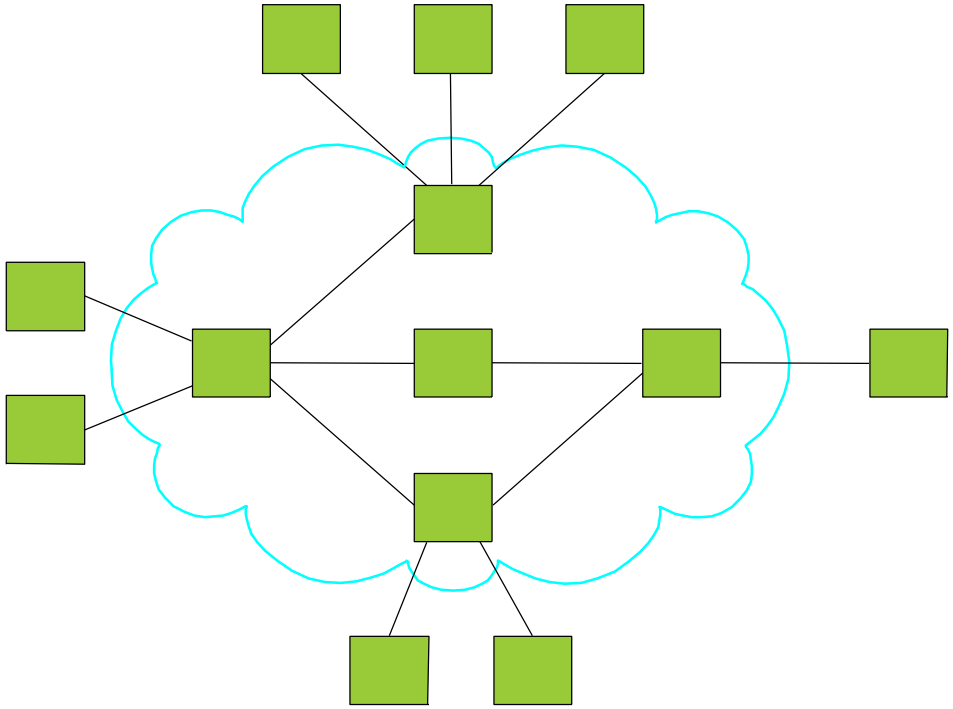
JAVA Socket Programming

Computer Network

A computer network is an interconnected collection of autonomous computers.



Protocol

A network protocol defines rules and conventions for communication between network devices. Network protocols include mechanisms for devices to **identify** and make connections with each other, as well as **formatting rules** that specify how data is packaged into sent and received messages.

Network Architecture

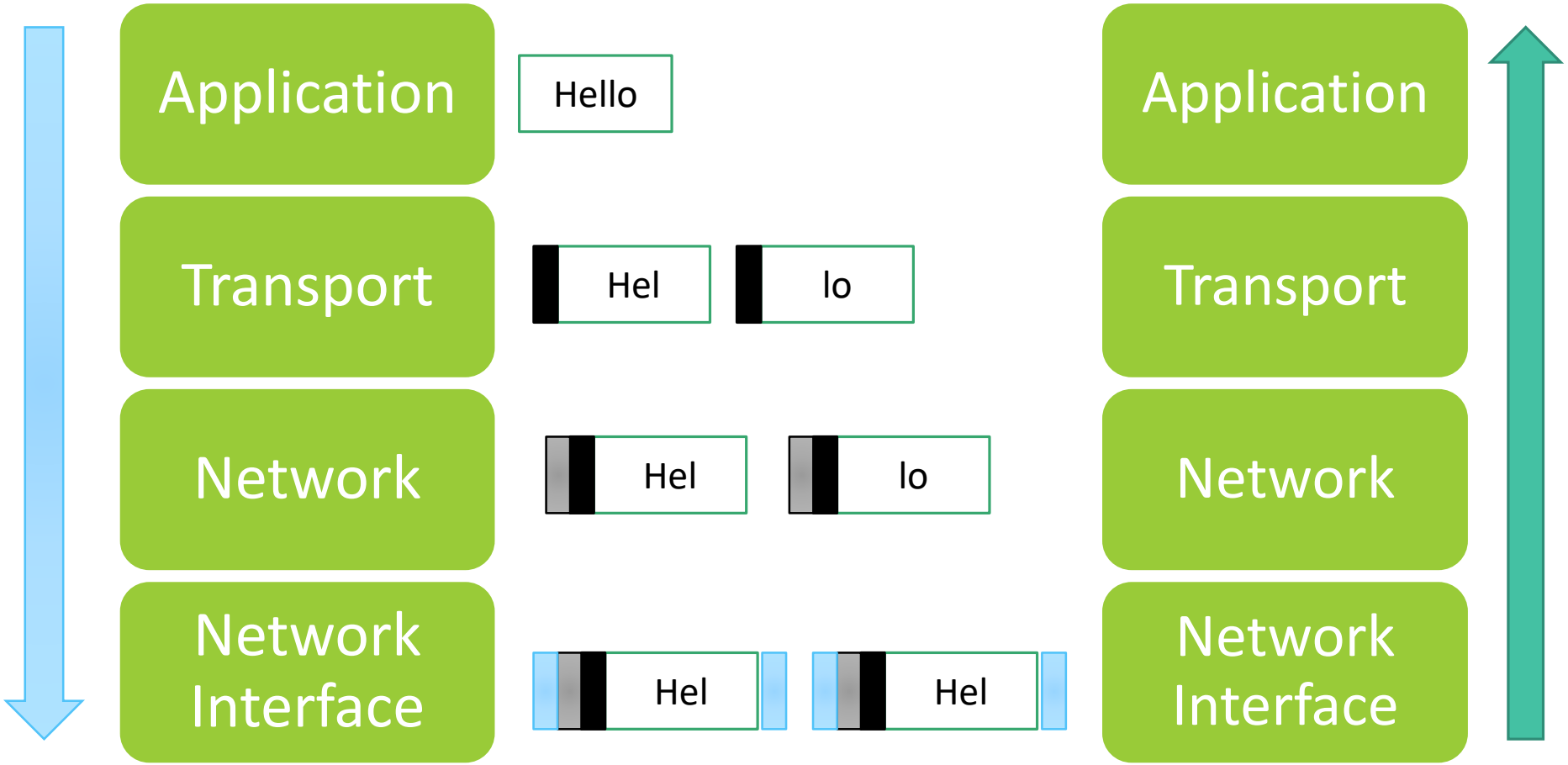
A network architecture is a set of layers and protocols used to reduce network design complexity.

