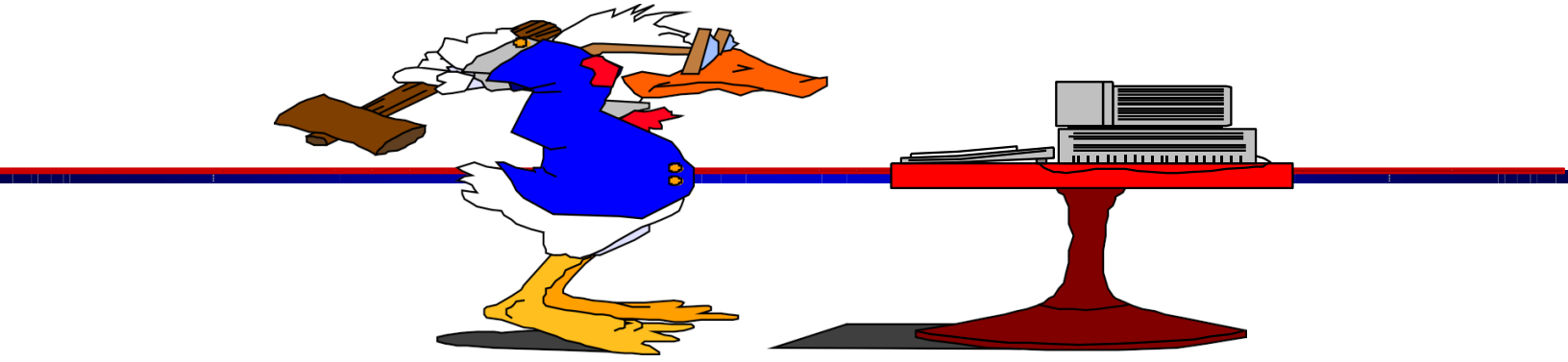


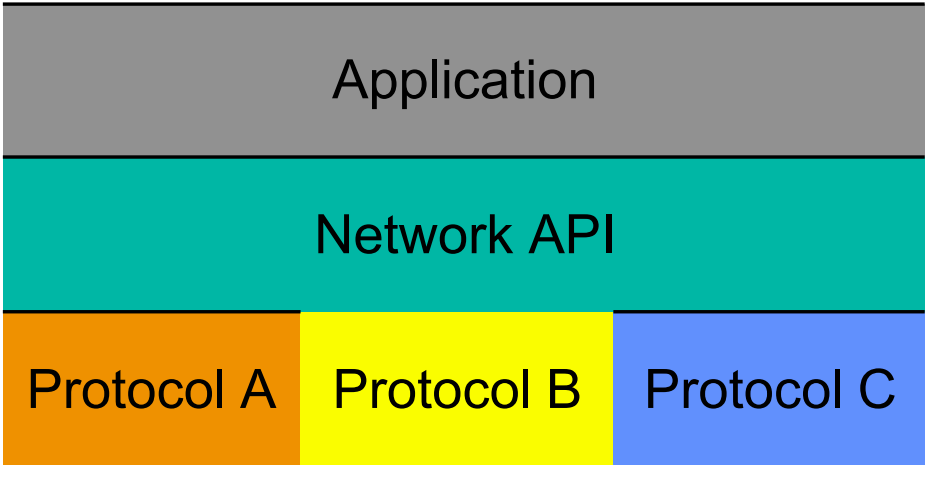
Overview of Network Programming: Sockets

