B.Sc. In Software Development. Year 3.
Applications Programming.
Networking.

LIMERICK INSTITUTE
OF TECHNOLOGY
SCHOOL OF SCIENCE,
ENGINEERING & I.T.

Department of Information Technology

Networking – The Basics

- Networking is tightly integrated in Java. Socket based communication is provided that enables programs to communicate through designated sockets.
- A socket is an abstraction that facilitates communication between a client and a server.
- Java treats sockets communication much as it treats I/O operations; thus programs can read from and write to sockets as easily as they can read from or write to files.

Networking – The Basics

- Java supports stream sockets and datagram sockets.
- Stream sockets use TCP (Transmission Control Protocol) for data transmission, whereas datagram sockets use UDP (User Datagram Protocol).
- Since TCP can detect lost transmission and resubmit them, transmissions are lossless and reliable.
- On the other hand UDP cannot guarantee lossless transmission.
- Therefore, stream sockets are used in most areas of Java programming.

Networking – The Basics

- Networking programming usually involves a server and one or more clients.
- The client sends requests to the server and the server then responds to these requests.
- The client begins by attempting to establish a connection to the server.
- The server can accept or deny the connection.
- Once a connection is established, the client and the server communicate through sockets.
- The server MUST be running before a client makes a request.

Networking – The Basics

- Once started, the server then waits for a client to make a request.
- To establish a server, you need to create a server socket and attach it to a port.
- This is where the server listens for communications.
- The port identifies the TCP service on the socket.
- Port numbers between 0 – 1023 are reserved for privileged processes.
- EMail is on 25.
- Web Servers are on 80.

Networking – The Basics

- You can choose any port number that is not currently used by any other process (beware a BindException)

- The following statement creates a server socket s.

```
ServerSocket s = new ServerSocket(port);
```

- After a server socket is created the server can use the following statement to listen for connections.

```
Socket connectToClient = s.accept();
```

Networking – The Basics

- This statement waits until a client connects to the server socket.
- The client issues the following statement to request a connection to a server.

```
Socket connectToServer =
                new Socket(ServerName, port);
```

- This statement opens a socket so that the client program can communicate with the server.
- ServerName is the servers Internet host name or IP address.

Networking – The Basics

- The following statement creates a socket at port 8000 on the clients machine to connect to the host lit.ie:

```
    Socket connectToServer =
                    new Socket(“lit.ie”, 8000);
```

- Alternatively, you can use the IP address:

```
    Socket connectToServer =
            new Socket(“192.1.88.11”, 8000);
```

Networking – The Basics

- An IP address, consisting of four dotted decimal numbers between 0 and 255, such as 192.1.88.11 is a computers unique identity on a network.
- Since these numbers are not that easy to remember, they are often mapped to more meaningful names called host names such as lit.ie.
- A program can use the name localhost or the IP address 127.0.0.1 to refer to the machine on which a client is running.

Networking – The Basics

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

Coding The Client and Server

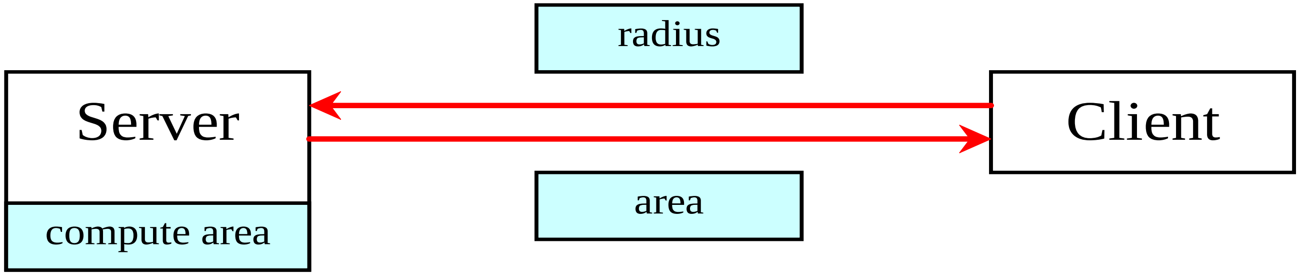
- To get an input stream and an output stream, use the getInputStream() and getOutputStream() methods on a socket object.

```
DataInputStream isFromServer = new
        DataInputStream(connectToServer.getInputStream());


DataOutputStream osToServer = new
    DataOutputStream(connectToServer.getOutputStream());
```