The TCP/IP Protocol Suite (also called the Internet Architecture) is an important example of a network architecture.

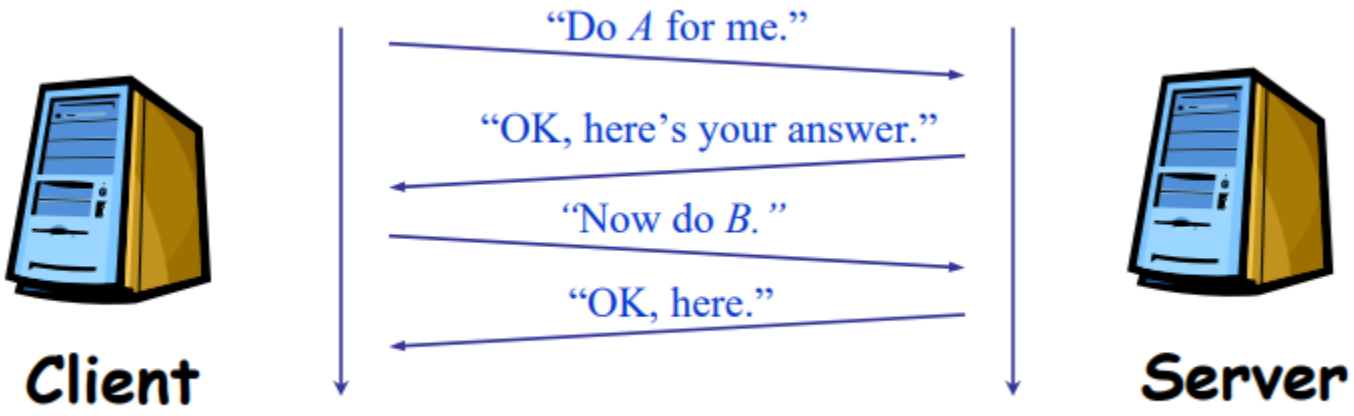
TCP/IP Protocol Suite

Application	• **Various applications (FTP,HTTP,…)**
Transport	• **Reliable, end-to-end byte stream (TCP)**
Network	• **Unreliable end-to-end transmission of packets**
Network Interface	• **transmission of raw bits**

