

Chapter 33 Networking



Objectives

- ♦ To explain terms: TCP, IP, domain name, domain name server, stream-based communications, and packet-based communications (§33.2).
- ♦ To create servers using server sockets (§33.2.1) and clients using client sockets (§33.2.2).
- ♦ To implement Java networking programs using stream sockets (§33.2.3).
- ♦ To develop an example of a client/server application (§33.2.4).
- ♦ To obtain Internet addresses using the **InetAddress** class (§33.3).
- ♦ To develop servers for multiple clients (§33.4).
- ♦ To send and receive objects on a network (§33.5).
- ♦ To develop an interactive tic-tac-toe game played on the Internet (§33.6).

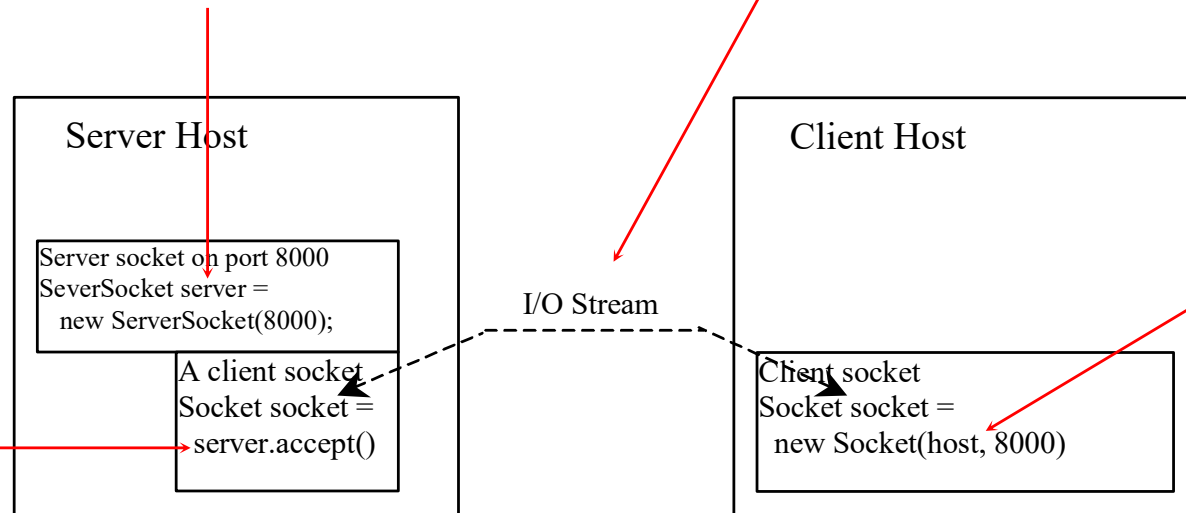


Client/Server Communications

The server must be running when a client starts. The server waits for a connection request from a client. To establish a server, you need to create a server socket and attach it to a port, which is where the server listens for connections.

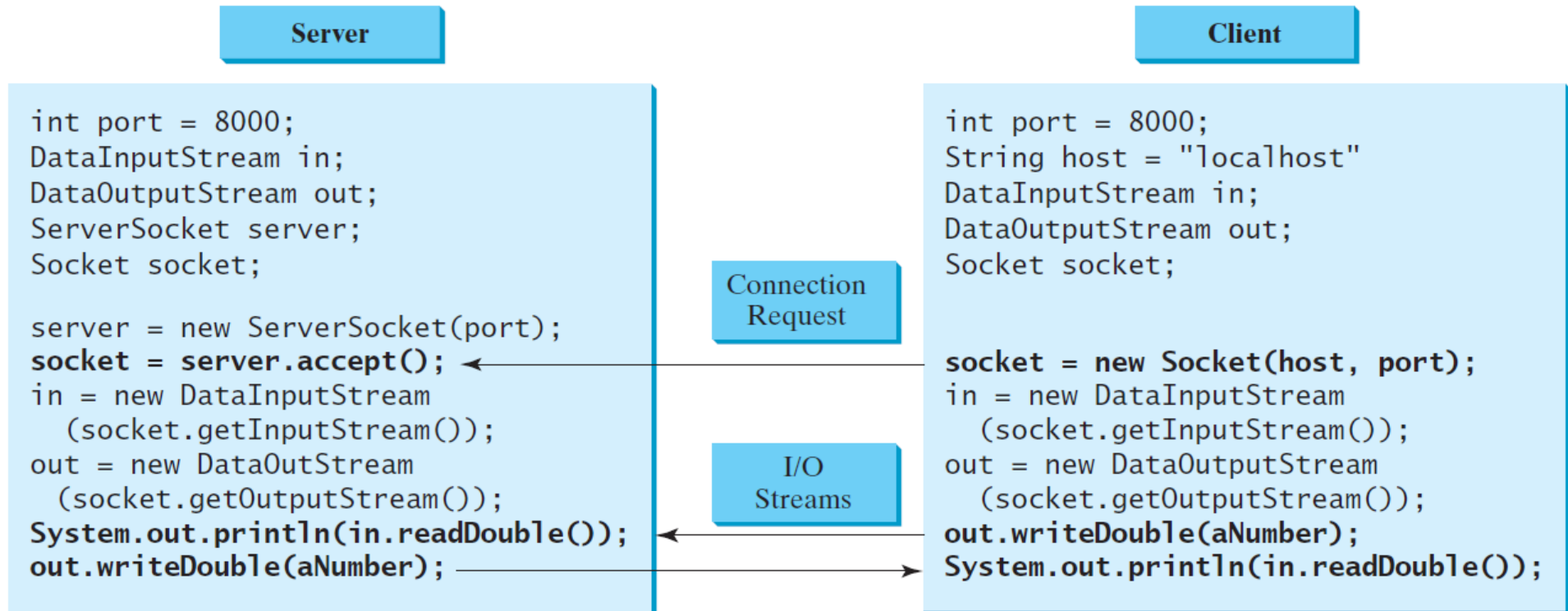
After the server accepts the connection, communication between server and client is conducted the same as for I/O streams.