EE450: Introduction to Computer Networks

Professor A. Zahid

Application Programming Interface

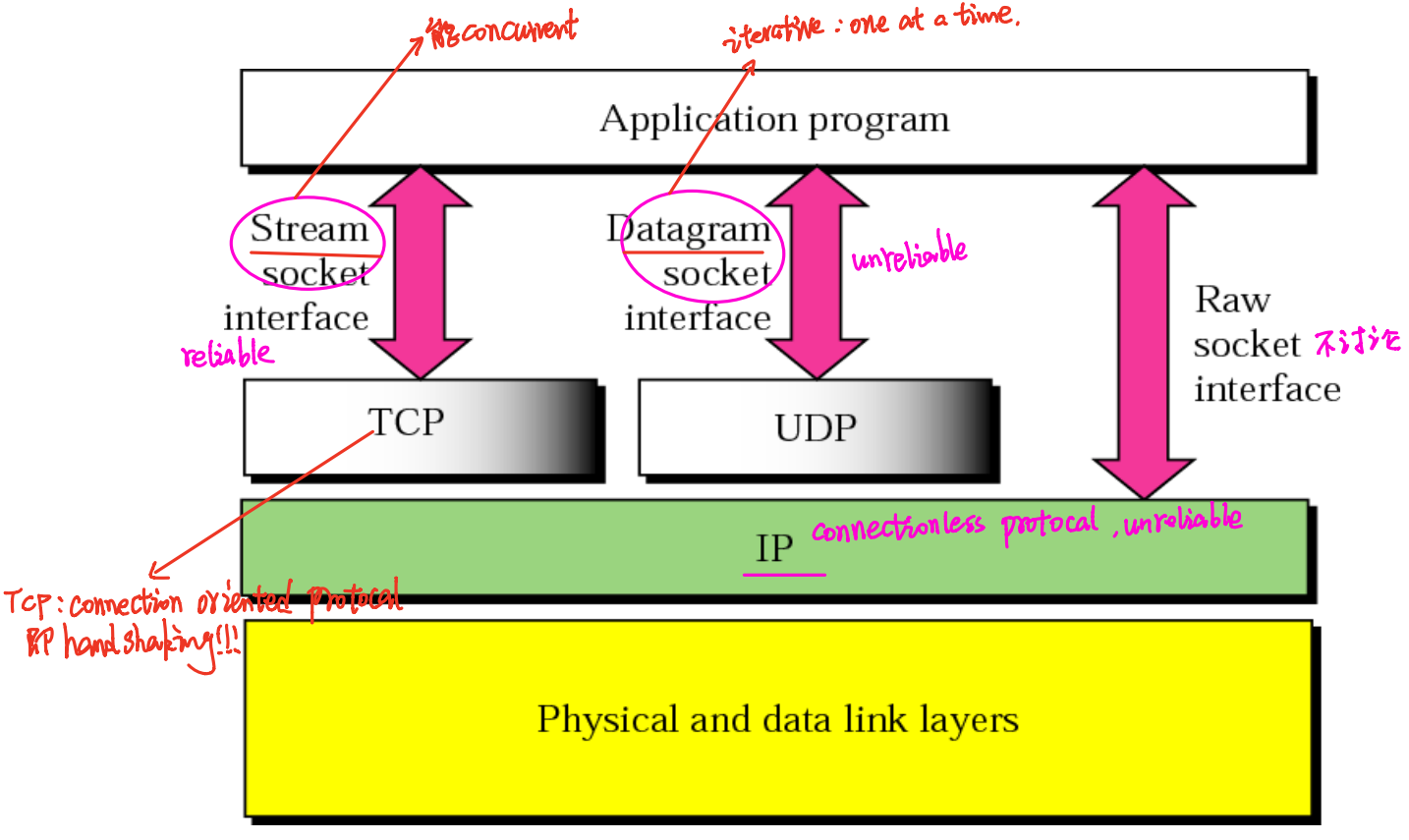
- The services provided by the operating system that provide the interface between application and the TCP/IP Protocol Suite.