TCP/IP Protocol Suite

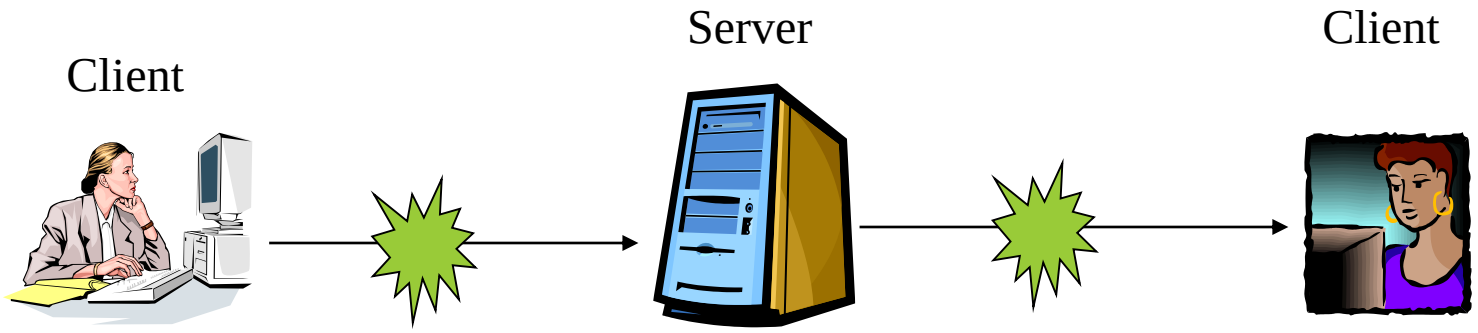


Server and Client



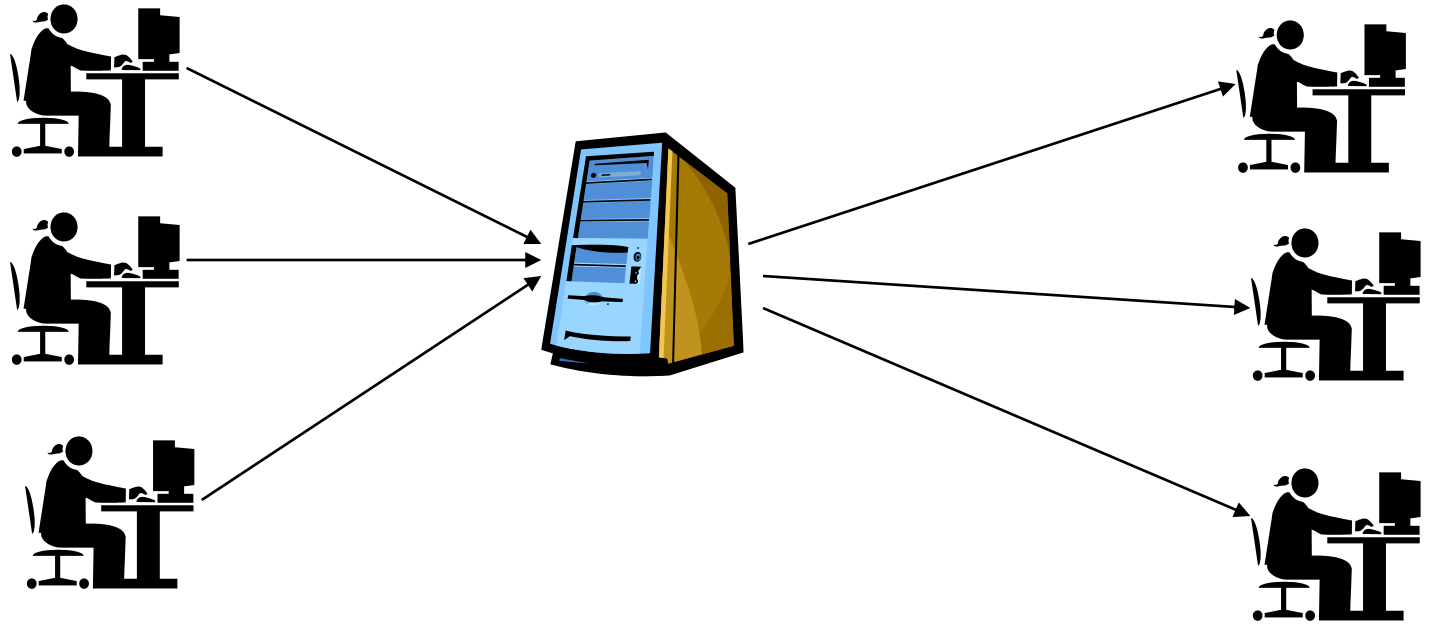
Server and Client

Email

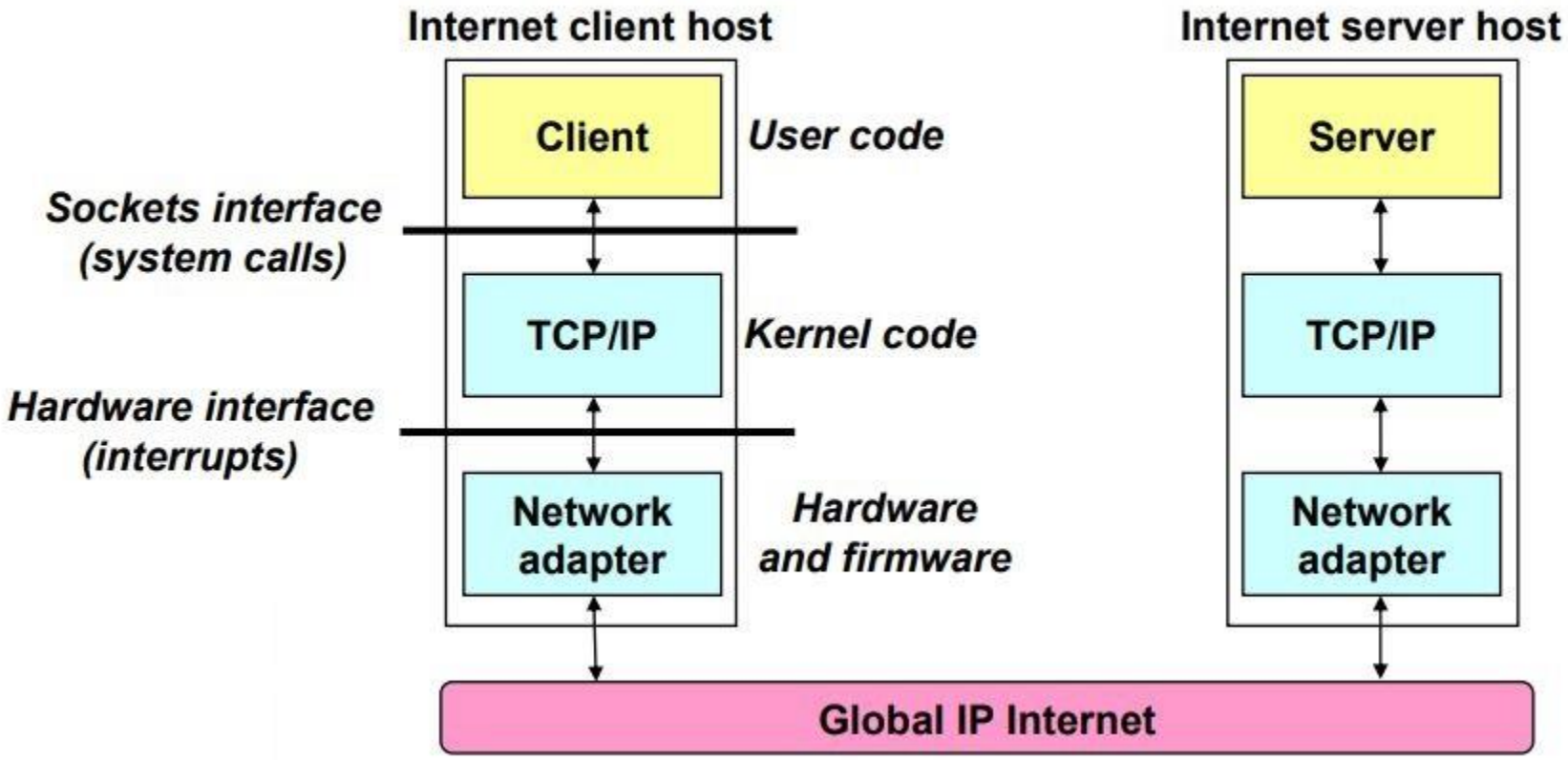


Server and Client

Chatroom



An Internet Application



A Programmer's View of the Internet

Hosts are mapped to a set of 32-bit IP addresses.

- 185.211.88.129

The set of IP addresses is mapped to a set of identifiers called Internet domain names.

- 185.211.88.129 is mapped to ce.aut.ac.ir

A process on one Internet host can communicate with a process on another Internet host over a connection.

Internet Connections

Most clients and servers communicate by sending streams of bytes over connections