After a server socket is created, the server can use this statement to listen for connections.



The client issues this statement to request a connection to a server.

Data Transmission through Sockets



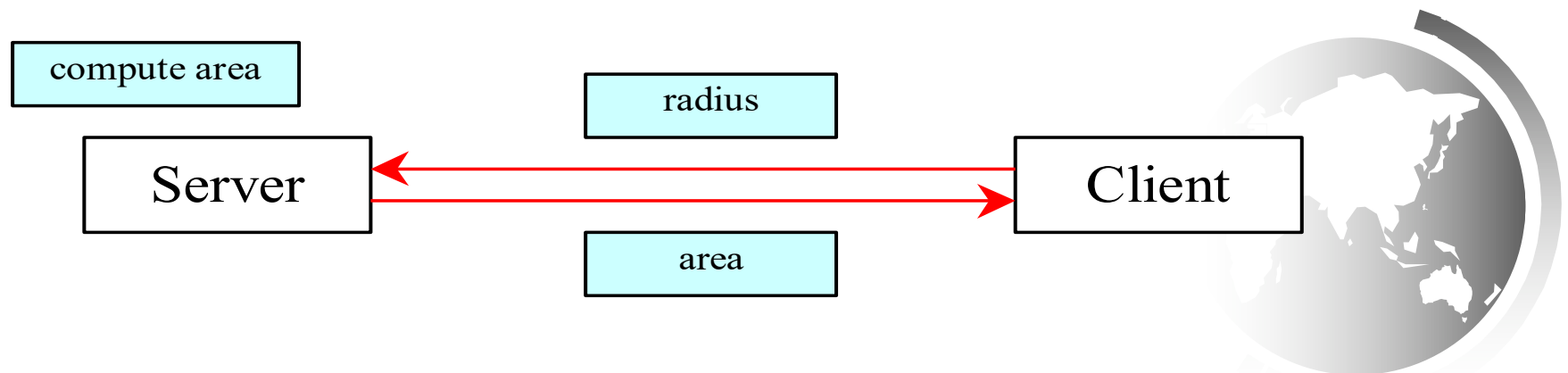
InputStream input = socket.getInputStream();

OutputStream output = socket.getOutputStream();

