Indian Institute of Information Technology, Nagpur

Course: Computer Networks (CSL 302, Core)
5th Semester

Topics Covered

➤ Sockets in Computer Networks

➤ Intro to Socket Programming

Dr. Aishwarya Ukey
Assistant Professor
Dept. of CSE, IIIT Nagpur

Sockets in Computer Networks

- Socket
  - One endpoint of a two-way communication link between two programs running on the network
  - Bound to a port number so that TCP layer can identify the application that data is destined to be sent to
  - A combination of an IP address and a port number
  - Every TCP connection can be uniquely identified by its two endpoints
    - i.e. can have multiple connections between host and server

Cont…

- Sockets allows a computer to send and receive data over the network
  - For example
    - Consider a client computer that wants to send a request to a server to access a webpage.
    - The client creates a socket and sends the request to the server through the socket.
    - The server receives the request and sends a response back to the client through the same socket.
    - This allows the two computers to communicate with each other and exchange data

Cont…

- Types of Sockets
  - Datagram Socket
  - Stream Socket

Cont…

- Datagram Socket
  - A type of network socket that allows data to be sent and received in a connectionless manner
    - There is no established connection between the sender and receiver before data is sent, and each datagram (packet) of data is treated as a separate unit
    - Allows for more flexibility and faster communication, but also means that there is a higher risk of data loss or corruption due to lack of error checking and retransmission.
    - Commonly used in real-time applications where latency is important, such as streaming audio or video
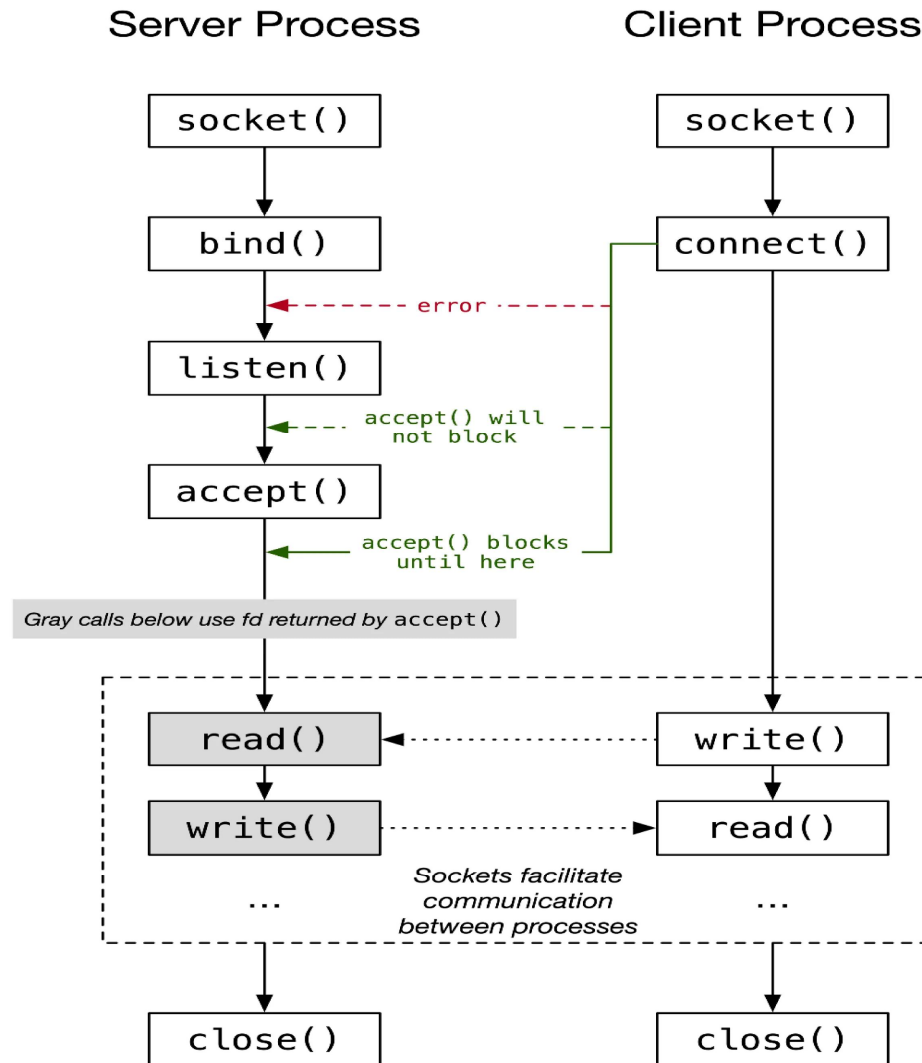
Cont…

- Stream Socket
  - A stream socket is a type of network socket that provides a connection-oriented, full-duplex communication channel between two network devices
  - It allows for the exchange of data between the devices in a continuous flow, similar to a stream of water
  - Stream sockets use the Transmission Control Protocol (TCP) to establish a connection and transmit data
  - Stream sockets can be used in a variety of applications
    - web browsers, email clients, and online games
    - commonly used in client-server architectures

