Software Practice 1 - Socket

- Terms of socket programming
- Socket
- Implementation (TCP, UDP)
- Socket with multithread
- Serialization
- Lab practice

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Terms of Network

- **Packet**
  - A formatted unit of data carried by a packet-switched network
- **Acknowledgement (ack)**
  - A signal passed between communicating processes or computers to signify acknowledgement, or receipt of response, as a part of a communications protocol

Terms of Network

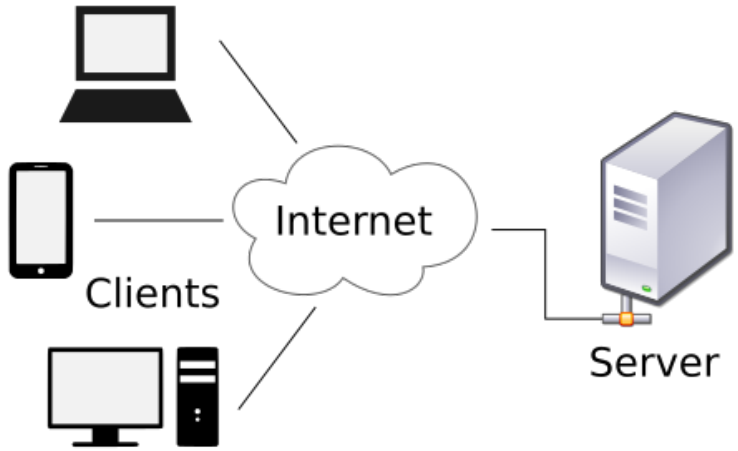
- **Internet Protocol (IP)**
  - IP has the task of delivering packets from the source host to the destination host solely based on the ip addresses in the packet header
  - Example of network address
    - “111.222.333.444” or “skku.edu” or “localhost”
- **Port**
  - An endpoint of communication in an operating system
  - While the term is used for receiver connectors on hardware devices, in software it is a logical construct that identifies a specific process or a type of network service

Terms of Network

- **Transmission Control Protocol (TCP)**
  - TCP provides reliable, ordered, and error-checked delivery of a stream of octets between applications running on hosts communicating by an IP network
- **User Datagram Protocol (UDP)**
  - UDP uses a simple connectionless transmission model with a minimum of protocol mechanism
  - There is no guarantee of reliability, delivery, ordering, or duplicate protection