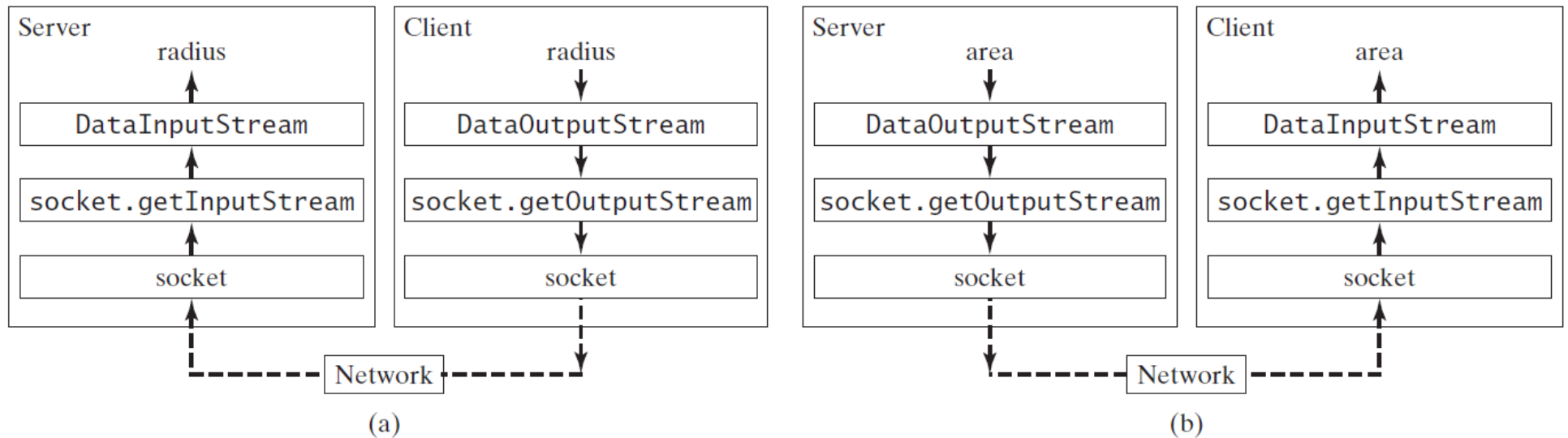


A Client/Server Example

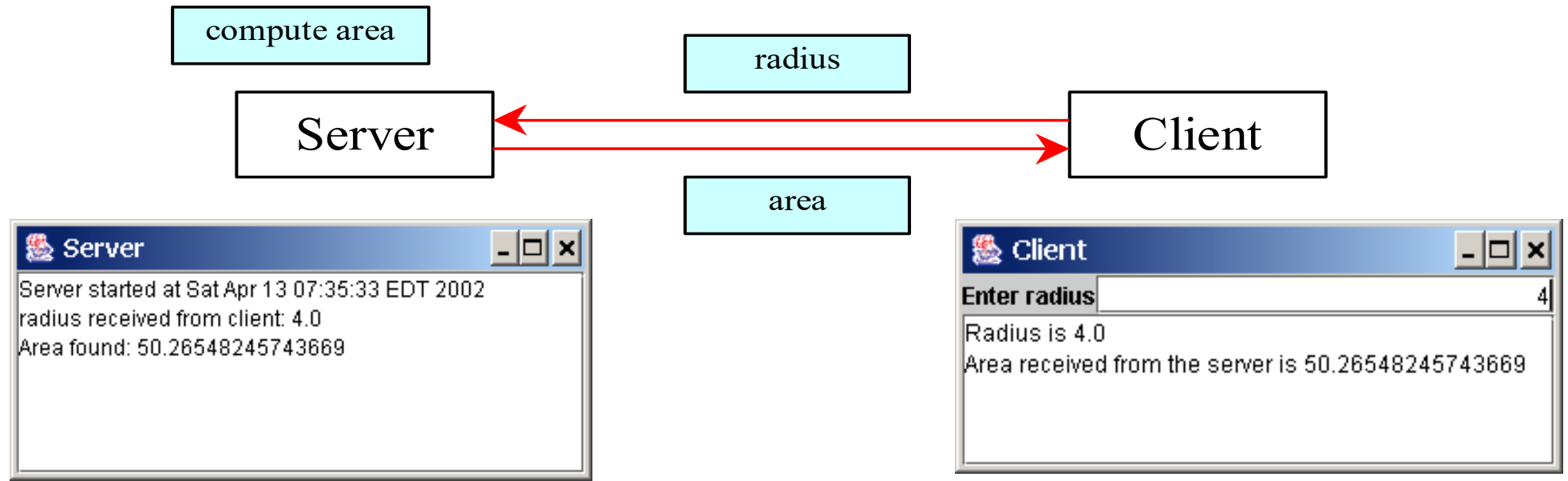
- ♦ Problem: Write a client to send data to a server. The server receives the data, uses it to produce a result, and then sends the result back to the client. The client displays the result on the console. In this example, the data sent from the client is the radius of a circle, and the result produced by the server is the area of the circle.



A Client/Server Example, cont.



A Client/Server Example, cont.



Server

Start Server

Client

Start Client

Note: Start the server, then the client.

The InetAddress Class

Occasionally, you would like to know who is connecting to the server. You can use the `InetAddress` class to find the client's host name and IP address. The `InetAddress` class models an IP address. You can use the statement shown below to create an instance of `InetAddress` for the client on a socket.

```
InetAddress inetAddress = socket.getInetAddress();
```

Next, you can display the client's host name and IP address, as follows:

```
System.out.println("Client's host name is " +  
    inetAddress.getHost_name());  
System.out.println("Client's IP Address is " +  
    inetAddress.getHostAddress());
```