Socket Programming

- Socket Programming is a method to connect two nodes over a network to establish a means of communication between those two nodes
  - A node represents a computer or a physical device with an internet connection
- A socket is the endpoint used for connecting to a node
- The signals required to implement the connection between two nodes are sent and received using the sockets on each node respectively

State Diagram: Client-Server Model

Cont…

Function Call	Description
Socket()	To create a socket
Bind()	It's a socket identification like a telephone number to contact
Listen()	Ready to receive a connection
Connect()	Ready to act as a sender
Accept()	Confirmation, it is like accepting to receive a call from a sender
Write()	To send data
Read()	To receive data
Close()	To close a connection

Cont…

- The nodes are divided into two types, server node and client node
  - Client node sends the connection signal
  - Server node receives the connection signal sent by the client node
- The connection between a server and client node is established using the socket over the transport layer of the internet
- After a connection has been established, the client and server nodes can share information between them using the read and write commands
- After sharing of information is done, the nodes terminate the connection

Cont…

- Stages for Server
  - A. Socket Creation
  - B. Setsockopt
  - C. Bind
  - D. Listen
  - E. Accept
  - F. Read/Write
  - G. Close
- Stages for Client
  - A. Socket Connection
  - B. Connect
  - C. Read/Write
  - D. Close

Socket Creation

- The first stage deals with the creation of a socket, which is the basic component for sending or receiving signals between nodes

- A socket can be created by the socket() function with syntax

  - **int socket(int domain, int type, int protocol);**
  - The socket() function
    - Creates a socket and returns a file descriptor

Cont…

- Domain
  - The address family over which the communication will be performed
    - AF_LOCAL or AF_UNIX is used for local communication or in the case where the client and server are on the same node.
    - AF_INET is used to represent the IPv4 address of the client to which a connection should be made. Similarly AF_INET6 is used for IPv6 addresses.
    - AF_BLUETOOTH is used for low-level Bluetooth connection.

Cont…

- Type
  - The type of communication used in the socket
    - SOCK_STREAM uses the TCP(Transmission Control Protocol) to establish a connection. This type provides a reliable byte stream of data flow and is a connection-based protocol. These sockets are called stream sockets.
    - SOCK_DGRAM uses the UDP(User Datagram Protocol) which is unreliable and a connectionless protocol. These sockets are also called datagram sockets.

Cont…

- Protocol
  - The protocol used in the socket.
  - This is represented by a number
    - When there is only one protocol in the protocol family, the protocol number will be 0, or else the specific number for the protocol has to be specified

Setsockopt

- Used to specify some options for the socket to control the behavior of the socket.

- **int setsockopt(int socket_descriptor, int level, int option_name, const void *value_of_option, socklen_t option_length);**

  - The socket is the file descriptor returned by the socket() function.

  - The level parameter represents the level at which the option for the socket must be applied.

    - The SOL_SOCKET represents the socket level
    - IPPROTO_TCP represents the TCP level.

Cont…

- The option_name specifies the rules or options that should be modified for the socket.
    - SO_DEBUG is used to enable the recording of debugging information.
    - SO_REUSEADDR is used to enable the reusing of local addresses in the bind() function.
    - SO_SNDBUF is used to set the maximum buffer size that can be sent using the socket connection.
- The option_value is used to specify the value for the options set in the option_name parameter.
- The option_length is the length of the variable used to set the option value.

Bind

- The bind() function is used to assign an address to a socket created using the socket() function

- **int bind(int socket_descriptor, const struct sockaddr *address, socklen_t length_of_address);**
  - The socket_descriptor is the value of the file descriptor returned by the socket() function.
  - The address is a structure of type sockaddr.
  - The length_of_address represents the size of the address passed as the second parameter.

Listen

- The listen() function in socket programming is used to make the server node wait and listen for connections from the client node on the port and address specified by the bind() function. The syntax is,

- **int listen(int socket_descriptor, int back_log);**

  - The socket_descriptor represents the value of the file descriptor returned by the socket() function.

  - The back_log marks the maximum number of connection requests that can be made to the server by client nodes at a time.

Accept

- The accept() function is used to establish a connection between the server and the client nodes for the transfer of data.

- **int accept(int socket_descriptor, struct sockaddr *restrict address, socklen_t *restrict length_of_address);**
  - The socket_descriptor represents the value of the file descriptor returned by the socket() function.
  - The address is the variable of the sockaddr_in structure in which the address of the socket returned from the function will be stored.
  - The length_of_address depicts the size of the address parameter.

Stages for Client

- Socket Connection
  - Similar to the server-side, the client-side also needs to create a socket using the socket() function and bind the socket to an address using the bind() function. This will create a socket that can send the connection request to the server.

Cont…

- Connect
  - The connect() function is used to send the connection request and connect to the server node
  - **int connect(int socket_descriptor, const struct sockaddr *address, socklen_t length_of_address);**
    - The socket_descriptor represents the value of the file descriptor returned by the socket() function during the creation of a socket on the client-side.
    - The address represents the structure with the information of the address and port number of the server node to which the connection is to be made.
    - The length_of_address is the size of the address structure used in the second parameter.