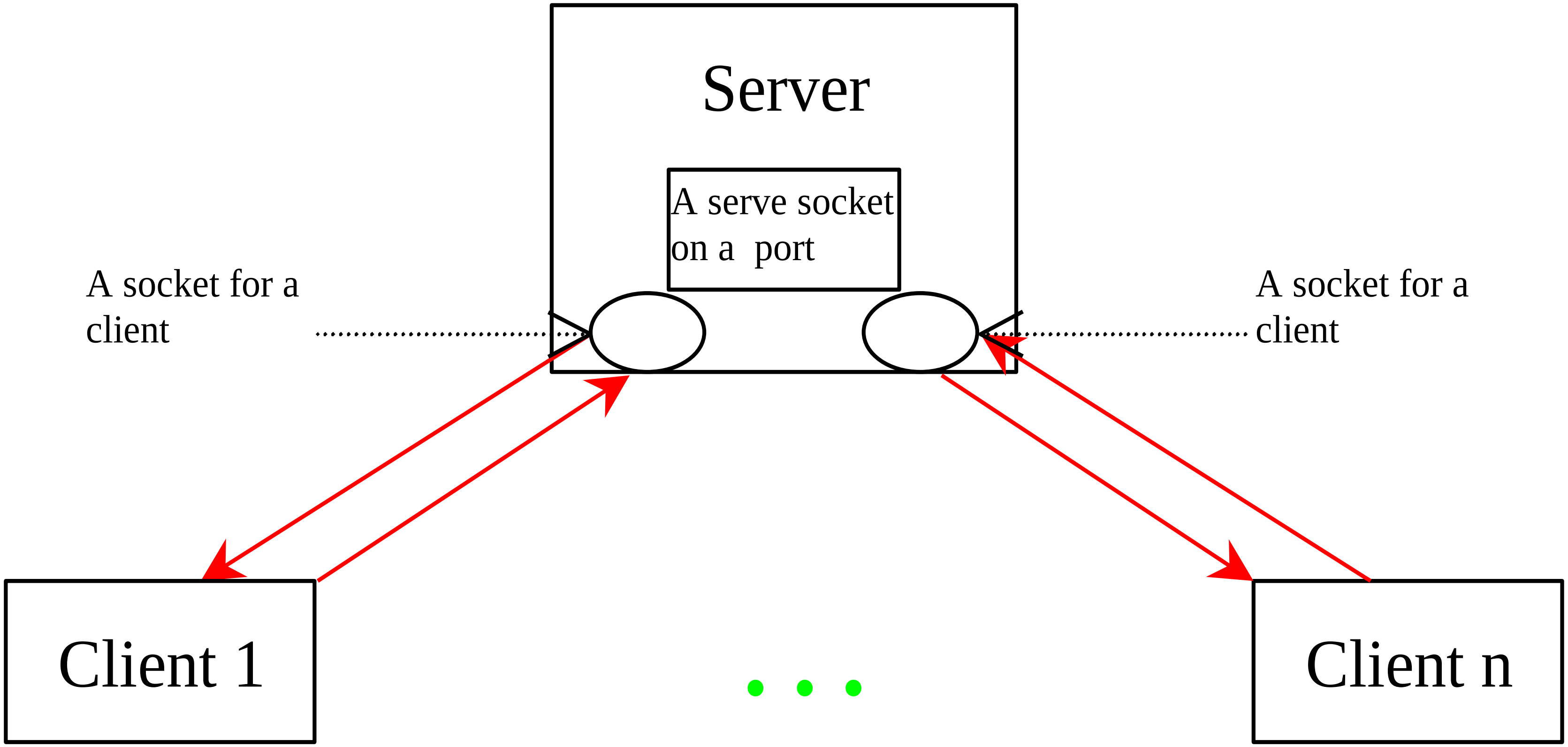
Example 1: Client/Server

- Objective: 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 then displays the result. In this example, the data sent from the client is the radius of a circle, and the result produced by server is the area of the circle.



- Consult CircleClient.java and CircleServer.java
- These classes are in a package called Example1.

Example 2: Serving Multiple Clients



Example 2: 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 can connect to it.
- You can use threads to handle the servers multiple clients simultaneously.
- Simply create a thread for each connection.
- The following code is how the server handles the establishment of a connection.

- Consult MultiThreadServer.java and CircleClient.java
- These classes are in a package called Example2.

Example 3: Passing Objects Over a Network.

- Objective: Develop an application that creates a Student object on the client side. The client will then pass this object to the (single-threaded) server, where the objects state will be made persistent (saved to a file).

  Consult the following code:

  RegistrationClientUsingObjectStream.java

  RegistrationServerUsingObjectStream

  Student.java

- All these classes are contained within a package called "Example3_Passing_Objects".

Programming With Datagram Sockets

- Clients and servers that communicate via stream sockets have a dedicated point-to-point channel between them.
  - Stream sockets communicate using TCP as its very reliable.
- Clients and servers that communicate using datagram's do not have a dedicated point-to-point channel.
  - Data is transmitted using packets.
  - Datagram’s use UDP to communicate but its not as reliable as TCP.
- Where a dedicated point-to-point connection is not required UDP is more efficient than TCP.

Programming With Datagram Sockets

- The java.net package contains two classes which help you develop Java programs that use datagram's to send and receive packets over the network.
  - DatagramPacket: represents a datagram packet and are used to implement a connectionless packet-delivery service. Each message is routed from one computer to another based solely on information contained within the packet.
  - DatagramSocket: represents a socket for sending and receiving datagram packets. A datagram socket is the sending/receiving point for a packet-delivery service. Each packet sent or received on a datagram socket is individually addressed and routed.

Programming With Datagram Sockets

- Datagram programming is different from stream socket programming in the sense that there is no concept of a StreamSocket for datagram's.
- Both the client and the server use DatagramSocket to send and receive packets.
- We designate one application as the server and create a DatagramSocket with a specified port.
- A client can then also create a DatagramSocket (without specifying a port number).
- When a client sends a packet to the server, the client's IP address and port number are contained within the packet.
  - The server can extract these details from the packet and use them to send information back to the client.

Example 4: Rework Example 1 Using Datagram’s

- Consult the classes DatagramClient.java and We are now going to rewrite example 1 using datagram's rather than socket streams.
- The client sends the radius to the server.
- The server receives this information, uses it to find the area and then sends it back to the client.

References

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