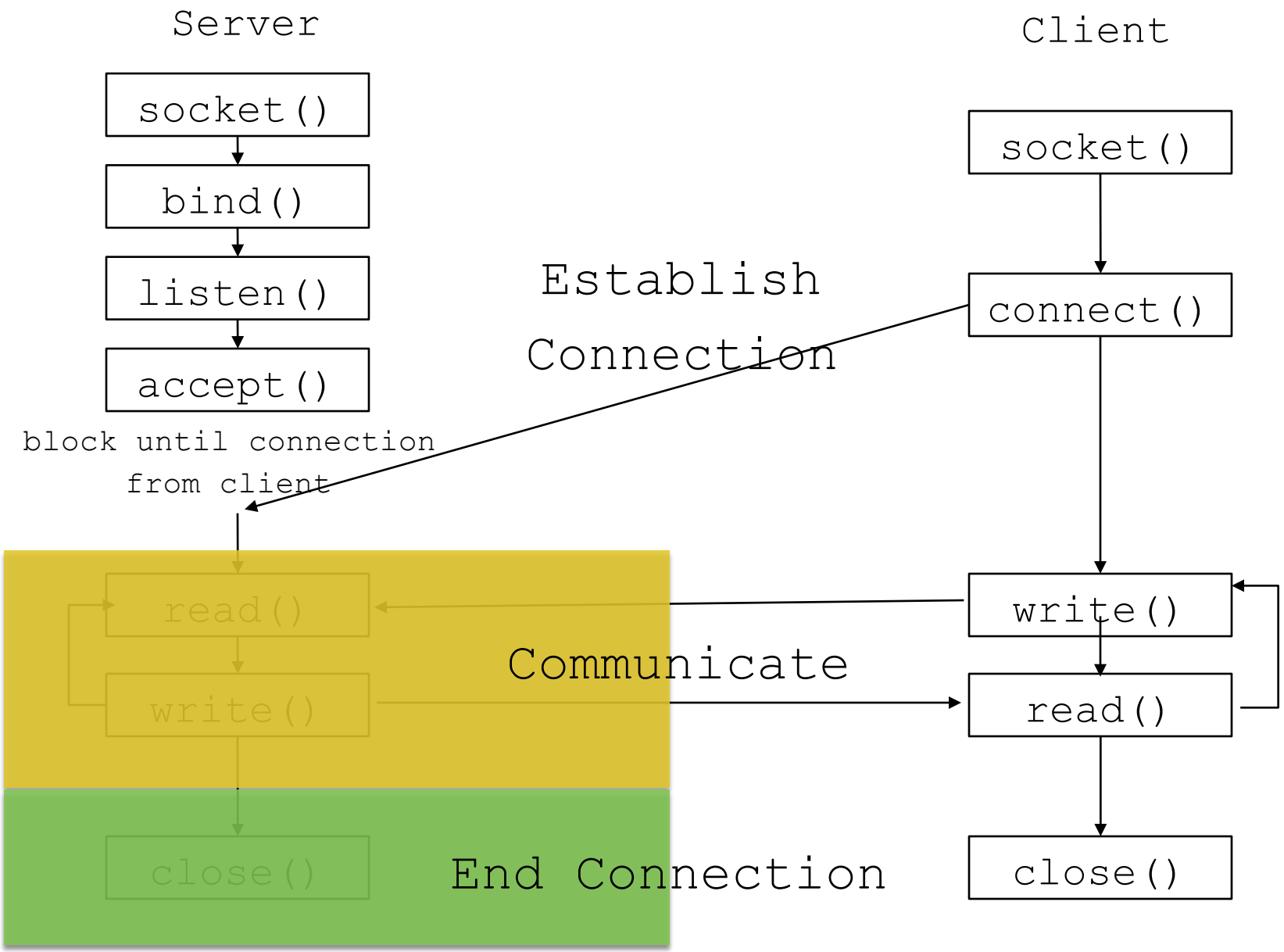
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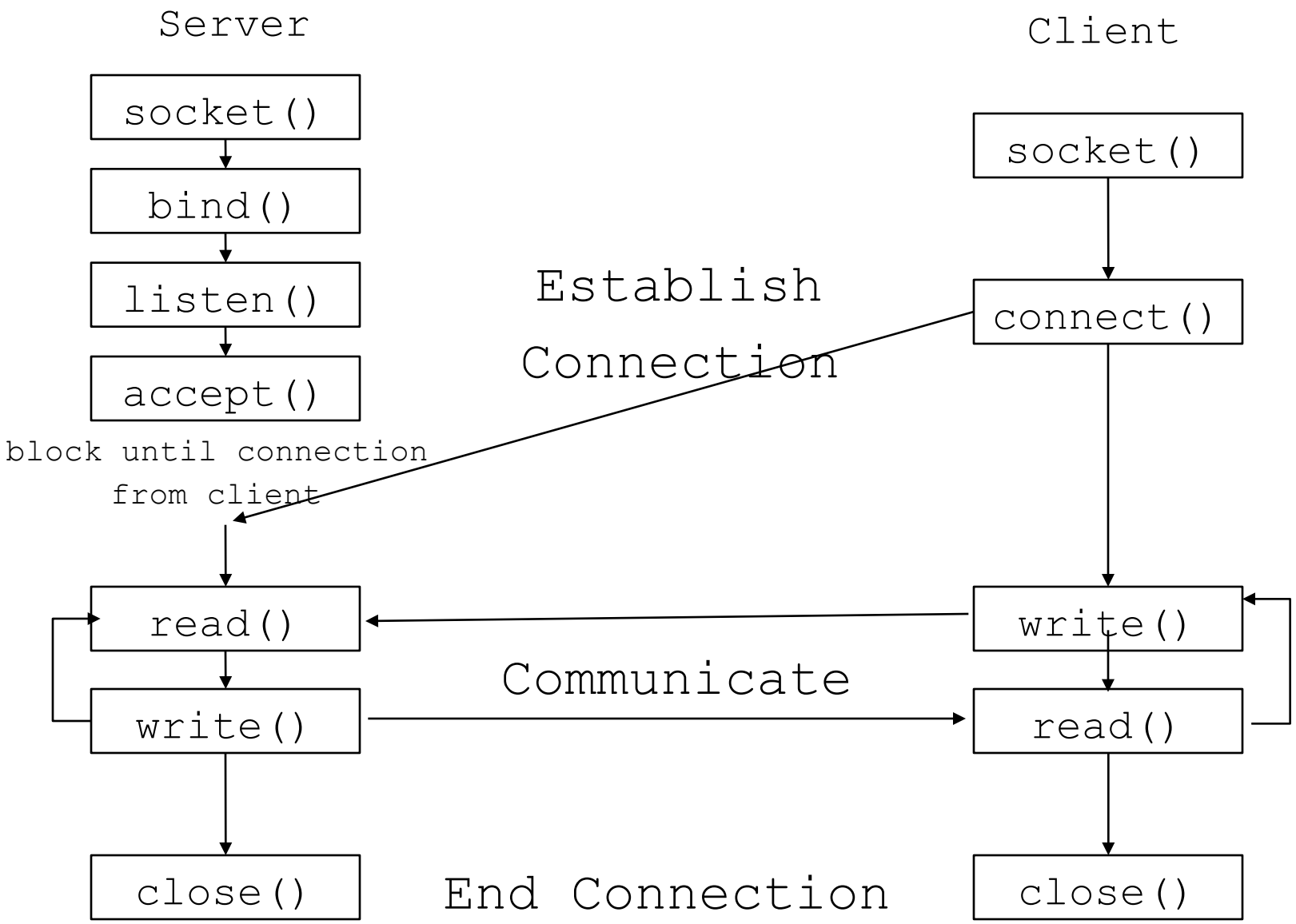
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Server side: socket() works same as for client