Terms of Network

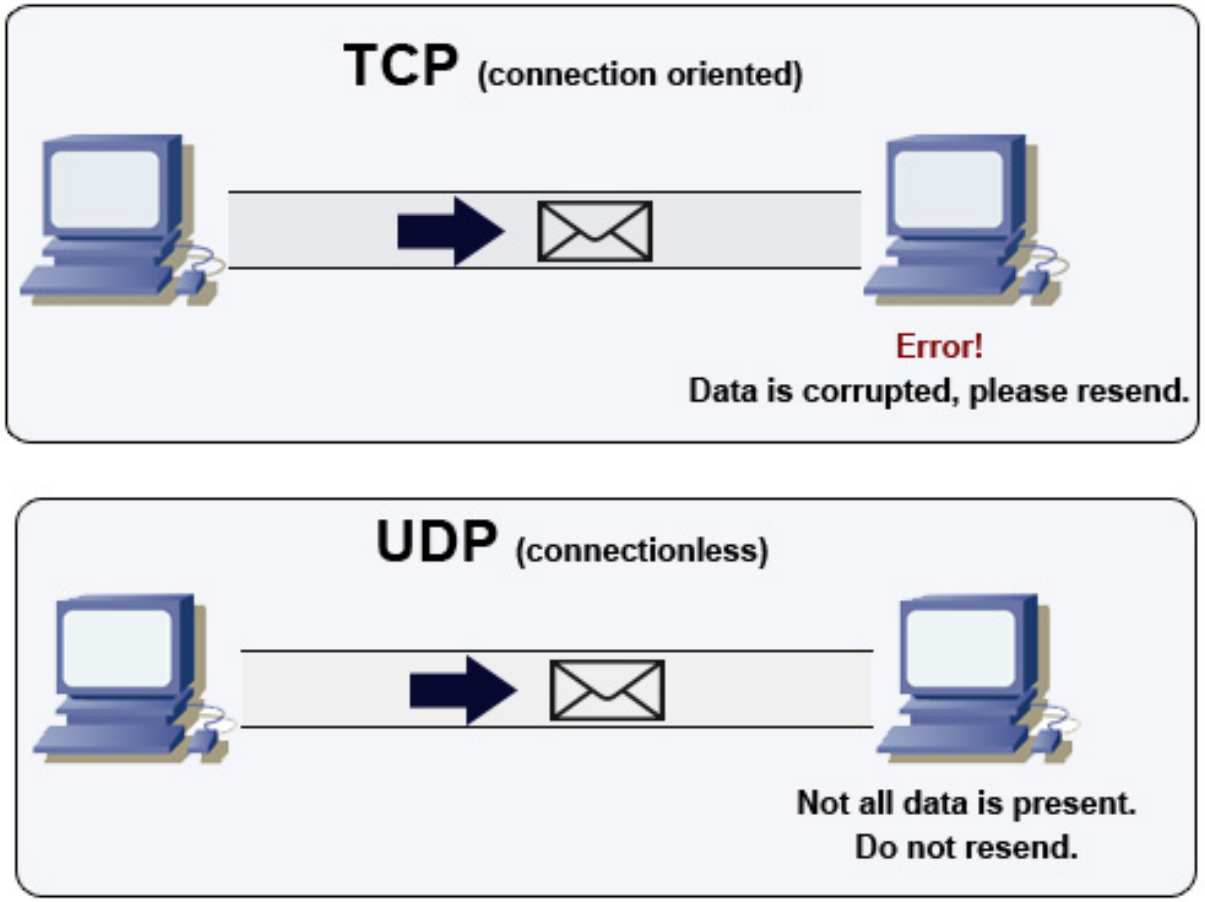
- **Server**
  - A computer program or a device that provides functionality for other programs or devices, called clients
- **Client**
  - A piece of computer hardware or software that accesses a service made available by a server



TCP versus UDP

	TCP	UDP
Protocol	Connection oriented protocol	Connection-less protocol
I/O stream	Connection in byte stream	Connection in message stream
Comm. type	Not support multicasting or broadcasting	Support both
Transport reliability	Provide error control and flow control	Not provide any of them
Packet is called as	Segment	Datagram

TCP versus UDP



Socket

- An internal endpoint for sending or receiving data at a single node in a computer network
- Concretely, it is a representation of this endpoint in networking software, such as an entry in a table, and is a form of system resource