- E.g., using TCP, the Transmission Control Protocol

A socket is an endpoint of a connection between two processes

- Java APIs

Or: the interface between user and network

Sockets

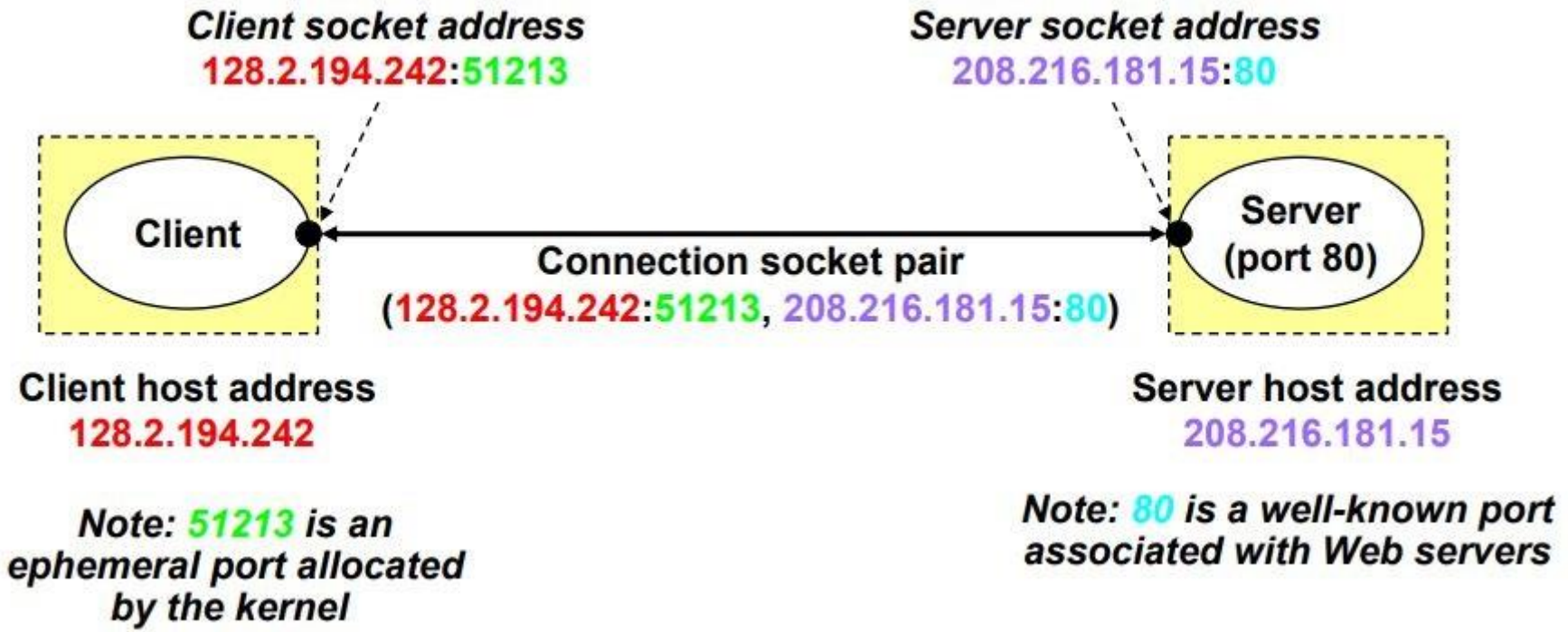

socket
socket
Client
Server
TCP byte-stream connection
(128.2.194.242, 208.216.181.15)
Client host address
128.2.194.242
Server host address
208.216.181.15

Sockets

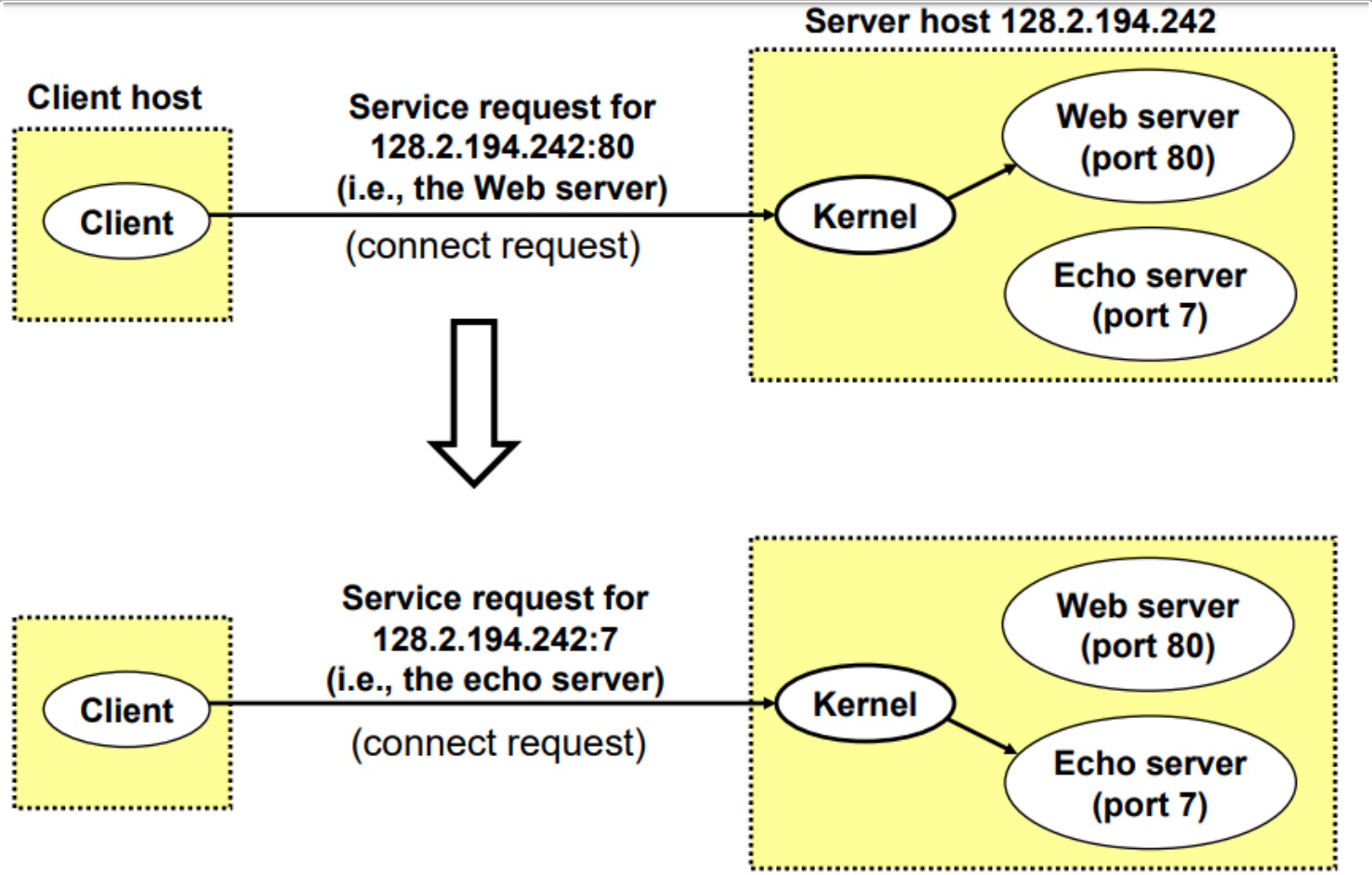
A host might have many open connections, possibly held by different processes.

A port is a unique communication endpoint on a host, named by a 16-bit integer, and associated with a process.