API: Sockets

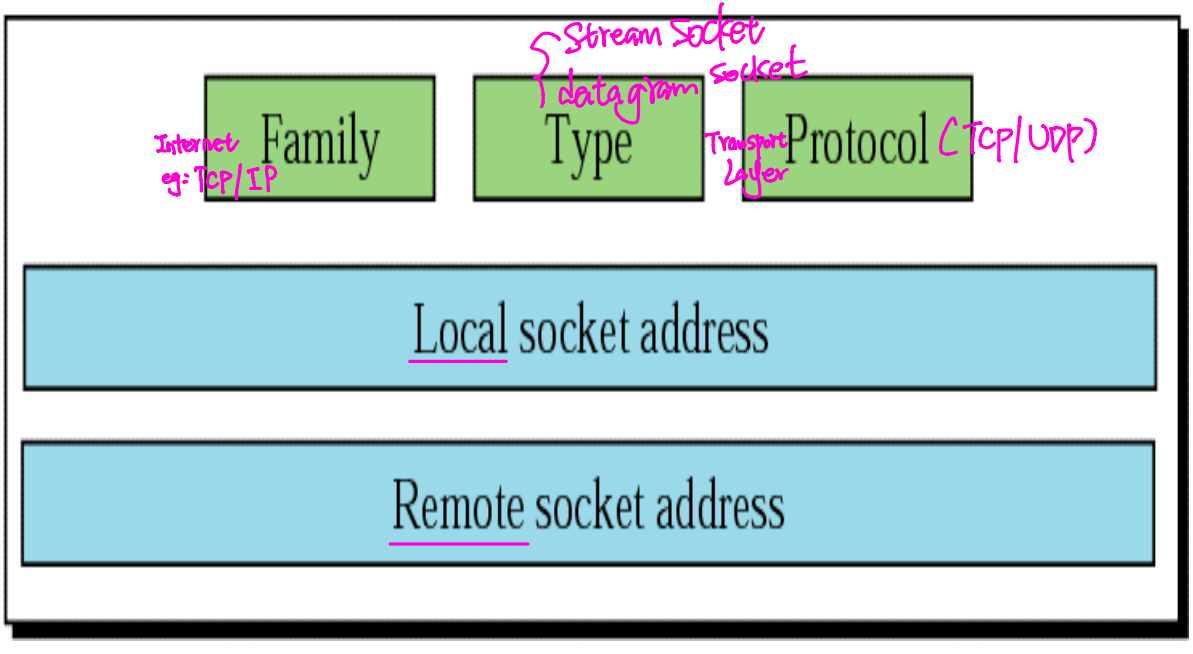
- TCP/IP does not include an API definition.
- There are a variety of APIs for use with TCP/IP:
  - UNIX Sockets
  - Winsock (Windows Sockets)
- A socket is an abstract representation of a communication endpoint.
- A socket allows the application to "plug in" to the network and communicate with other applications
- A socket is uniquely identified by the (1) IP address, (2) Port number and the underlying (3) transport layer protocol

