Redes de Comunicação
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TP05
Programming with sockets and TCP

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TP05: Programming with sockets and TCP

Overview:

- Socket programming (TCP)
- Client-Server implementation structure
- Socket programming in C (functions)

Socket programming (TCP)

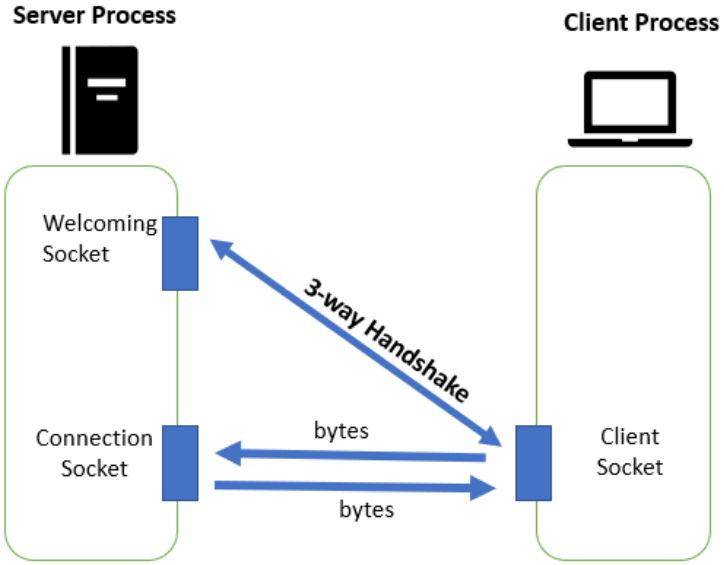
- TCP is a connection-oriented transport-layer protocol, it provides guaranteed, in-order and error-free packet communications between applications on *hosts*

- Before exchanging information, the client and server must establish a TCP connection

- When one side wants to send data to the other side it just drops data into the TCP connection via its socket:
  - Remember that with UDP you must attach a destination address to the packet before sending
  - A TCP socket is already identified by a 4-tupple (destination address and port, source address and port)

Socket programming (TCP)

- A TCP Server uses two different types of sockets:
  - A *welcoming socket*, where new connections are received by the server: <u>remains open so that server can receive connections from multiple clients</u>
  - A *connection socket:* created/opened and closed as required, to handle communications with clients



Client-socket, Welcoming-socket and Connection-socket

Client-Server implementation

TCP Server:

Create a TCP socket for incoming requests (welcoming socket)

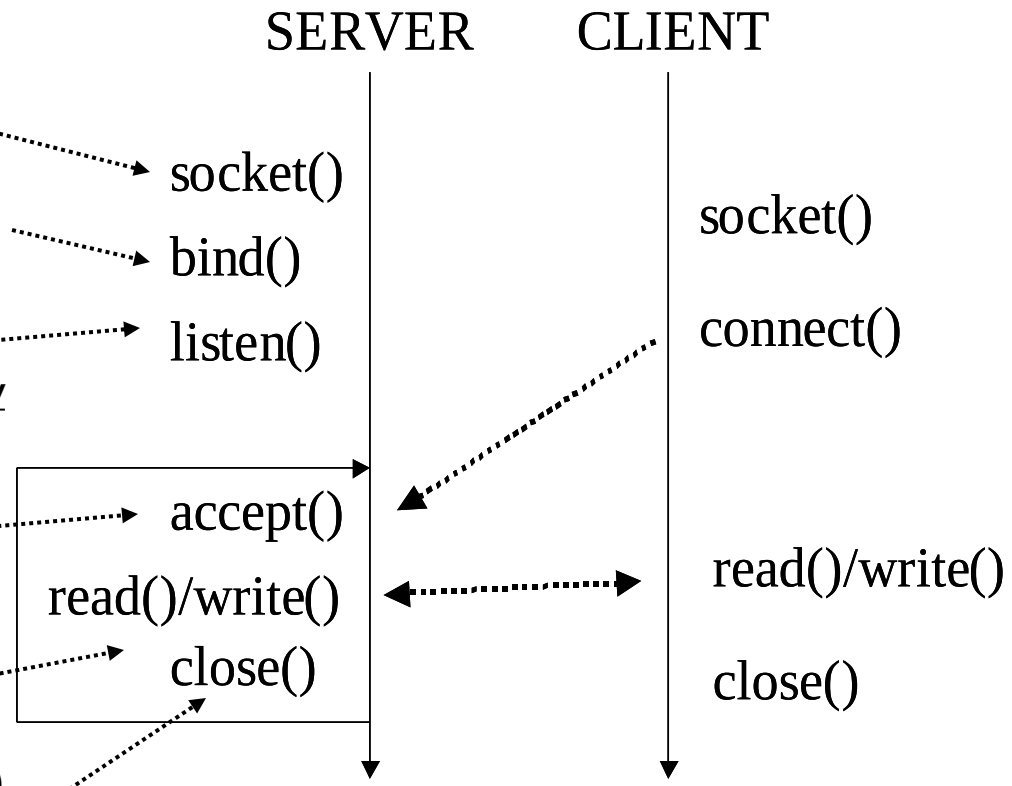
Bind the socket to server address and port