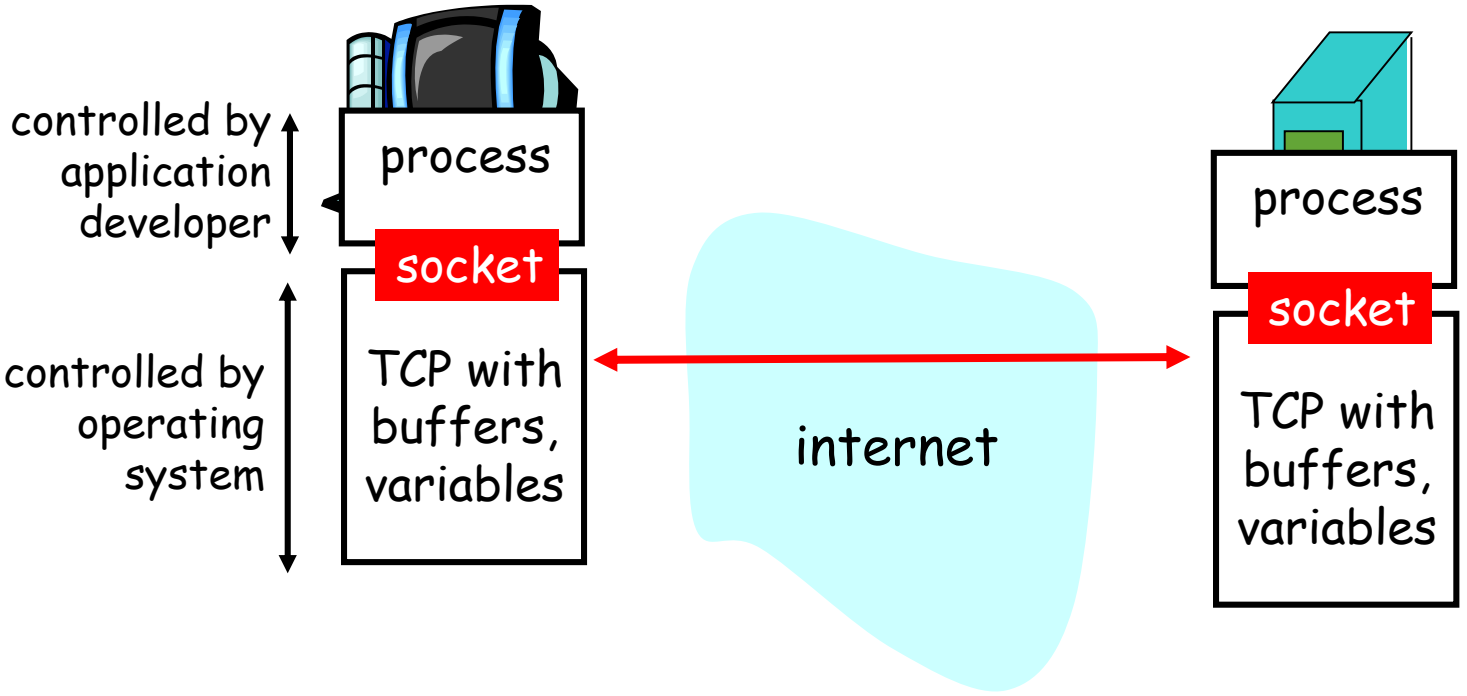
Sockets


Client socket address
128.2.194.242:51213
Server socket address
208.216.181.15:80
Client
Server
(port 80)
Connection socket pair
(128.2.194.242:51213, 208.216.181.15:80)
Client host address
128.2.194.242
Server host address
208.216.181.15
Note: 51213 is an ephemeral port allocated by the kernel
Note: 80 is a well-known port associated with Web servers

Sockets


Server host 128.2.194.242
Client host
Service request for
128.2.194.242:80
(i.e., the Web server)
Client
(connect request)
Kernel
Web server
(port 80)
Echo server
(port 7)
Service request for
128.2.194.242:7
(i.e., the echo server)
Client
(connect request)
Kernel
Web server
(port 80)
Echo server
(port 7)

Sockets


controlled by application developer
controlled by operating system
process
socket
TCP with buffers, variables
internet
process
socket
TCP with buffers, variables

What is a socket?

Socket

- The combination of an IP address and a port number.
- Two types
  - Stream socket : reliable two-way connected communication streams (TCP)
  - Datagram socket (UDP)

Socket pair

- Specified the two end points that uniquely identifies each TCP connection in an internet.
- 4-tuple: (client IP address, client port number, server IP address, server port number)

TCP Sockets for server and client

Server

- Welcoming socket
  - Welcomes some initial contact from a client.
- Connection socket
  - Is created at initial contact of client.
  - New socket that is dedicated to the particular client.

Client

- Client socket
  - Initiate a TCP connection to the server by creating a socket object. (Three-way handshake)
  - Specify the address of the server process, namely, the IP address of the server and the port number of the process.