Socket Types

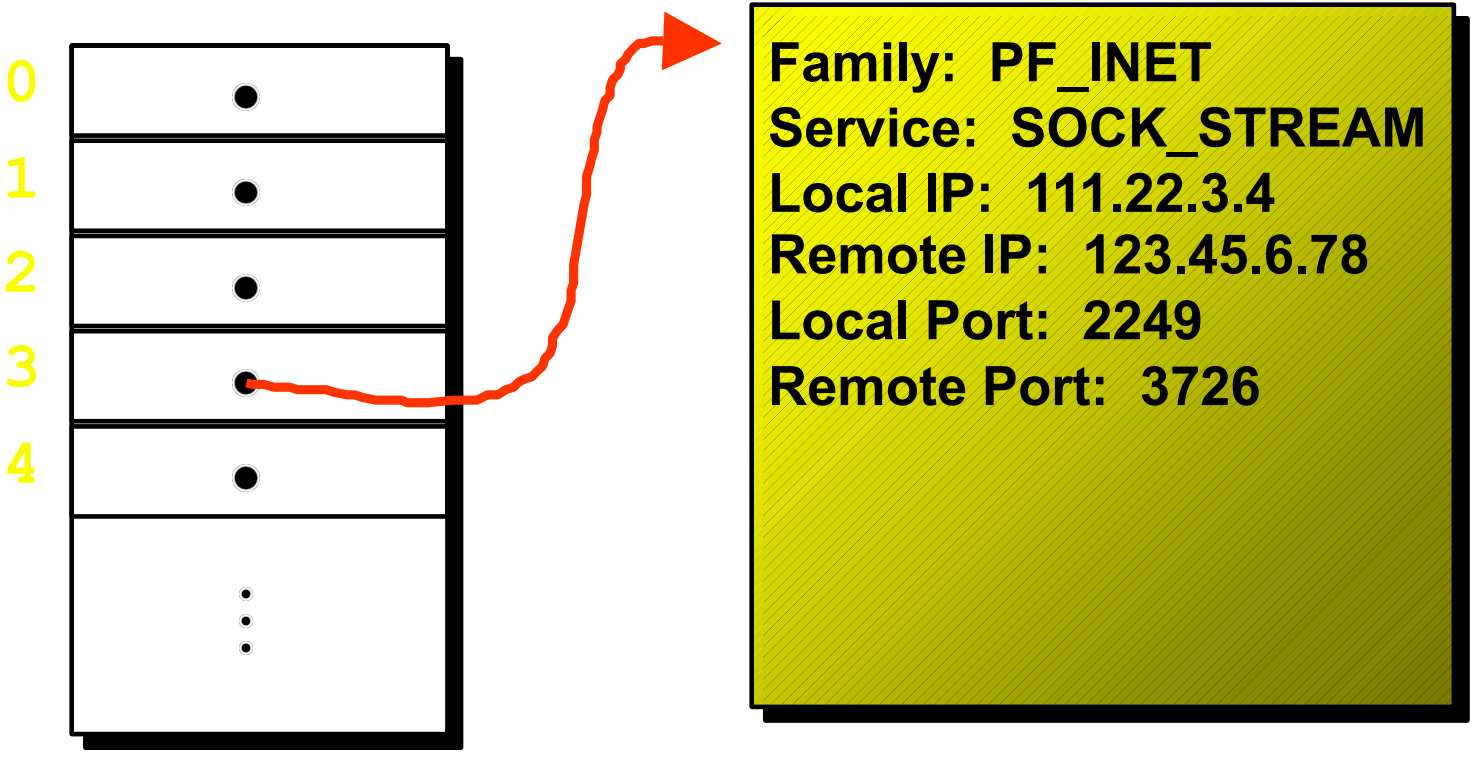


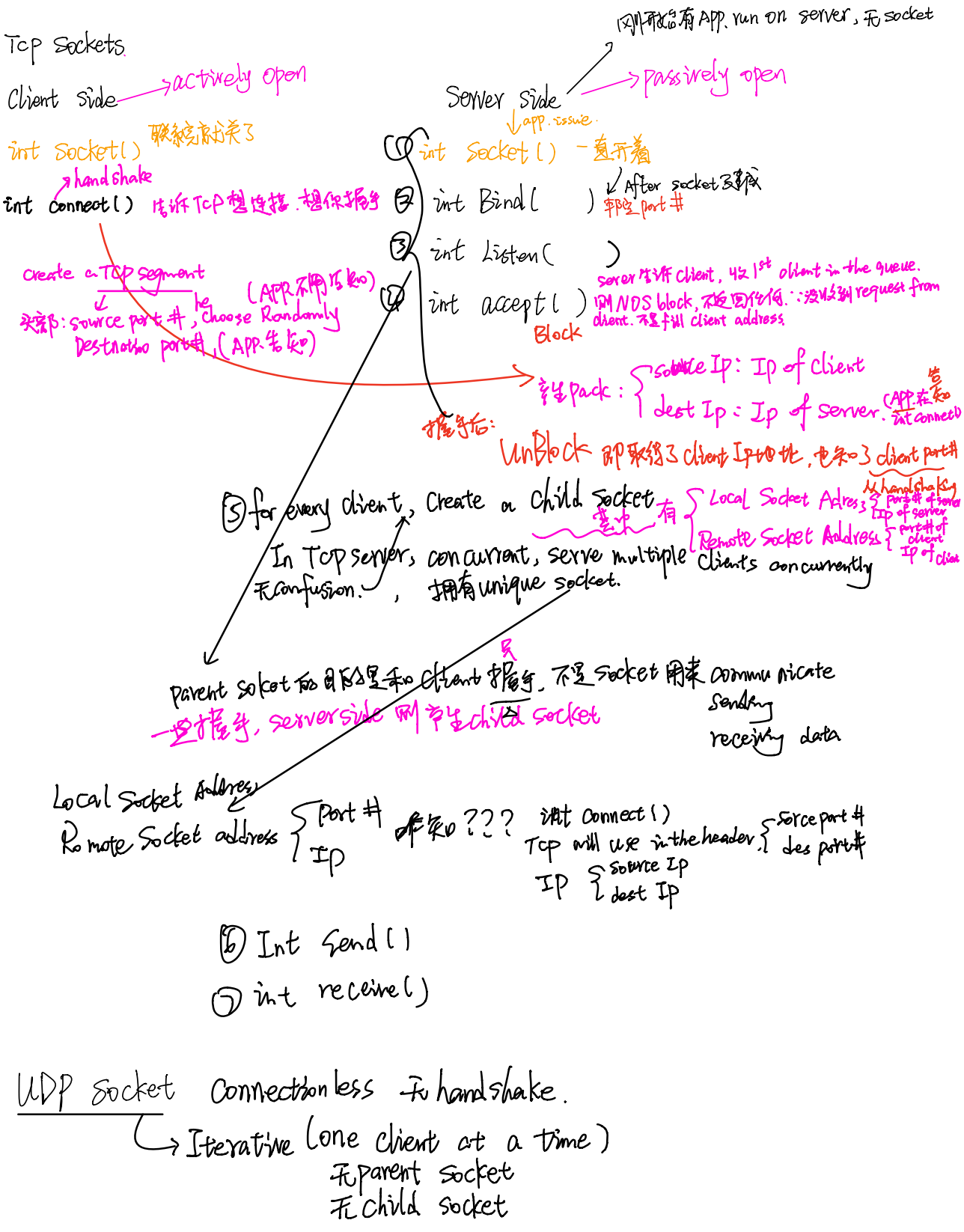
Socket Structure

Socket : file 类似:



Socket Descriptor Data Structure




Tcp Sockets
Client side
actively open
int Socket()
handshake
int connect()
Server side
passively open
int Socket()
int Bind()
int Listen()
int accept()
Block
create a TCP segment
Unblock
for every client, Create a child socket
In Tcp server, concurrent, serve multiple clients concurrently
parent socket
Local Socket Address
Remote Socket address
Int Send()
int receive()
UDP Socket Connectionless
Iterative (one client at a time)

Basic Sockets API

- Clients and Servers differ in some aspects of their use of API and they are the same in other aspects
- Both client and server programs begin by asking the NOS to "create" a socket. The function to accomplish that is Socket ( )
  - int socket (int protocol family, int type, int protocol)
  - Protocol family: PF_INET
  - Type: SOCK_STREAM, SOCK_DGRAM
  - Protocol: TCP, UDP
- Return value of Socket ( ) is a non-negative integer called Socket Descriptor (or –1 if errors)

TCP Server

- Create a TCP socket using Socket ( )
- Assign a port number to the socket using Bind ( )
  - int bind (int socket, local address, address length)
  - Local address is the IP address and the port number of the server. It is this address that the client and the server need to agree on to communicate. Neither one need to know the client address.
  - Address length is length of address structure
  - If successful, Bind ( ) returns a 0, otherwise it returns -1
  - If successful, the socket at server side is "associated" to the local IP address and the local port number
- Listen to connections from clients using Listen ( )
  - int listen (int socket, int queue limit)
  - Queue limit is an upper bound on # of clients that can be waiting
  - If successful, Listen ( ) returns a 0, otherwise it returns -1

TCP Server (Continued)

- The socket that has been bounded to a port and marked for listening is never actually used for sending and receiving. The socket (known as the welcoming socket or the "parent" socket.
- "Child" sockets are created for each client. It is this socket that is actually used for sending and receiving
- Server gets a socket for an incoming client connection by calling Accept ( )
  - int accept (int socket, client address, address length)
  - If successful, accept ( ) returns a descriptor for the new socket, otherwise it returns -1

