Client-Server Model

Client-Server Model

- Client application program running on the local machine requests a service from another application program – server – running on the remote machine.
- Commonly server provides service to any client, not a particular client
- Generally, a client application program that requests a service should run only when it is needed. A server program providing service should run all the time, as it does not know when its services will be needed.

Client-Server Model

- A client opens the communication channel using IP address of the remote host and the port address of the specific server program running on the host – Active open.
- Request-response may be repeated several times, the process is finite.
- The client closes the communication channel with an Active close.

Client-Server Model

- A server program opens its door for incoming requests from clients but never initiates a service unless explicitly requested – Passive open.
- A server program is infinite – runs unless a problem occurs.
- Concurrency in client: two or more clients can run at the same time on a machine – current trend, alternatively: one client must start, run, and terminate before another client may start (iterative).

Client-Server Model

- Concurrency in server: An iterative server can process only one request at a time whereas a concurrent server can process many requests at the same time – share its time.
- Connectionless iterative server: the ones that use UDP are iterative, server uses one single port, arriving packets wait in line,
- Connection oriented concurrent server: the ones that use TCP are normally concurrent,

Client-Server Model

- A connection is established between server and each client, remains open until the entire stream is processed
- Each connection requires a port and many connections may remain open simultaneously,
- Server can use only one well-known port.
- Solution: use additional *ephemeral* ports
- Client makes request through the well-known port, once the connection is made, server assigns a temporary port to this connection.

Client-Server Model

- => well-known port is free to receive requests for additional connections
- A program is code (in UNIX) and defines all the variables and actions to be performed on those variables.
- A process is an instance of a program.
- An OS creates a process when executing a program, several processes can be created from one program running concurrently.

Client-Server

1. _ can provide a service.

a) An iterative server

b) A concurrent server

c) A client

d) (a) and (b)

2. The client program is _ as it terminates after it has been served.

a) Active

b) Passive

c) Finite

d) Infinite

Client-Server

3. A connection oriented concurrent server uses _ ports.

a) Ephemeral

b) Well-known

c) Active

d) (a) and (b)

4. Machine A requests service X from machine B. Machine B requests service Y from machine A. What is the total number of application programs required?

a) One

b) Two

c) Three

d) Four

Client-Server

5. A server program, once it issues _, waits for clients to request its service.

a) An active open

b) A passive open

c) An active request

d) A finite open

6. _ processes requests one at a time.

a) An iterative client

b) An iterative server

c) A concurrent client

d) A concurrent server

Client-Server

7. In a connection oriented concurrent server, the _ is used for connection only.

a) Ephemeral port

b) Well-known port

c) Infinite port

d) (a) and (b)

8. _ is an instance of a _.

a) Process; service

b) Program; process

c) Process; program

d) Structure; process

Socket

- Socket: is a construct that supports network input/output.
- An application creates a socket when it needs a connection to a network.
- It then establishes a connection to a remote application via the socket.
- Communication is achieved by reading data from the socket and writing data to it.
- Socket acts as an endpoint.

Socket

- A socket is defined in the OS as a structure.
- Simplified socket structure with five fields:

  - Family: defines the protocol group (IPv4, IPv6, UNIX domain protocols)

  - Type: defines the exchange-type (stream, packet, raw)

  - Protocol: set to zero for TCP/ UDP

  - Local address: combination of local IP and application port address.

  - Remote address: combination of remote IP and application port address.

Socket

- Stream socket: to be used with connection oriented protocol (TCP)
- Datagram socket: to be used with connectionless protocol (UDP)
- Raw socket: some protocols (ICMP) directly use the service of IP. Raw sockets are used in these applications.