Socket functional calls

socket (): Create a socket

bind(): bind a socket to a local IP address and port #

listen(): passively waiting for connections

connect(): initiating connection to another socket

accept(): accept a new connection

Write(): write data to a socket

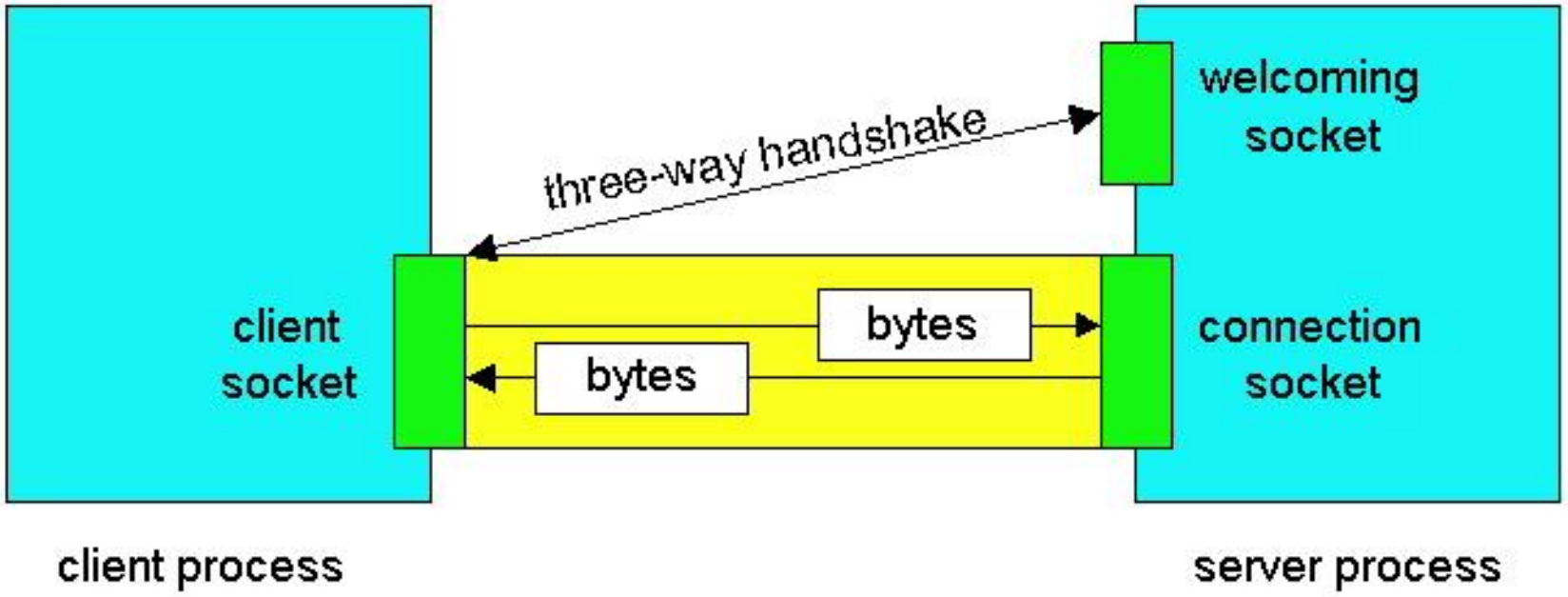
Read(): read data from a socket

sendto(): send a datagram to another UDP socket

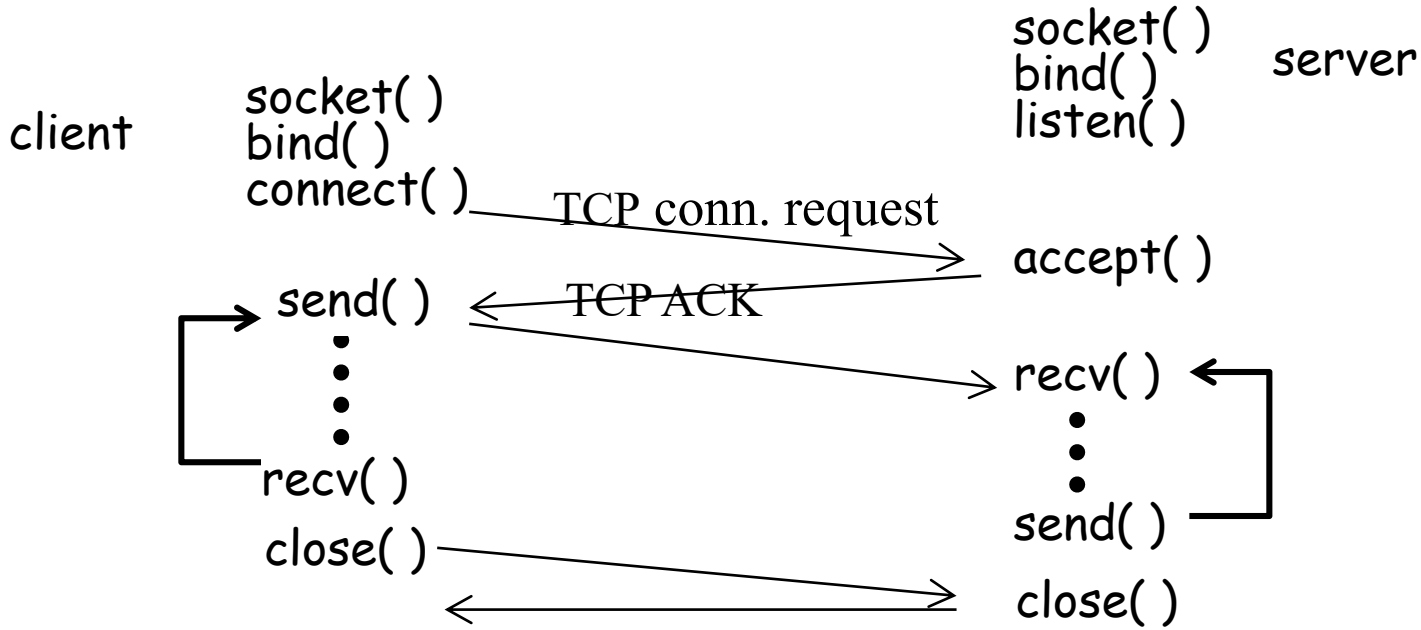
recvfrom(): read a datagram from a UDP socket

close(): close a socket (tear down the connection)

TCP Sockets


welcoming
socket
three-way handshake
client
socket
bytes
bytes
connection
socket
client process
server process

Socket-programming using TCP



Client/server socket interaction: TCP

Server (running on **hostid**)

Client

create socket,
port=**x**, for
incoming request:
welcomeSocket =
ServerSocket()

Client/server socket interaction: TCP

Server (running on **hostid**)

Client

create socket,
port=**x**, for
incoming request:
welcomeSocket =
ServerSocket()

wait for incoming
connection request
connectionSocket =
welcomeSocket.accept()

Client/server socket interaction: TCP

Server (running on **hostid**)

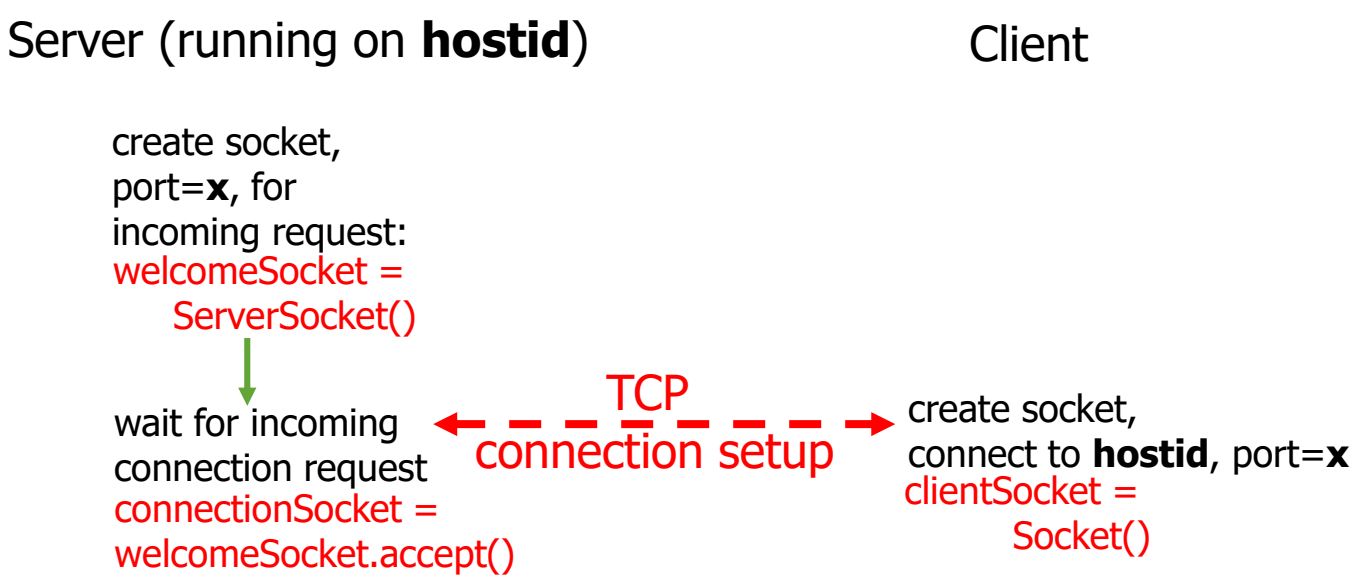
create socket,
port=**x**, for
incoming request:
welcomeSocket =
ServerSocket()

wait for incoming
connection request
connectionSocket =
welcomeSocket.accept()