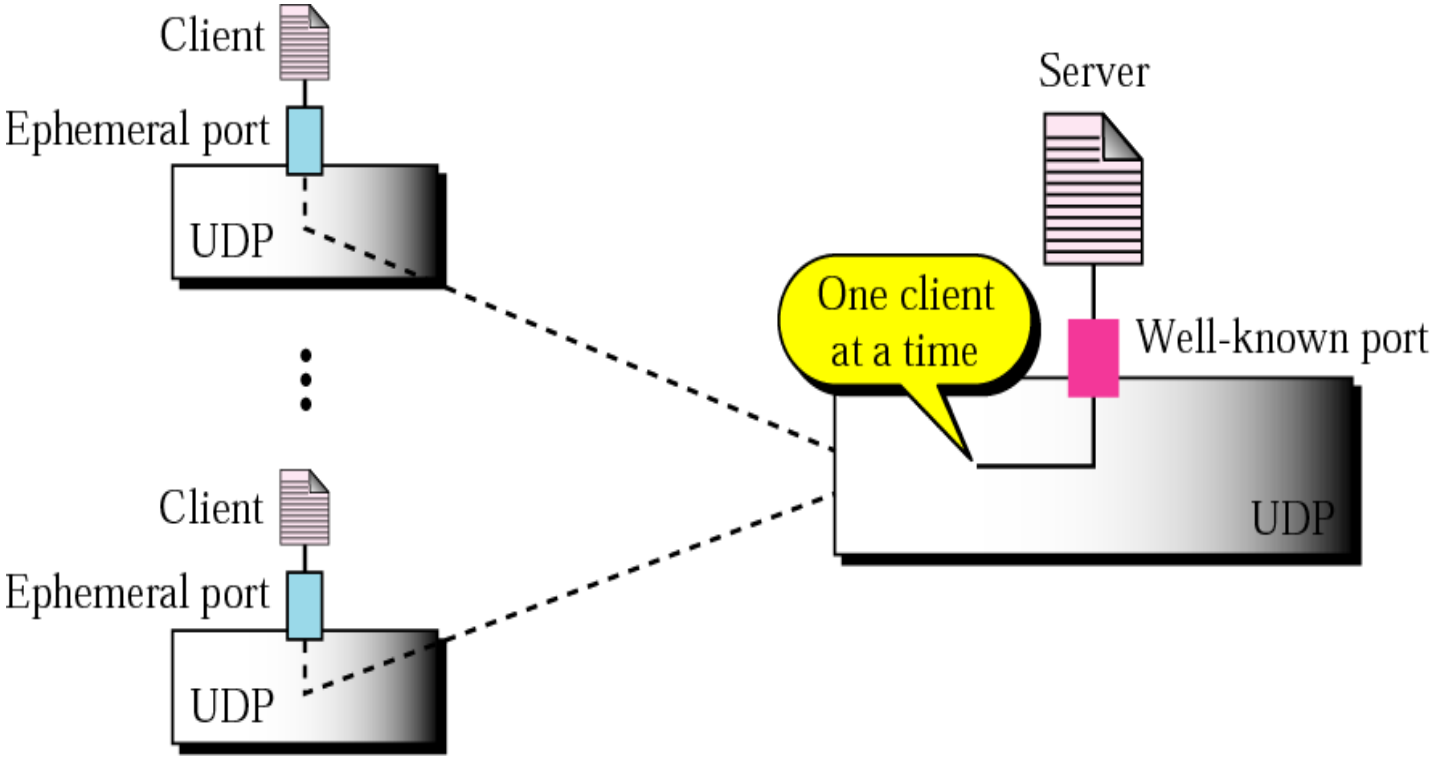
TCP Server (Continued)