Prepares the socket to <u>accept new incoming connections</u>

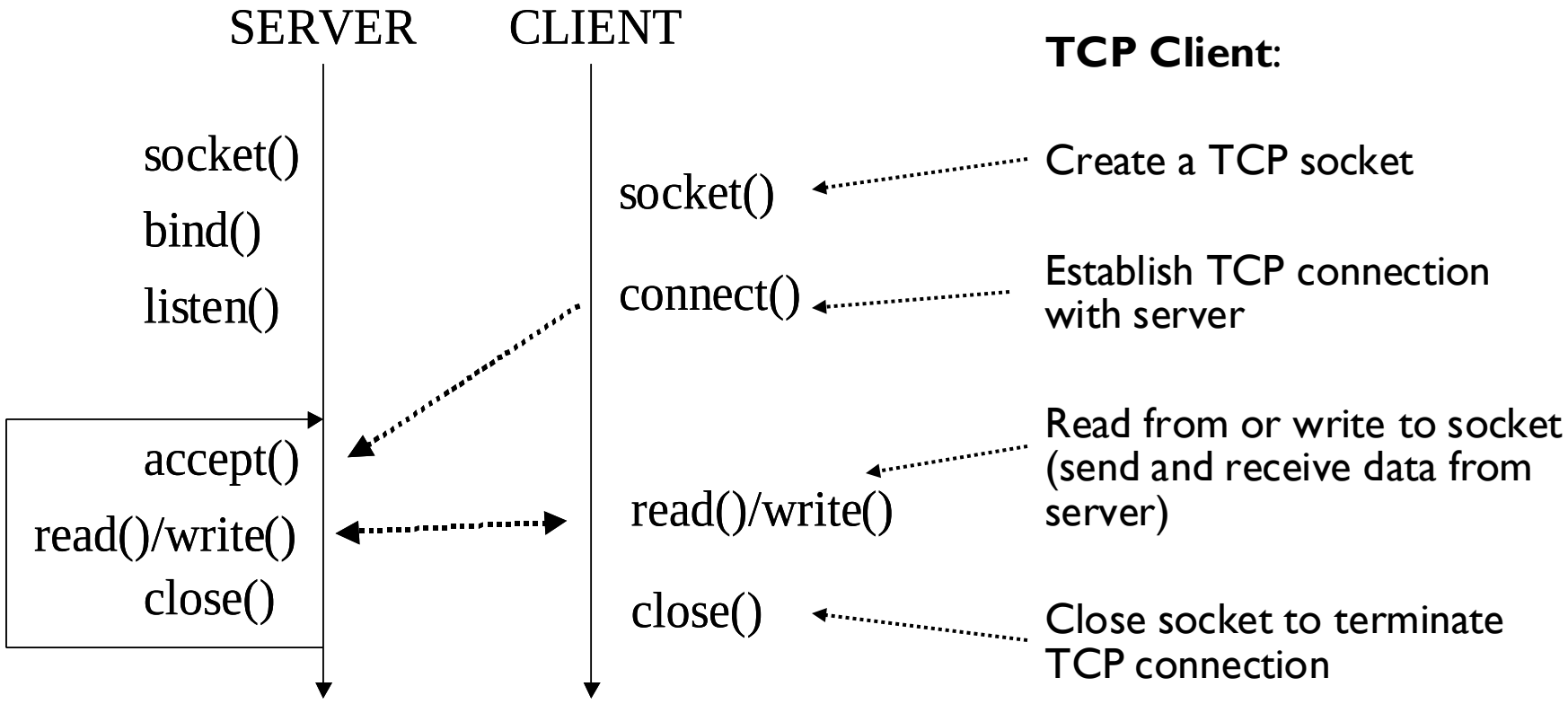
Accepts a new connection (waits until one is received)