Serving Multiple Clients

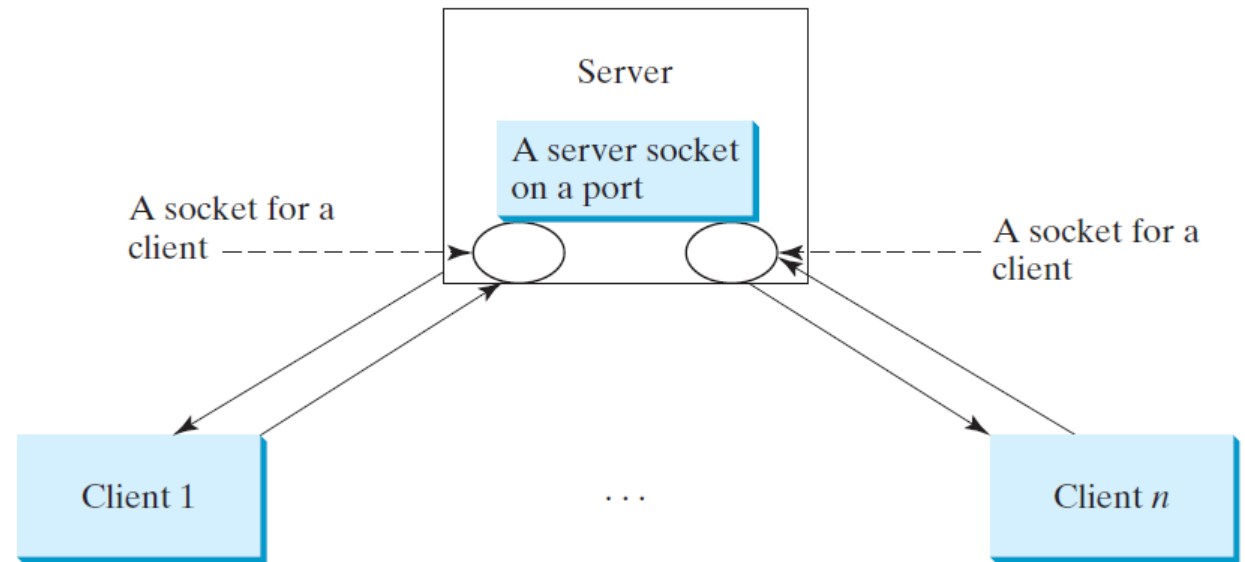
Multiple clients are quite often connected to a single server at the same time. Typically, a server runs constantly on a server computer, and clients from all over the Internet may want to connect to it. You can use threads to handle the server's multiple clients simultaneously. Simply create a thread for each connection. Here is how the server handles the establishment of a connection:

```
while (true) {  
    Socket socket = serverSocket.accept();  
    Thread thread = new ThreadClass(socket);  
    thread.start();  
}
```

The server socket can have many connections. Each iteration of the while loop creates a new connection. Whenever a connection is established, a new thread is created to handle communication between the server and the new client; and this allows multiple connections to run at the same time.



Example: Serving Multiple Clients



MultiThreadServer

Start Server

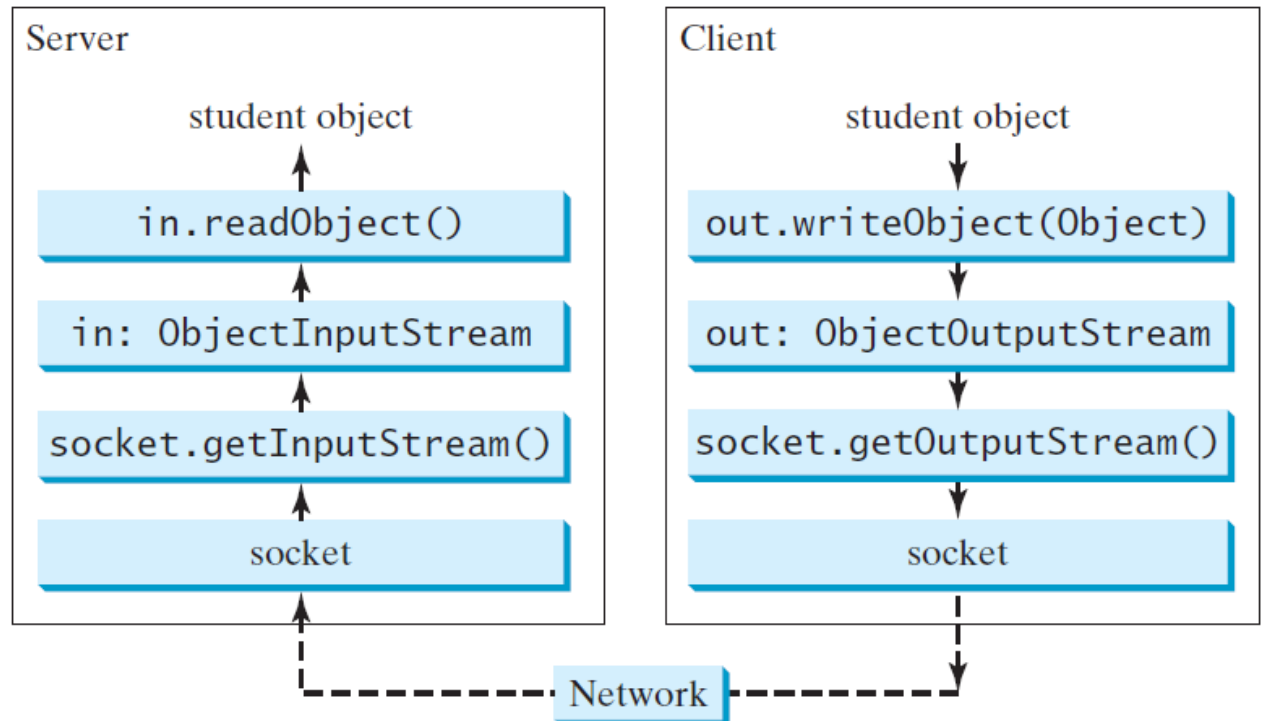
Start Client

Note: Start the server first, then start multiple clients.