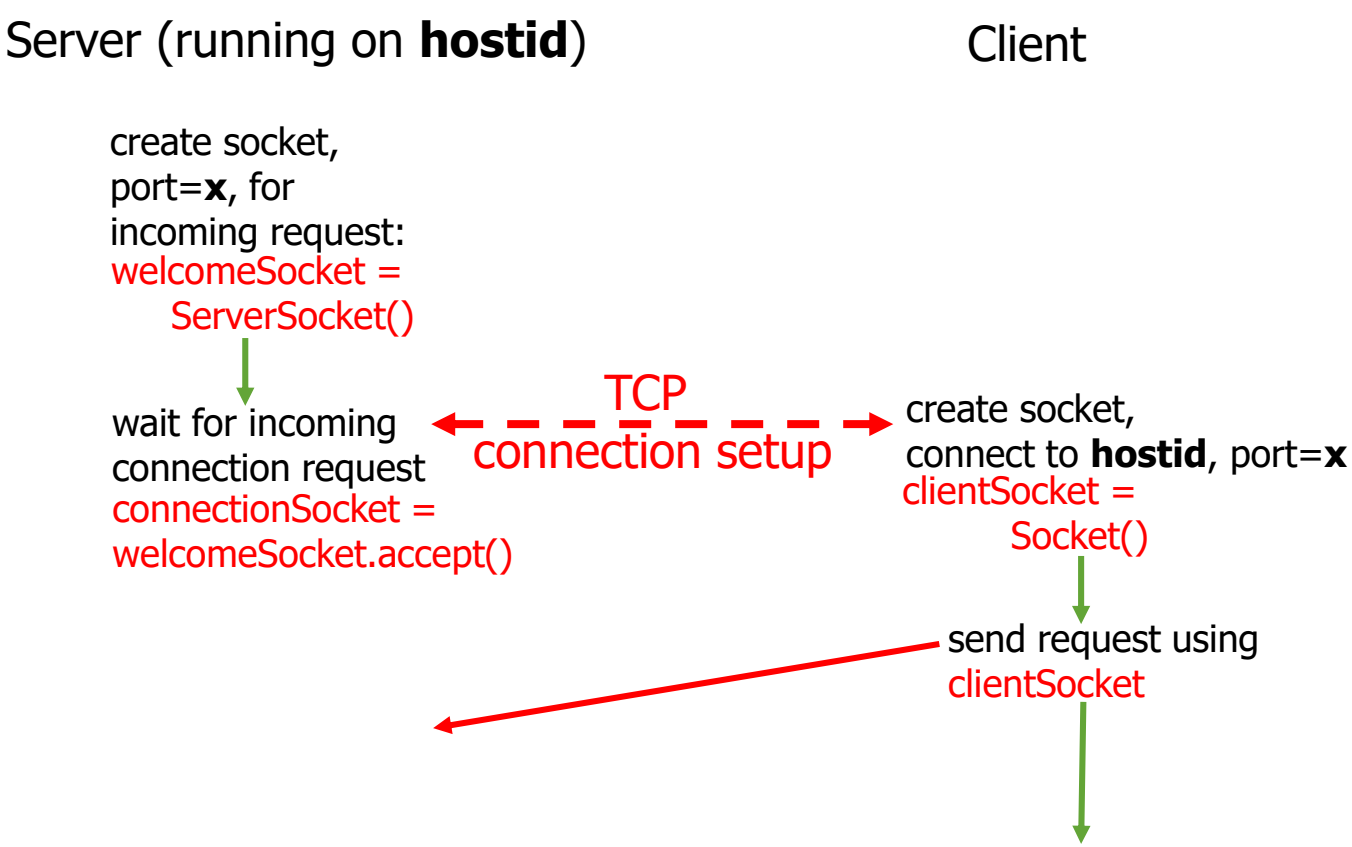
Client

create socket,
connect to **hostid**, port=**x**
clientSocket =
Socket()