Read from or write to socket (send and receive data from client)

Close socket to terminate TCP connection



Client-Server implementation



Socket programming in C (functions)

- The application invokes the **socket** function to create an UDP or TCP socket

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

Returns socket file descriptor

Communication domain:
AF_INET for IPv4
AF_INET6 for IPv6

Type of socket to be created:
SOCK_STREAM for TCP
SOCK_DGRAM for UDP

Protocol to be used by socket:
IPPROTO_UDP for UDP
IPPROTO_TCP for TCP

Socket programming in C (functions)

- The **bind** function is used by the server to assign an address to the unbound socket

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

File descriptor of socket to be binded

Structure in which address to be binded to is specified

Size of addr structure

Socket programming in C (functions)

- The **listen** function is used in the server to prepare the socket to receive new connections

int listen(int sockfd, int backlog)

File descriptor of socket to listen for new connection requests

How many clients are keep in the queue waiting for accept

Socket programming in C (functions)

- The **accept** function is used in the server to accept a new connection (wait if none in the queue)

int accept(int sockfd, const struct sockaddr *address, socklent_t *address_len)

Returns file descriptor of socket for new connection

File descriptor of welcoming socket

Structure containing information about the new connection is returned

Variable in which size of address structure is returned

Socket programming in C (functions)

- The **connect** function is used in the client to initiate a new TCP connection

int connect(int sockfd, const struct sockaddr *address,
socklent_t address_len)

File descriptor of socket to initiate a new connection

Structure containing information about the address and port of the server

Variable with size of the address structure

Socket programming in C (functions)

- The **close** function is used to close a file descriptor

int close(int fd)

Return code
(is 0 if success)

File descriptor to close

Socket address structures

- Most socket functions require a pointer to a socket address structure
- The names of these structures begin with *sockaddr_* and end with a unique suffix for each protocol suite

Generic structure (used in declarations, to deal with address structures from any supported protocol families)

```
#include <arpa/inet.h>

struct in_addr {
    in_addr_t   s_addr;                 /* 32-bit IPv4 address */
                                        /* network byte ordered */
};

struct sockaddr_in {
    uint8_t         sin_len;            /* length of structure (16) */
    sa_family_t     sin_family;         /* AF_INET */
    in_port_t       sin_port;           /* 16-bit TCP or UDP port number */
                                        /* network byte ordered */
    struct in_addr  sin_addr;           /* 32-bit IPv4 address */
                                        /* network byte ordered */
    char            sin_zero[8];        /* unused */
};
```

Other useful functions

- Convert host name to IP address:

struct hostent * gethostbyname(const char* name)

Return structure with IP address corresponding to name

Name of host (server)

- **Network byte order** is *big endian*. Convert to network byte order when sending data and using addresses and ports:

```
uint32_t htonl(uint32_t hostlong);
uint16_t htons(uint16_t hostshort);
uint32_t ntohl(uint32_t netlong);
uint16_t ntohs(uint16_t netshort);
```

TP05: Summary

What we have covered here?

- Socket programming (TCP)
- Client-Server implementation structure
- Socket programming in C (functions)