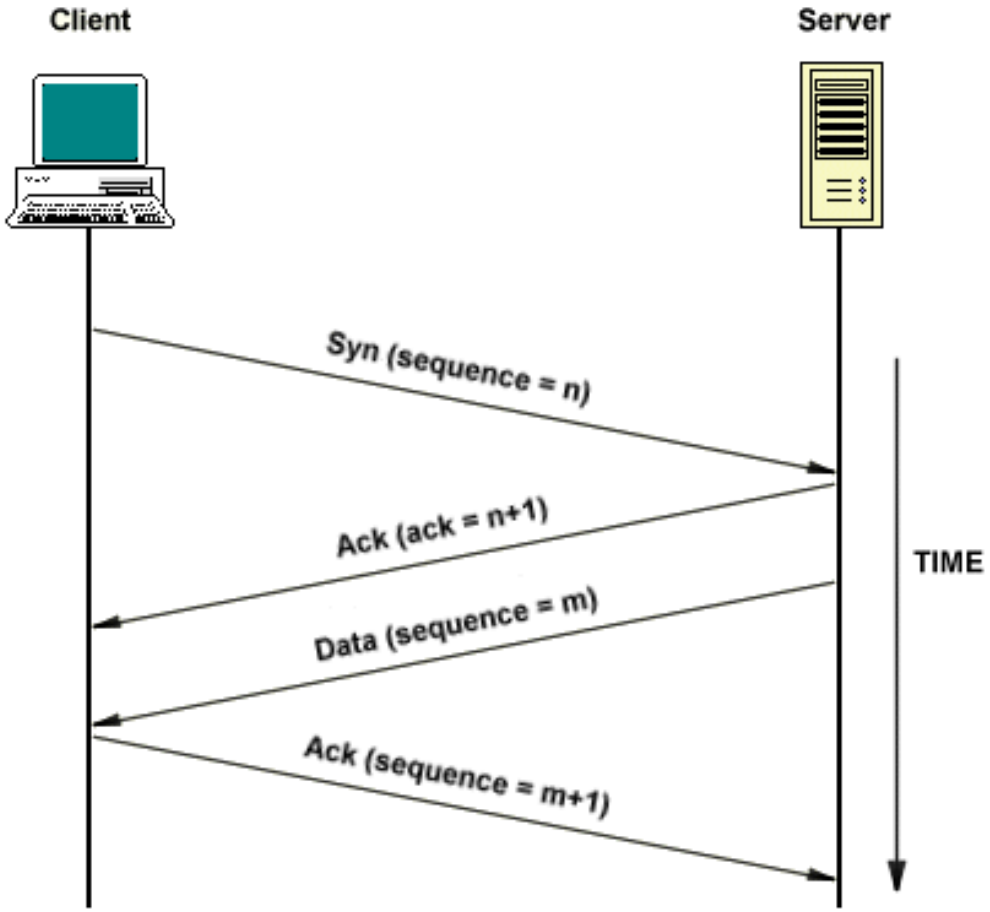
Socket programming

- **TCP version**

- **5 steps for communication**
  1. Create server
  2. Create client
  3. Establish connection
  4. Data transport
  5. Close connection

- **Examples are written without try-catch**

Process of TCP



Java class for TCP

- **ServerSocket**
  - http://docs.oracle.com/javase/7/docs/api/java/net/ServerSocket.html?is-external=true
- **Socket**
  - https://docs.oracle.com/javase/7/docs/api/java/net/Socket.html

TCP server side

```
ServerSocket ss = new ServerSocket(5000);

while (true) {
    Socket soc = ss.accept();
    OutputStream out = soc.getOutputStream();
    DataOutputStream dos = new DataOutputStream (out);

    dos.writeUTF ("message from server");

    dos.close ();
    soc.close ();
}
```

TCP client side

```
String serverIP = "localhost";
Socket soc = new Socket(serverIP, 5000);

InputStream in = soc.getInputStream();
DataInputStream dis = new DataInputStream (in);

System.out.println (dis.readUTF ());

dis.close();
soc.close();
```

Socket programming

- **UDP version**

- **4 steps for communication**
  1. Create server
  2. Create client
  3. Request data
  4. Receive data

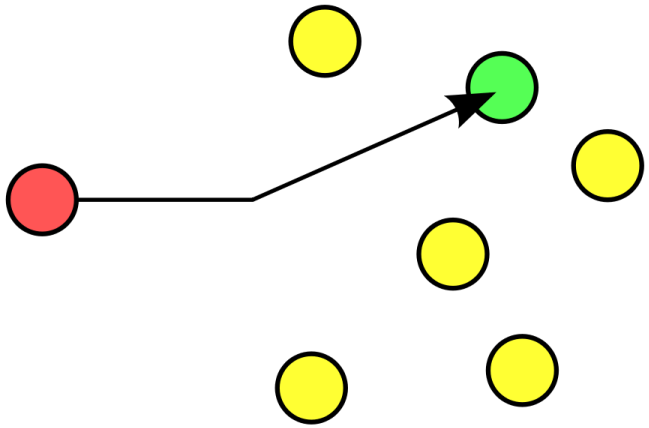
- **Examples are written without try-catch**