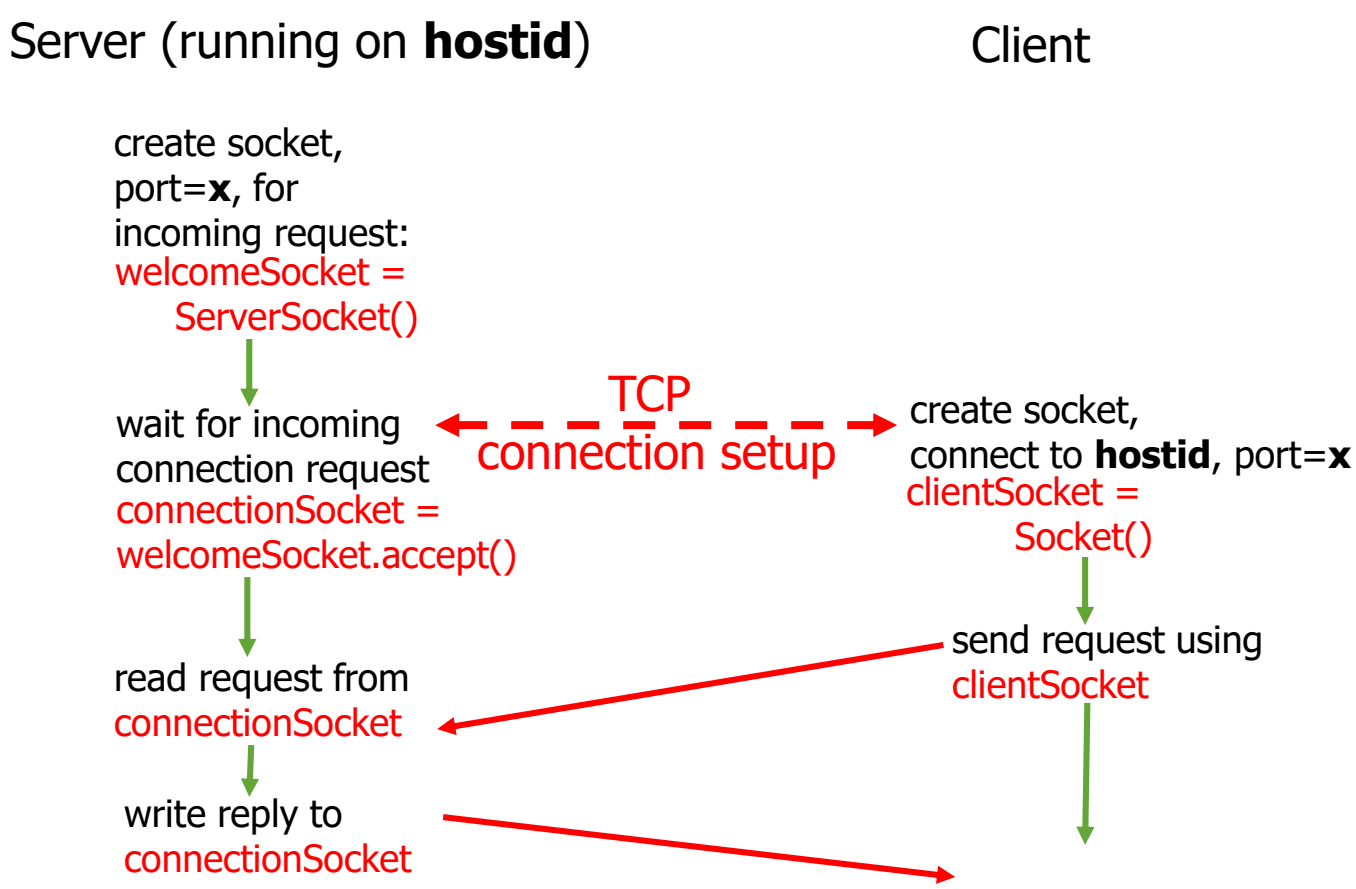
Client/server socket interaction: TCP



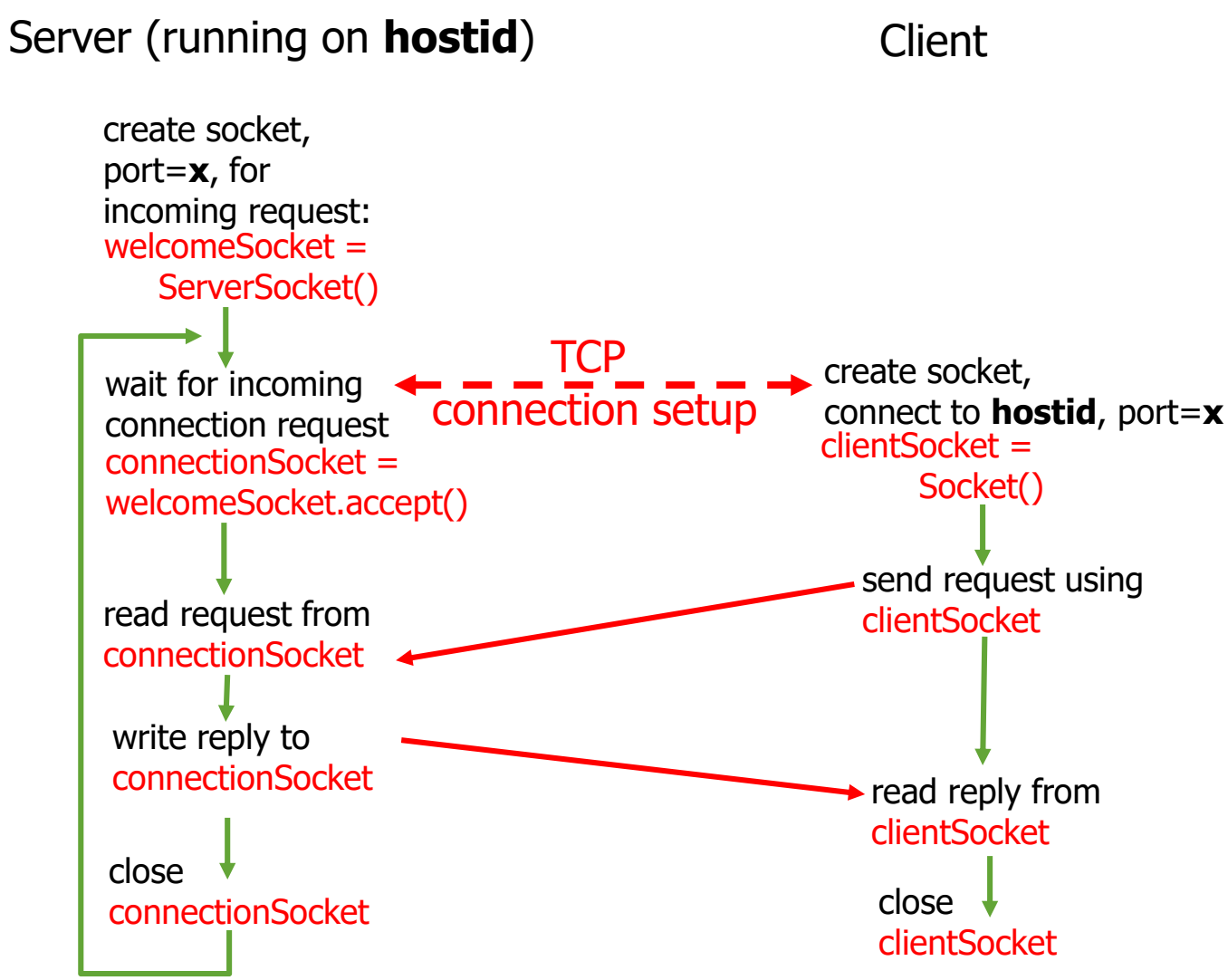
Client/server socket interaction: TCP



Client/server socket interaction: TCP



Client/server socket interaction: TCP



Socket-programming using TCP

See single-thread-server Example.

Concurrent server

Servers need to handle a new connection request while processing previous requests.

- Most TCP servers are designed to be concurrent.

When a new connection request arrives at a server, the server accepts and invokes a new process to handle the new client.

Socket-programming using TCP

See multi-thread-server Example.