Socket

- Connectionless iterative server: receives a request packet from UDP, processes the request, gives response to the UDP to send to the client,
- Packets are stored in a queue, and processed in order of arrival.
- Server function:

  - Create a socket (asks the OS)

  - Bind (asks the OS to enter information in the socket related to the server – server socket binding)

Socket

- Repeats steps infinitely:

a) receive a request (asks the OS to wait for a request to this socket and receive it)

b) process (by itself)

c) send (response sent to the client)

- Client function:
  - Create a socket (asks the OS)
  - Repeats steps as long as it has requests:

Socket

a) send a request (asks the OS)

b) receive (asks the OS to wait for a response and deliver it when it has arrived)

- Destroy (asks the OS to destroy the socket once requests are exhausted)

Socket

- Connection oriented concurrent server:
- A connection for each client, one buffer for each connection
- *Parent and child server:* server running infinitely accepting connections is parent, after establishing connection, parent creates child-server and ephemeral ports to handle the client.

Socket

- Server function:

  - Create a socket (asks the OS)

  - Bind (asks the OS to enter information in the socket related to the server – server socket binding)

  - Listen (asks the OS to be passive and listen to the client

  - Repeats steps infinitely:

  a) Create a child (temporary child process is assigned to serve the client, parent is free)

  b) create a new socket (to be used by the child process)

Socket

c) Repeat (the following steps as long as the child has requests from the client)

- Read (child reads a stream of bytes from the connection)
- Process (the child processes the stream of bytes)
- write (the child writes the result as a stream of bytes to the connection)

d) Destroy (asks the OS to destroy the temporary socket once the client has been served)

Socket

- Client function:

  - Create a socket

  - Connect (asks the OS to make a connection)

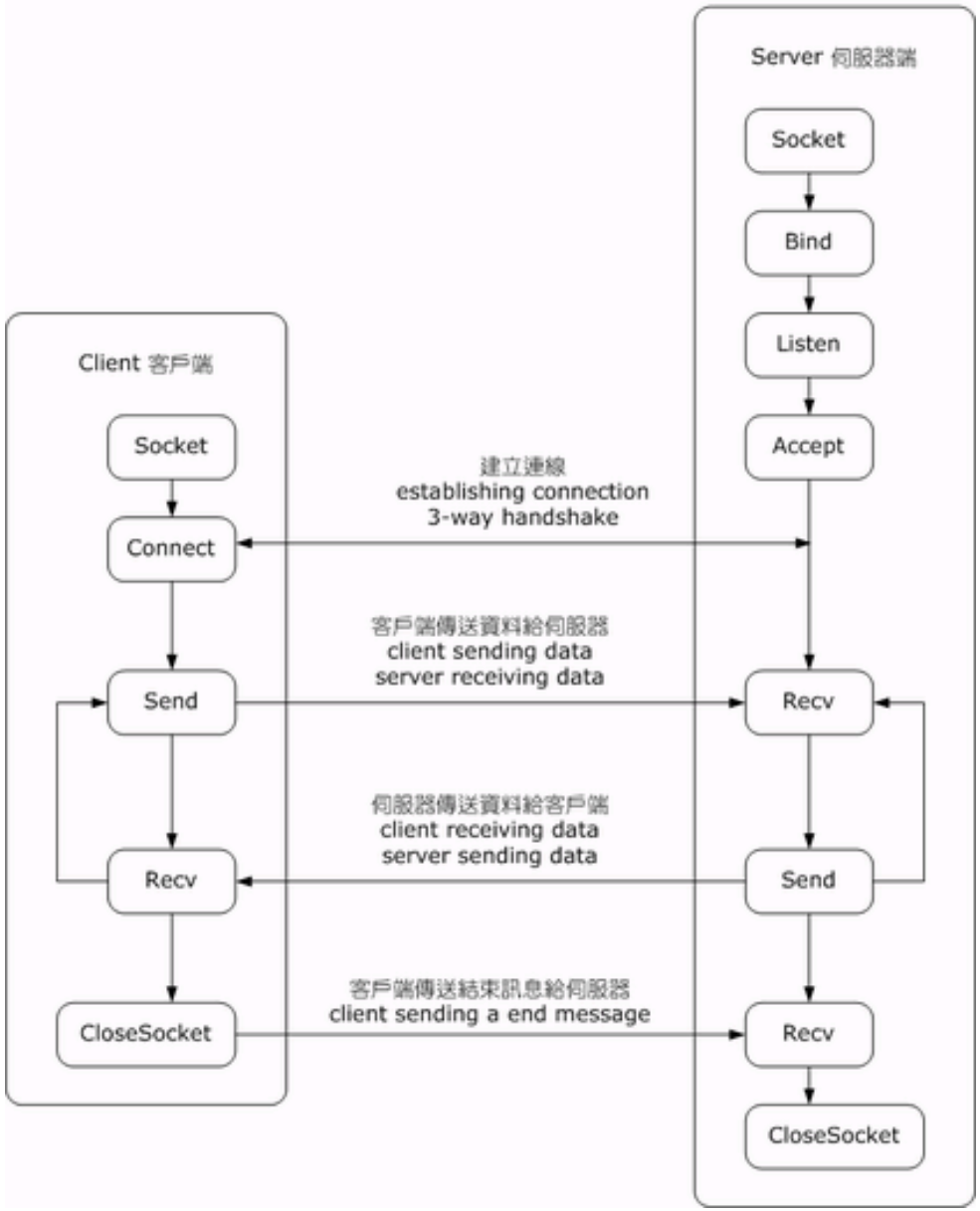
  - Repeats steps as long as it has data to send:

  a) Write (sends a stream of bytes to the server)

  b) Read (receives a stream of bytes from the server)

  - Destroy (asks the OS to destroy the socket once it has finished)

TCP Socket 基本流程圖
TCP Socket flow diagram



Socket

1. The _ socket is used with a connection oriented protocol.

a) Stream
b) Datagram
c) Raw
d) Remote

2. The _ socket is used with a connectionless protocol.

a) Stream
b) Datagram
c) Raw
d) Remote

Socket

3. The _ socket is used with a protocol that directly uses the services of IP.

a) Stream

b) Datagram

c) Raw

d) Remote

4. A _ server serves multiple clients, handling one request at a time.

a) Connection-oriented iterative

b) Connection-oriented concurrent

c) Connectionless iterative

d) Connectionless concurrent

Socket

5. A _ server serves multiple clients simultaneously.

a) Connection-oriented iterative

b) Connection-oriented concurrent

c) Connectionless iterative

d) Connectionless concurrent

Socket

- Data structures:

  sockaddr_in

  sin_family: 16-bit integer specifying protocol

  sin_port: 16-bit field specifying port number (application)

  s_addr: 32-bit Internet address

  hostent

  h_name: character string of text address of host

Socket

h_alias: alternative names

h_addrtype: type of address

h_length: Address length

h_addr_list: additional addresses

Socket

Socket Commands:

‘socket’ – creates a socket

‘gethostbyname’ – returns a host IP address corresponding to a name

‘gethostname’ – returns the host name

‘connect’ – requests a connection with a remote socket

‘bind’ – assigns an address and port number to a socket

Socket

Socket Commands:

‘listen’ – server is ready for connection requests and listens for them

‘accept’ – accepts a connection request over a socket

‘send’ – sends data through a socket

‘recv’ – receives data from a socket

‘close’ – closes a socket

Socket

Does the client or the server or both usually execute each of the following socket commands?

a. Socket b. connect c. bind d. accept

e. Listen f. send g. recv h. close

Socket

Client server example: outline / framework of socket related calls

‘client and server run concurrently on different machines’

Socket

Client:

socket (creates a socket)

…..

gethostbyname (maps remote host name to an IP address)

…….

Connect (issues a connection request to a specific server on the remote host)

…..

Socket

exchange information using ‘send’ and ‘recv’ commands

…..

close (terminate connection)

Server:

socket (creates a socket)

…..

gethostname (get the local host name)

Socket

gethostbyname (maps the host name to an IP address)

…..

bind (specifies the IP address and the port number and associates them with the socket)

…..

listen (puts socket in passive mode; ready to accept request)

…..

Socket

accept (accepts a connection request)

…..

exchange information using ‘send’ and ‘recv’ commands

…..

close (terminates current connection)