Java class for UDP

- **DatagramSocket**
  - http://docs.oracle.com/javase/7/docs/api/java/net/DatagramSocket.html?is-external=true
- **DatagramPacket**
  - http://docs.oracle.com/javase/7/docs/api/java/net/DatagramPacket.html
- **MulticastSocket**
  - http://docs.oracle.com/javase/7/docs/api/java/net/MulticastSocket.html

Types of transport

- **Unicast**
  - One-to-one association between a sender and destination
  - Each destination address uniquely identifies a single receiver endpoint



Unicast server side

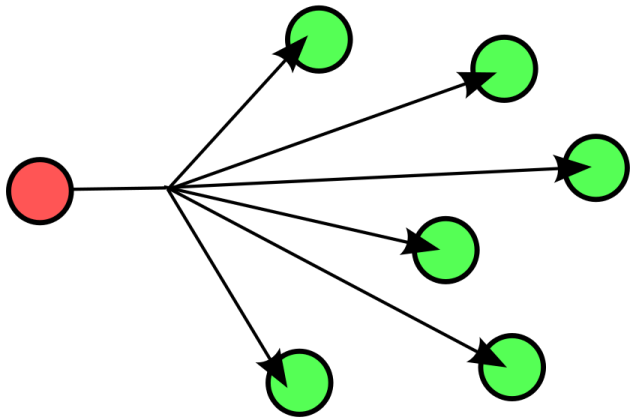
```
DatagramSocket sender = new DatagramSocket (5000);
byte[] receiveData = new byte[1024];
byte[] sendData = new byte[1024];
String message = “get you";

while (true) {
   DatagramPacket rp = new DatagramPacket (receiveData, receiveData.length);
   sender.receive (rp);
   String data = new String (rp.getData ());

   InetAddress ip = rp.getAddress ();
   int port = rp.getPort ();
   sendData = message.getBytes();
   DatagramPacket sp = new DatagramPacket (sendData, sendData.length, ip, port);
   sender.send (sp);
}
```

Unicast client side

```
DatagramSocket receiver = new DatagramSocket ();
InetAddress ip = InetAddress.getByName ("localhost");

BufferedReader in = new BufferedReader (new InputStreamReader (System.in));
byte[] sendData = new byte[1024];
byte[] receiveData = new byte[1024];
sendData = in.readLine ().getBytes();

DatagramPacket sp = new DatagramPacket (sendData, sendData.length, ip, 5000);
receiver.send (sp);

DatagramPacket rp = new DatagramPacket (receiveData, receiveData.length);
String rData = new String (rp.getData ());

receiver.close ();
```

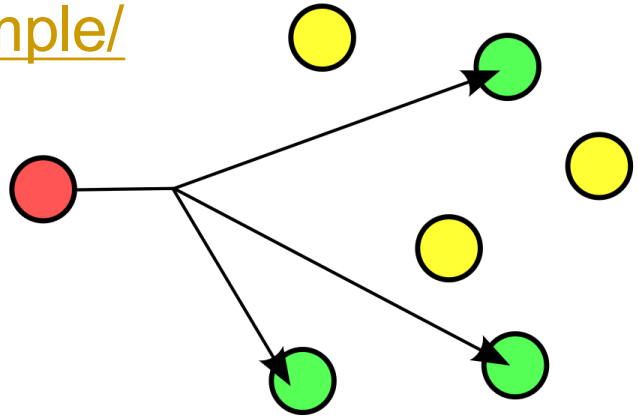
Types of transport

- **Broadcast**
  - One-to-all association
  - A single datagram from one sender is routed to all of the possibly multiple endpoints associated with the broadcast address
  - http://michieldemey.be/blog/network-discovery-using-udp-broadcast/



Types of transport

- **Multicast**
  - One-to-many-of-many association
  - Differs from broadcast in that the destination address designates a subset not necessarily all, of the accessible nodes
  - https://examples.javacodegeeks.com/core-java/net/multicastsocket-net/java-net-multicastsocket-example/