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

- family specifies protocol family:
  - `AF_INET` – IPv4
  - `AF_LOCAL` – Unix domain
- type
  - `SOCK_STREAM`, `SOCK_DGRAM`, `SOCK_RAW`
- protocol
  - set to 0 except for RAW sockets
- returns a socket descriptor

bind() socket to a name

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

- Servaddr sets IP address & port at which to accept requests
- Returns negative value on error, zero on success

- ```
  struct sockaddr_in {
    short          sin_family; /*AF_INET */
    u_short        sin_port;
    struct in_addr sin_addr;
    char           sin_zero[8]; /*filling*/
  };
  ```
- `sin_addr` can be set to `INADDR_ANY` to communicate on any network interface.
  ```

Set up queue in kernel

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

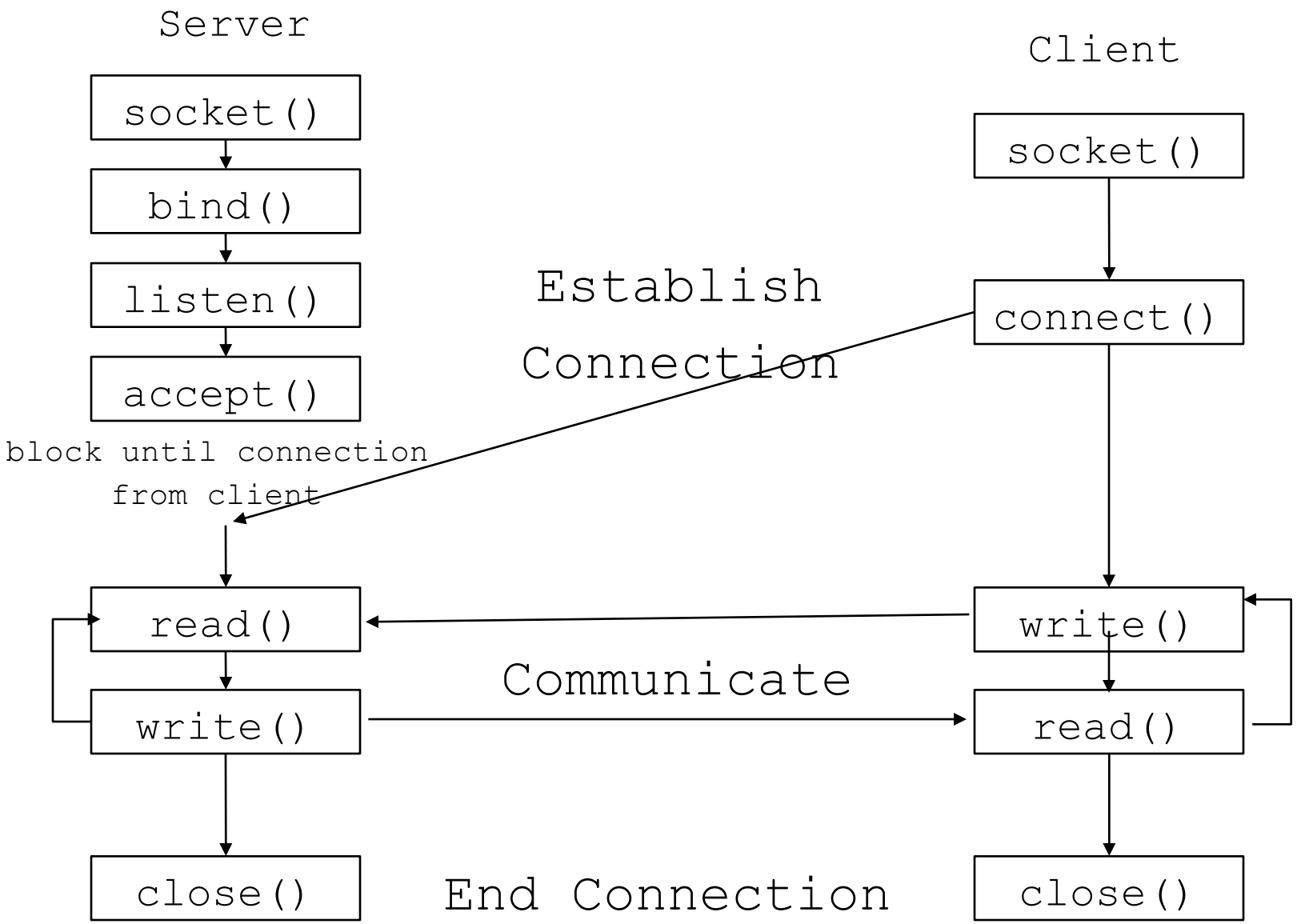