Example: Passing Objects in Network Programs

Write a program that collects student information from a client and send them to a server. Passing student information in an object.



StudentAddres Class

StudentServer

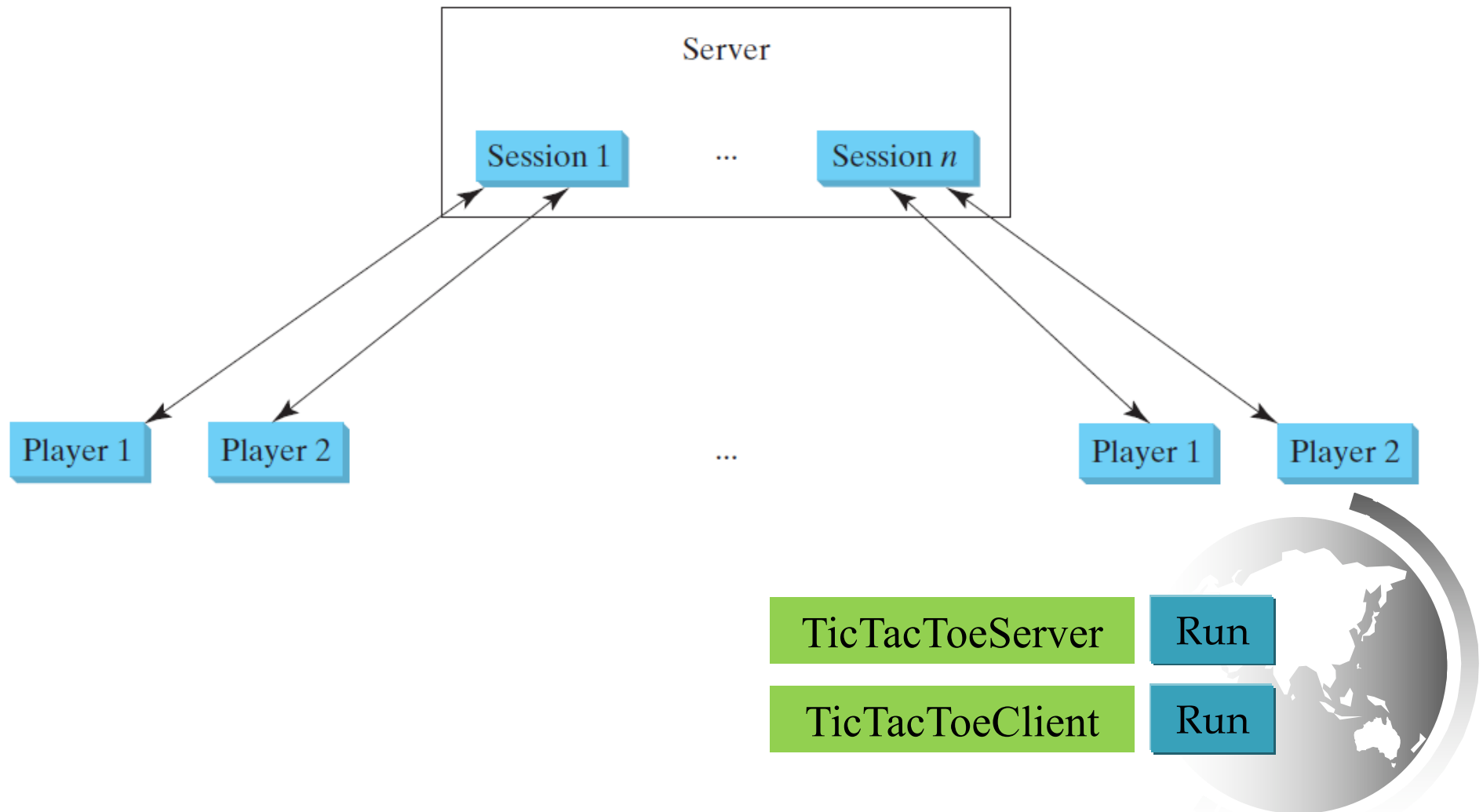
StudentClient