Socket with multithread

- **Socket server of background thread**
  - Thread of socket server cannot do anything except for waiting connection
  - Therefore, it has to be implemented with multithread to concurrently do its all jobs
- **Deal with comm. channels for many clients**
  - Even when the multiple clients request to connect with server simultaneously, it is also necessary to deal with multithread

Background socket thread

- **3 components are necessary**
  - Background server class (ServerThread.java)
  - Foreground main class (MainThread.java)
  - Client class (same with previous TCP client)

ServerThread.java

```
public class ServerThread extends Thread {
  private String name = null;
  private static SimpleDateFormat sdfDate = new SimpleDateFormat ("yyy-MM-dd HH:mm:SSS");
  private static String getLog (String msg) {
    return "[" + sdfDate.format(new Date ()) + "] Server thread: " + msg;
  }

  public ServerThread () {
    this.name = "ServerThread";
  }

  public void run () {
    ServerSocket ss = null;
    try {
      ss = new ServerSocket(5000);
    } catch (IOException e) {
      // TODO Auto-generated catch block
      e.printStackTrace();
    }
    while (true) {
      Socket soc = null;
      OutputStream out = null;
      try {
        soc = ss.accept();
        System.out.println(ServerThread.getLog("new connection arrived"));
        out = soc.getOutputStream();
        DataOutputStream dos = new DataOutputStream (out);
```

ServerThread.java

```
            dos.writeUTF ("message from server");

            dos.close ();
            soc.close ();
        } catch (IOException e) {
            // TODO Auto-generated catch block
            e.printStackTrace();
        } finally {
            try {
                soc.close();
            } catch (IOException e) {
                // TODO Auto-generated catch block
                e.printStackTrace();
            }
        }
    }
  }
}
```

MainThread.java

```
public class MainThread {
  private static SimpleDateFormat sdfDate = new SimpleDateFormat ("yyy-MM-dd HH:mm:SSS");
    private static String getLog (String msg) {
    return "[" + sdfDate.format(new Date ()) + "] Main thread: " + msg;
  }

  public static void main (String[] args) {
    Thread t = new ServerThread ();
    t.start ();
    System.out.println(getLog ("server thread started"));
    boolean flag = true;
    while (flag) {
      try {
        Thread.sleep(1000);
      } catch (InterruptedException e) {
        // TODO Auto-generated catch block
        e.printStackTrace();
      }
      System.out.println(getLog ("server still alive"));
    }
  }
}
```

Multiple channels

- **3 components are necessary**
  - Channel management class (Server.java)
  - Communication server class (CommThread.java)
  - Client class (Clients.java)

Server.java

```
public class Server {
  private static ArrayList<Thread> arr = new ArrayList<Thread> ();
  private static SimpleDateFormat sdfDate = new SimpleDateFormat ("yyy-MM-dd HH:mm:SSS");

  public static String getLog (String msg) {
    return "[" + sdfDate.format(new Date ()) + "] Server thread: " + msg;
  }

  public static void main (String[] args) {
    ServerSocket ss = null;
    int id = 0;
    try {
      ss = new ServerSocket (5000);
    } catch (IOException e) {
      // TODO Auto-generated catch block
      e.printStackTrace();
    }
    System.out.println("server is ready");
```

Server.java

```
    while (true) {
      try {
        Socket soc = ss.accept ();
        System.out.println(Server.getLog ("new connection arrived"));
        Thread t = new CommThread (soc, id ++);
        t.start ();
        arr.add(t);
        Iterator<Thread> iter = arr.iterator ();
        while (iter.hasNext ()) {
          t = iter.next ();
          if (!t.isAlive ()) {
            iter.remove ();
          }
        }
      } catch (IOException e) {
        // TODO Auto-generated catch block
        e.printStackTrace();
      }
    }
  }
}
```