- after calling `listen`, a socket is ready to accept connections
- prepares a queue in the kernel where partially completed connections wait to be accepted.
- `backlog` is the maximum number of partially completed connections that the kernel should queue.

Complete the connection

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

- blocks waiting for a connection (from the queue)
- returns a new descriptor which refers to the TCP connection with the client
  - This is the descriptor to be used for reads and writes from/to the client.
- `sockfd` is the listening socket
- `cliaddr` is used to return the address of the client

Done!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Next: Writing a server that can handle multiple clients

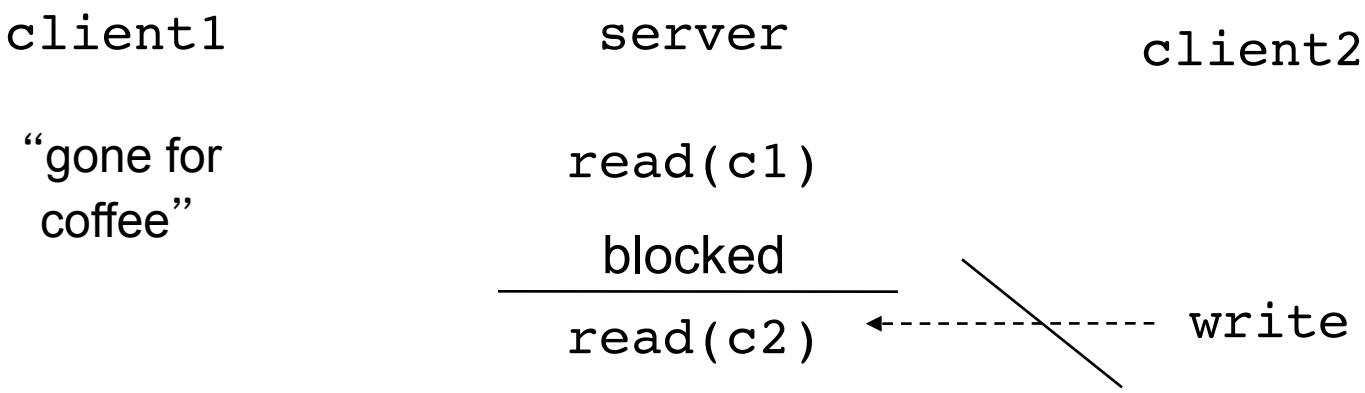
```
client1                server                client2