Start Server

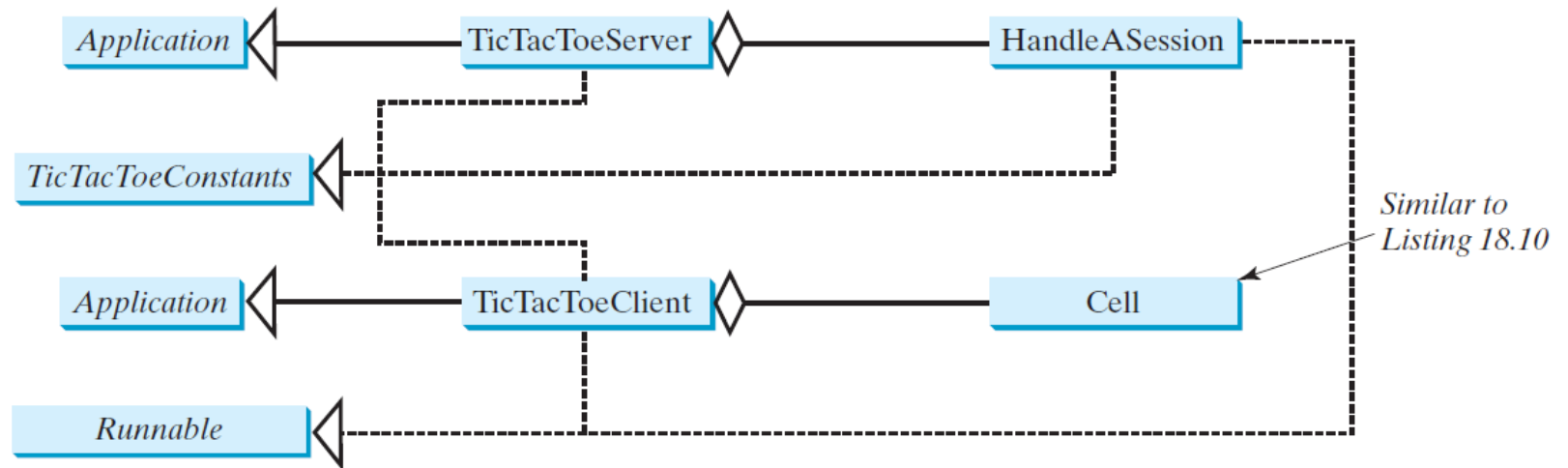
Start Client

Note: Start the server first, then the client.

Case Studies: Distributed TicTacToe Games



Distributed TicTacToe, cont.



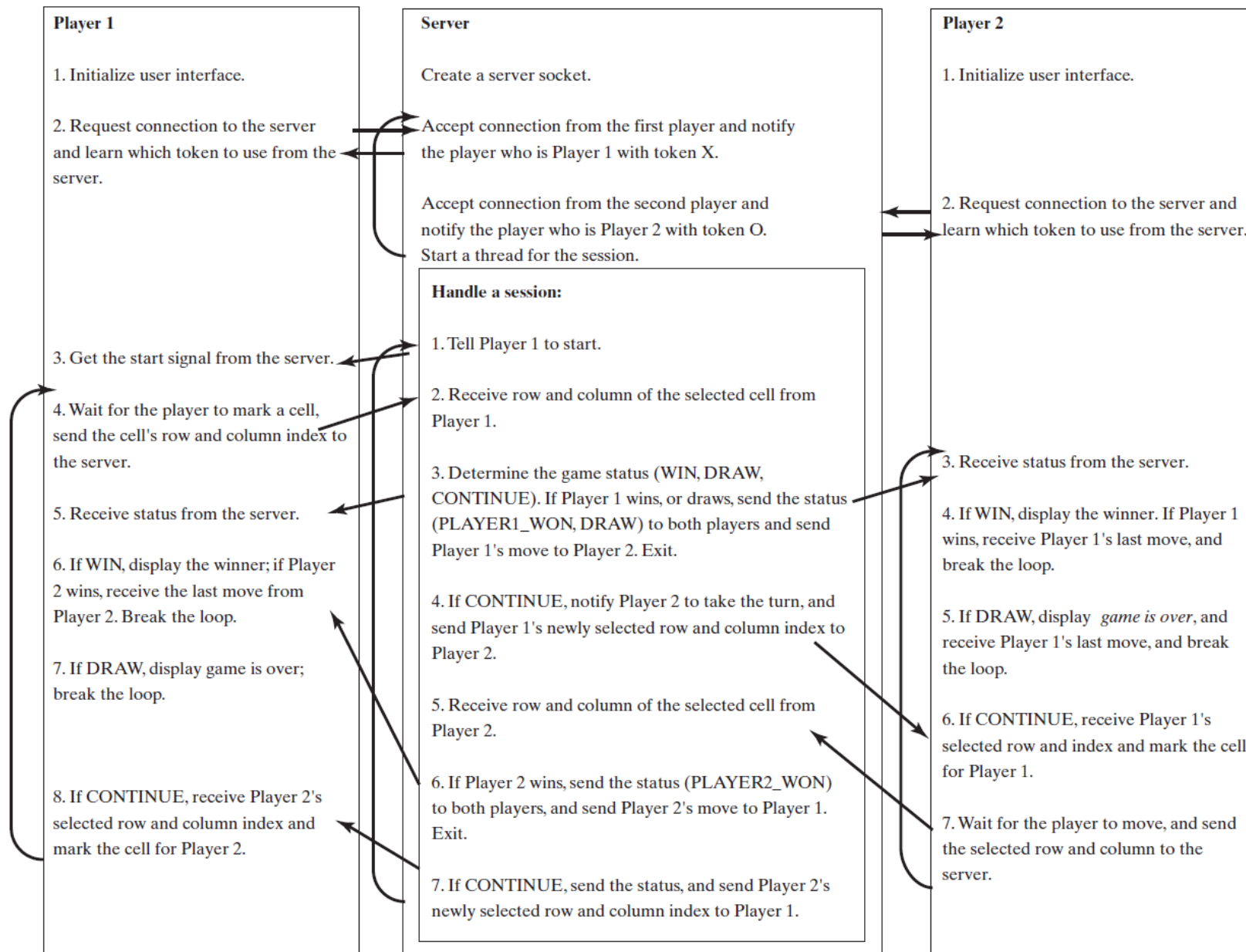
TicTacToeServer
start(primaryStage: Stage): void