CommThread.java

```
public class CommThread extends Thread {
  private Socket soc;
  private int id;
  public CommThread (Socket soc, int id) {
    this.soc = soc;
    this.id = id;
  }

  public void run () {
    try {
      OutputStream os = soc.getOutputStream ();
      DataOutputStream dos = new DataOutputStream (os);

      dos.writeUTF ("message from server (" + id + ")");
      System.out.println (Server.getLog ("message is sent (" + id + ")"));

      dos.close ();
      this.soc.close ();
    } catch (IOException e) {
      // TODO Auto-generated catch block
      e.printStackTrace();
    }
  }
}
```

Clients.java

```
class Test extends Thread {
  public void run () {
    try {
      Socket soc = new Socket("localhost", 5000);
      DataInputStream dis = new DataInputStream (soc.getInputStream());

      System.out.println(dis.readUTF());

      dis.close();
      soc.close();
    } catch (IOException e) {
      // TODO Auto-generated catch block
      e.printStackTrace();
    }
  }
}

public class Clients {
  public static void main (String[] args) {
    for (int i = 0; i < 100; i ++) {
      new Test ().start ();
    }
  }
}
```

Serialization

- **The process of translating data structures or object state into a format that can be stored or transmitted and reconstructed later**
- **Serialization in Java**
  - public interface serializable (in java.io.Serializable)
  - Classes that do not implement this interface will not have any of their state serialized or deserialized

Example of Serializable

```
public class Employee implements java.io.Serializable {
   public String name;
   public String address;
   public transient int SSN;
   public int number;

   public void mailCheck() {
      System.out.println("Mailing a check to " + name + " " + address);
   }
}
```

Example of serialization

```
public class SerializeDemo {

   public static void main(String [] args) {
      Employee e = new Employee();
      e.name = "Reyan Ali";
      e.address = "Phokka Kuan, Ambehta Peer";
      e.SSN = 11122333;
      e.number = 101;

      try {
         FileOutputStream fileOut = new FileOutputStream("/tmp/employee.ser");
         ObjectOutputStream out = new ObjectOutputStream(fileOut);
         out.writeObject(e);
         out.close();
         fileOut.close();
         System.out.printf("Serialized data is saved in /tmp/employee.ser");
      }catch(IOException i) {
         i.printStackTrace();
      }
   }
}
```

Example of deserialization

```
public class DeserializeDemo {

   public static void main(String [] args) {
      Employee e = null;
      try {
         FileInputStream fileIn = new FileInputStream("/tmp/employee.ser");
         ObjectInputStream in = new ObjectInputStream(fileIn);
         e = (Employee) in.readObject();
         in.close();
         fileIn.close();
      }catch(IOException i) {
         i.printStackTrace();
         return;
      }catch(ClassNotFoundException c) {
         System.out.println("Employee class not found");
         c.printStackTrace();
         return;
      }

      System.out.println("Deserialized Employee...");
      System.out.println("Name: " + e.name);
      System.out.println("Address: " + e.address);
      System.out.println("SSN: " + e.SSN);
      System.out.println("Number: " + e.number);
   }
}
```

[Lab – Practice]

- Multiple channel + Serialization
- Make 4 classes (Server, CommThread, Client, Student)
- Establish connection between two programs in a single node with port number 5000

[Lab – Practice]

- **Server**
  - If a client connects, it starts a new thread of CommThread and adds that to arraylist.
  - It prints each status (Start, Stop)
  - If it have processed 10 clients, it will stop.
- **CommThread**
  - Receive and print object information.
- **Client**
  - Send and print object information.
- **Student**
  - Object to be exchanged, and it has a num variable

Example of Output

Output:

Server Start

<input Name>: send0

<input Name>: send1

…

<input Name>: send9

Server Stop

Receive: student0

Receive: student1

…

[Submit]

- **Upload to i-Campus**
  - Compress your all java files to zip file
  - File name: studentID_lab9.zip

- **Due date**
  - Today 23:59:59
    - Class 42 (05/28 Monday)
    - Penalty: -10% of each lab score per one day