- Once the child socket is created, communications (send and receive) can take place
  - int send (int socket, message, message length)
  - int recv (int socket, recv buffer, buffer length)
- When the application is done with the socket, it needs to close it (The child socket, not the parent socket which is passively open to welcome new clients). This is done by calling Close ( )
  - int close (int socket)

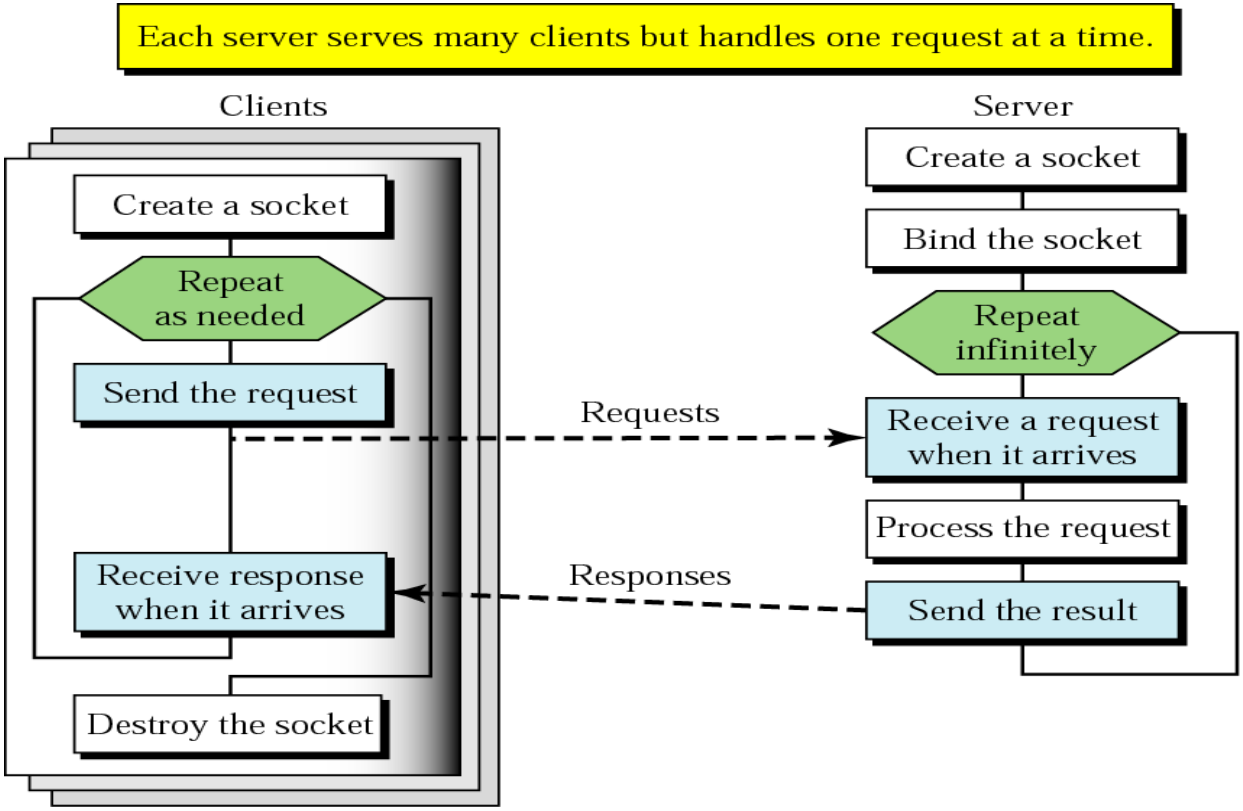
TCP Client

- Create a TCP socket using Socket ( )
- Establish a connection to the server using Connect ( )
  - int connect (int socket, foreign address, address length)
  - Foreign address is the address of the server and the port number of the server (The well-known port number)
- Communications using Send and Recv
  - int send (int socket, message, message length)
  - int recv (int socket, recv buffer, buffer length)
- Close the socket using Close ( )
  - int close (int socket)