                   while(1){
                      read(c1);
                      read(c2);
                   }
```

The above is a draft for a server that reads from two clients.

Problems?

The problem



When reading from multiple sources, blocking on one of the sources could be bad.

One solution: one process for every client. What are the pros and cons of this solution?

The solution: Multiplexing

```
int select(int maxfdp1,
           fd_set *readset,
           fd_set *writeset,
           fd_set *exceptset,
           const struct timeval *timeout);
```

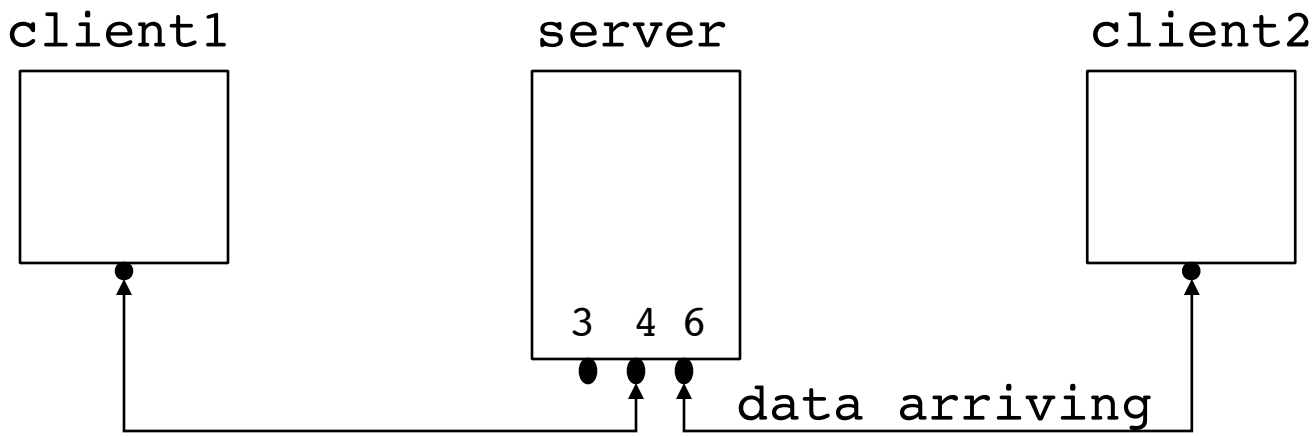
A call to select returns when one of the file descriptors in one of the sets is ready for I/O.

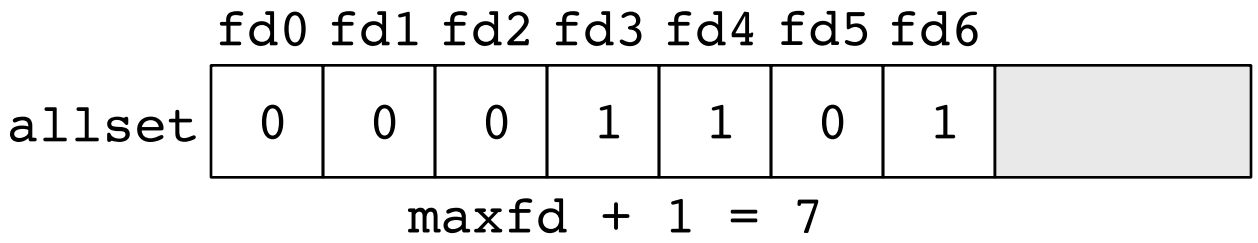
Upon return, the file descriptor set contains the file descriptors that are ready for I/O.

If timeout is not NULL, then select returns when a descriptor is ready or timeout time has passed.

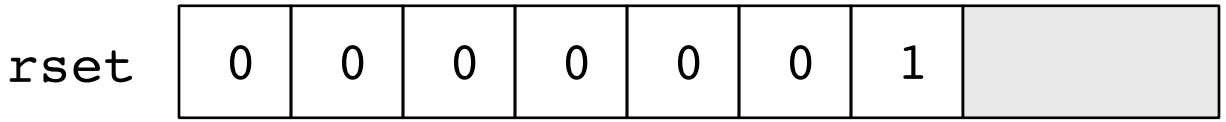
If timeout is 0, select returns immediately after checking descriptors.

Descriptor sets





After select (assuming client2 has written some data):



Readiness

Ready to read when

- there is data in the receive buffer to be read
- end-of-file state on file descriptor
- the socket is a listening socket and there is a connection pending
- a socket error is pending

Ready to write when

- there is space available in the write buffer
- a socket error is pending

Exception condition pending when

- TCP out-of-band data

We are typically interested in when bytes are available to be read, but sometimes we use select on write or exception sets

Descriptor sets

- Implementation is hidden in the `fd_set` data type
- `FD_SETSIZE` is the number of descriptors in the data type
- `maxfdp1` specifies the number of descriptors to test

Macros:

```
void FD_ZERO(fd_set *fdset);
void FD_SET(int fd, fd_set *fdset);
void FD_CLR(int fd, fd_set *fdset);
int  FD_ISSET(int fd, fd_set *fdset);
```

Let's put this into practice on the worksheet

```
FD_ZERO(fd_set *set)
FD_SET(int fd, fd_set *set)
FD_ISSET(int fd, fd_set *set)

select(int max_fd,
       fd_set *read_fds,
       fd_set *write_fds,
       fd_set *except_fds,
       struct timeval *timeout)
```

STDIN_FILENO
STDOUT_FILENO

} File descriptors for stdin and stdout