«interface» TicTacToeConstants
+PLAYER1 = 1: int
+PLAYER2 = 2: int
+PLAYER1_WON = 1: int
+PLAYER2_WON = 2: int
+DRAW = 3: int
+CONTINUE = 4: int

HandleASession
-player1: Socket
-player2: Socket
-cell: char[][]
-continueToPlay: boolean
+run(): void
-isWon(): boolean
-isFull(): boolean
-sendMove(out: DataOutputStream, row: int, column: int): void

TicTacToeClient
-myTurn: boolean
-myToken: char
-otherToken: char
-cell: Cell[][]
-continueToPlay: boolean
-rowSelected: int
-columnSelected: int
-fromServer: DataInputStream
-toServer: DataOutputStream
-waiting: boolean
+run(): void
-connectToServer(): void
-receiveMove(): void
-sendMove(): void
-receiveInfoFromServer(): void
-waitForPlayerAction(): void

Distributed TicTacToe Game



Stream Socket vs. Datagram Socket

Stream socket

- ◆ A dedicated point-to-point channel between a client and server.
- ◆ Use TCP (Transmission Control Protocol) for data transmission.
- ◆ Lossless and reliable.
- ◆ Sent and received in the same order.

Datagram socket

- ◆ No dedicated point-to-point channel between a client and server.
- ◆ Use UDP (User Datagram Protocol) for data transmission.
- ◆ May lose data and not 100% reliable.
- ◆ Data may not received in the same order as sent.



DatagramPacket

The DatagramPacket class represents a datagram packet. Datagram packets are used to implement a connectionless packet delivery service. Each message is routed from one machine to another based solely on information contained within the packet.

java.net.DatagramPacket	
length: int	A JavaBeans property to specify the length of buffer.
address: InetAddress	A JavaBeans property to specify the address of the machine where the package is sent or received.
port: int	A JavaBeans property to specify the port of the machine where the package is sent or received.
+DatagramPacket(buf: byte[], length: int, host: InetAddress, port: int)	Constructs a datagram packet in a byte array <u>buf</u> of the specified <u>length</u> with the <u>host</u> and the <u>port</u> for which the packet is sent. This constructor is often used to construct a packet for delivery from a client.
+DatagramPacket(buf: byte[], length: int)	Constructs a datagram packet in a byte array <u>buf</u> of the specified <u>length</u> .
+getData(): byte[]	Returns the data from the package.
+setData(buf: byte[]): void	Sets the data in the package.

DatagramSocket

DatagramSocket The DatagramSocket class represents a socket for sending and receiving datagram packets. A datagram socket is the sending or receiving point for a packet delivery service. Each packet sent or received on a datagram socket is individually addressed and routed. Multiple packets sent from one machine to another may be routed differently, and may arrive in any order.

**Create a server
DatagramSocket** To create a server DatagramSocket, use the constructor `DatagramSocket(int port)`, which binds the socket with the specified port on the local host machine.

**Create a client
DatagramSocket** To create a client DatagramSocket, use the constructor `DatagramSocket()`, which binds the socket with any available port on the local host machine.



Sending and Receiving a DatagramSocket

Sending

To send data, you need to create a packet, fill in the contents, specify the Internet address and port number for the receiver, and invoke the `send(packet)` method on a `DatagramSocket`.