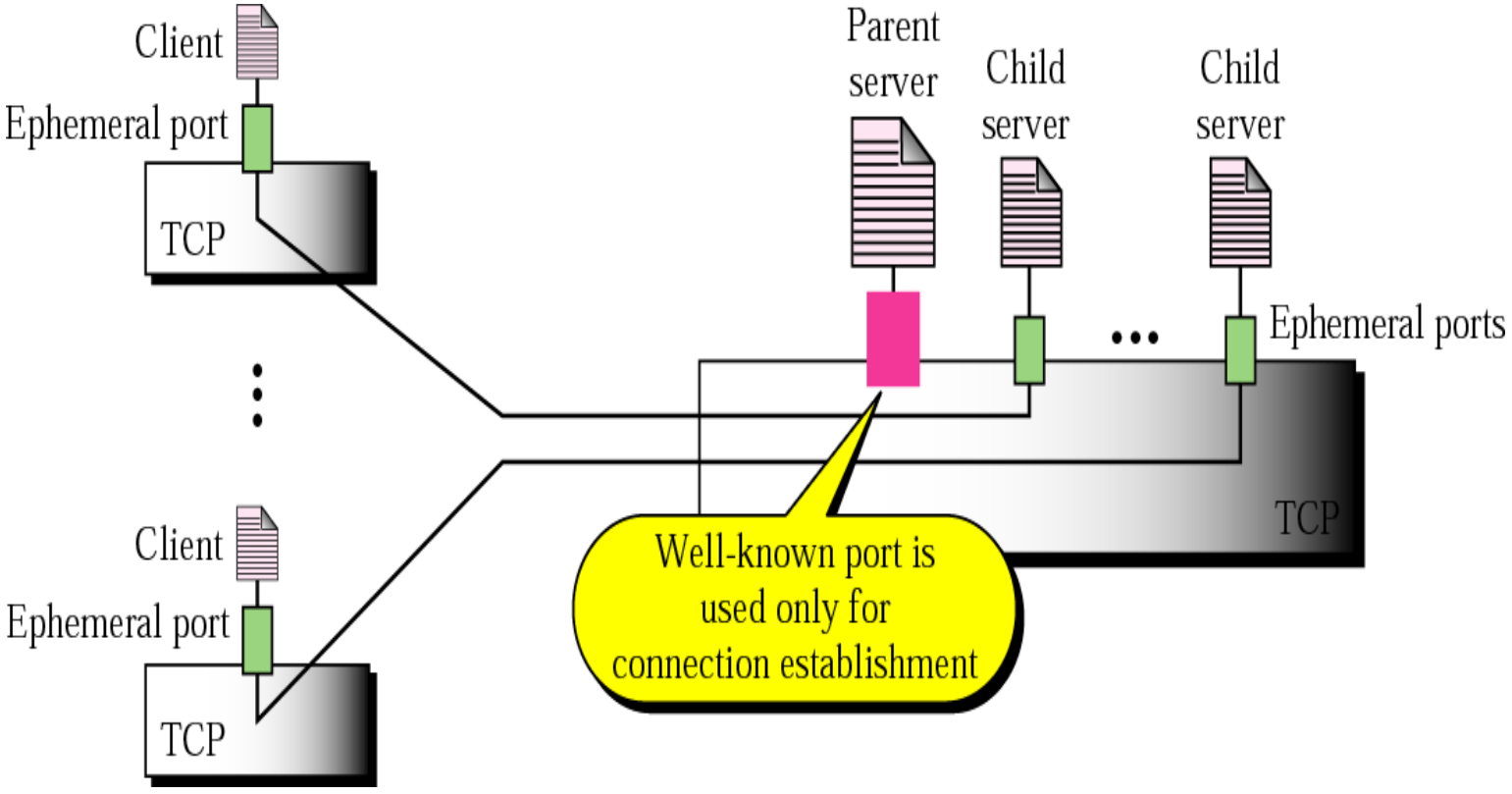
Connection-less Iterative Server



Flow Chart: Socket Interface for Connection-Less Iterative Server



Connection-oriented Concurrent Server



Flow Chart: Socket Interface for Connection-Oriented Concurrent Server