Receiving

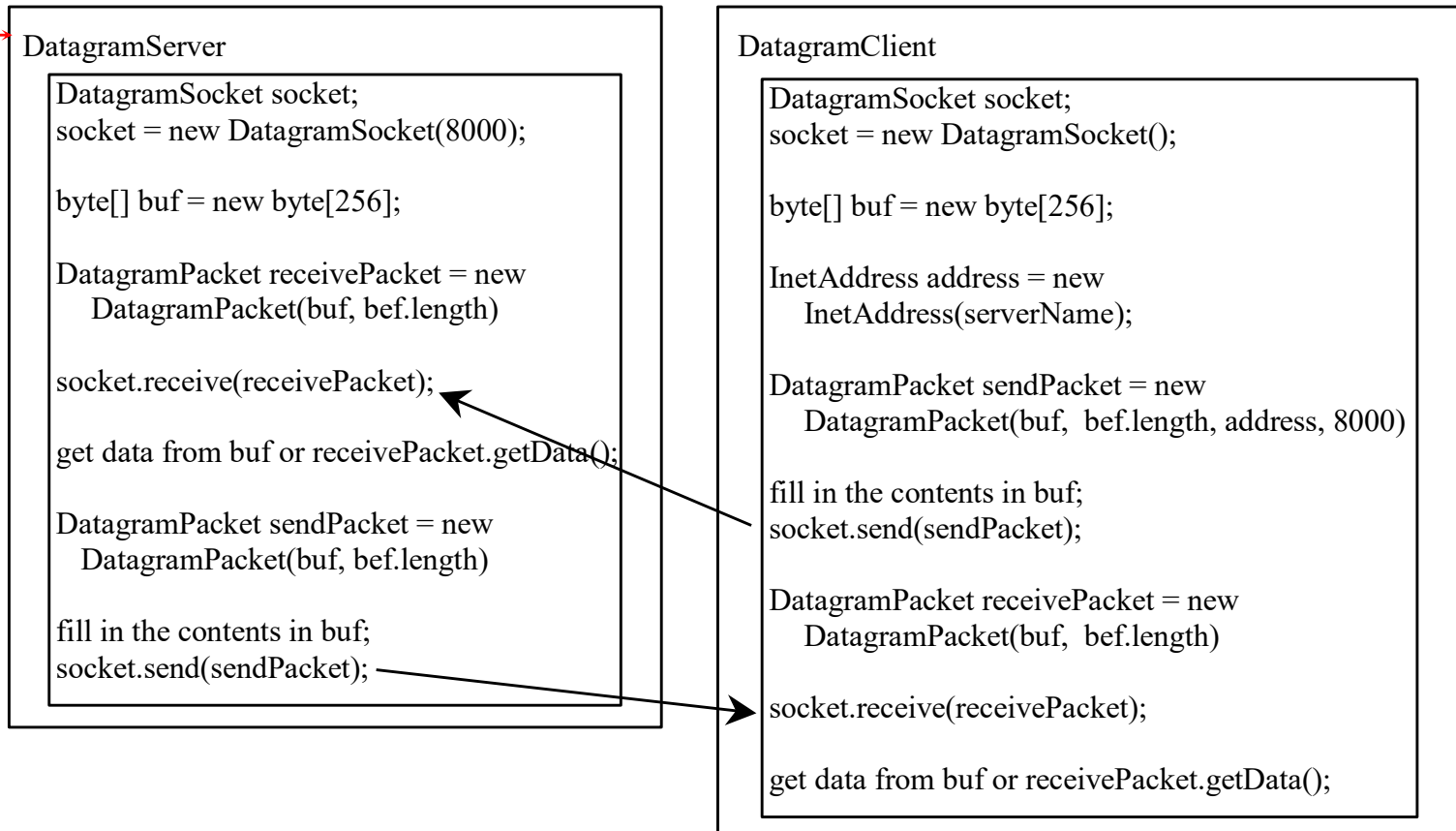
To receive data, create an empty packet and invoke the `receive(packet)` method on a `DatagramSocket`.



Datagram Programming

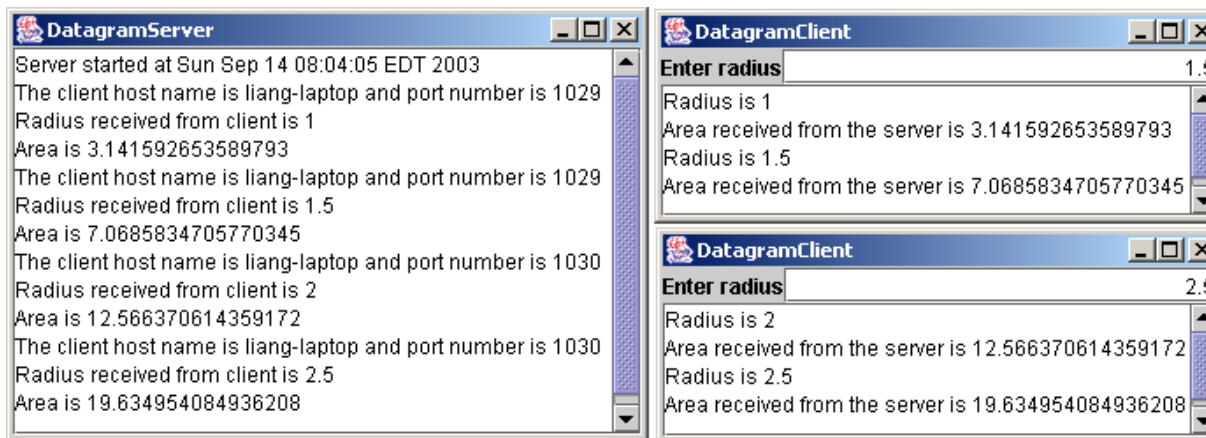
Datagram programming is different from stream socket programming in the sense that there is no concept of a `ServerSocket` for datagrams. Both client and server use `DatagramSocket` to send and receive packets.

Designate
one a server



Example: A Client/Server Example

Section 33.2 presents a client program and a server program using socket streams. The client sends radius to a server. The server receives the data, uses them to find the area, and then sends the area to the client. Rewrite the program using datagram sockets.



DatagramServer

Run

DatagramClient

Run

Note: Start the server,
then the client.

