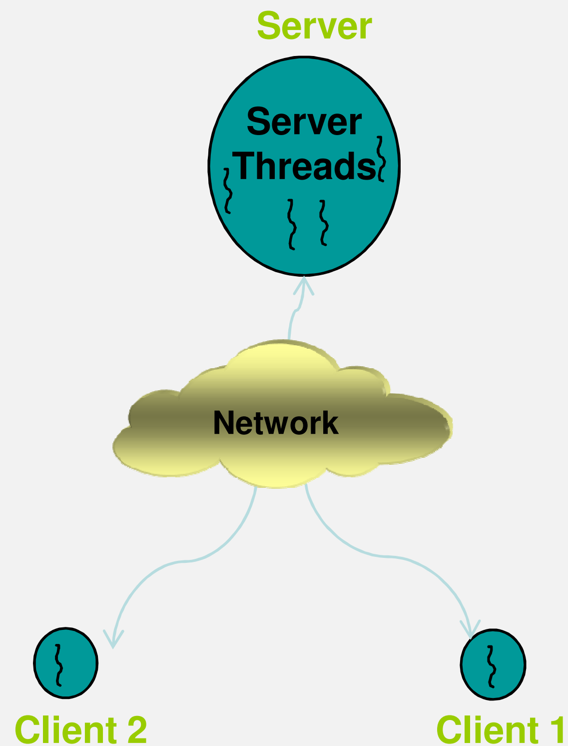
Additional information on socket programming

Dr F. Belqasmi,

Industrial Research Post Doctoral Fellow, Ericsson Canada

Agenda



- Multithreading
- Blocking and Timeouts
- Multiple recipients

Multithreading

- Iterative servers handle clients sequentially, finishing with one client before servicing the next.
  - Work best for applications where the processing time of each client is small
  - Waiting time for subsequent clients may be unacceptable
- Multithreading allows a server to handle clients in parallel

Multithreading

- **Thread example**

```
public class OneClientHandler implements Runnable {
    private Socket clntSock; // Socket connect to client
    public OneClientHandler(Socket clntSock, Logger logger) {
            this.clntSock = clntSock;
    }
    public static void handleClient(Socket clntSock) {
      try {
            // Get the input and output I/O streams from socket
            InputStream in = clntSock.getInputStream();
            OutputStream out = clntSock.getOutputStream();
            .........
               clntSock.close();
        } catch (IOException e) { }
      }
   public void run() {
          handleClient(clntSock);
      }
}
```

Multithreading

- **Multithreading Server example**

```
public class MultithreadingServer {
    public static void main(String[] args) throws IOException {
                ...
        int echoServPort = Integer.parseInt(args[0]); // Server port
        ServerSocket servSock = new ServerSocket(echoServPort);

        // Run forever, accepting and spawning a new client thread for each connection
        while (true) {
                Socket clntSock = servSock.accept();
                // Spawn thread to handle new connection
                Thread thread = new Thread(new
                                        OneClientHandler(clntSock));
                thread.start();
        }
    }
}
```

Blocking and Timeouts

- Socket calls may block
  - accept() method of ServerSocket() blocks until a connection is established
  - Socket constructor blocks until a connection is established
  - read() and receive() block if data is not available
  - write() blocks if no sufficient space in the output buffer
- A blocked method call makes the thread that is running it useless
  - E.g. waiting for lost datagrams

Blocking and Timeouts

- How to get around blocking calls
  - Set an upper-bound on the maximum time to block
    - Works for accept(), read() and receive()

```
try{
        sock.setSoTimeout(timeBoundMillis);
        //serverSocket.setSoTimeout(timeBoundMillis);
        //datagramSocket.setSoTimeout(timeBoundMillis);

} catch (InterruptedIOException ex) { //blocking timeout is reached   }
```

  - Use the available() method
    - Check for available data before calling read()

```
InputStream in = clntSock.getInputStream();
if (in.available()){
        in.read(…);}
```

Blocking and Timeouts

- Connecting a socket

```
Try{
        InetAddress addr = InetAddress.getByName("java.sun.com");
        int port = 80;
        SocketAddress sockaddr = new InetSocketAddress(addr, port);
        //Create an unbound socket
        Socket sock = new Socket();
        int timeoutMillis = 2000; // 2 seconds
        sock.connect(sockaddr, timeoutMillis);
}catch (SocketTimeoutException ex){….}
```

- Writing to a socket
  - The amount of time that a write() may block is controlled by the receiving application
  - Currently, Java does not provide any way to cause a write() call to time out

Multiple recipients

- The information provided by the server may be of interest to multiple recipients
  - Unicast a copy of the data to each recipient
    - Inefficient (wastes bandwidth)
    - E.g,
      - The server sends 1Mbps streams
      - The network connection is 3Mbps
      - Only three simultaneous users can be supported
  - Networks provide a way to use bandwidth more efficiently
    - Packets are duplicated by the network (and not by the application) only when appropriate
    - 2 ways:
      - Broadcast
      - Multicast

Multiple recipients

- Broadcasting
  - Broadcasting UDP datagrams is similar to unicasting datagrams, except that a *broadcast address* is used instead of a regular (unicast) IP address
    - IPv4: 255.255.255.255
    - IPv6: FFO2::1
  - All of the hosts on the same (local) broadcast network receive a copy of the message.

Multiple recipients

- Multicasting
  - A multicast address identifies a set of receivers
    - IPv4: adresses between 224.0.0.0 and 239.255.255.255
    - IPv6: any address starting with FF

Multiple recipients

- Multicasting example

Multicast message sender

```
import java.net.MulticastSocket;
public class MulticastSender {
   public void sendMulticastMessage(String msg) {
      try{
         MulticastSocket mSocket = new MulticastSocket();
         mSocket.setTimeToLive(TTL); // Set TTL for all datagrams
         ….
         DatagramPacket message = new DatagramPacket(msg, msg.length,
                                                     multicastDestAddr, destPort);
         mSocket.send(message);
         mSocket.close();
      }catch (IOException ex){….}
} }
```

Multiple recipients

- Multicasting example

Multicast message receiver

```
Try{
        MulticastSocket  mSock = new MulticastSocket(port); // for receiving
        mSock.joinGroup(multicastAddress); // Join the multicast group

        // Receive a datagram
        DatagramPacket packet = new DatagramPacket(new
        byte[MAX_MSG_LENGTH],
        VoteMsgTextCoder.MAX_WIRE_LENGTH);

        sock.receive(packet);

        sock.close();
}
```

- References
  - TCP/IP Sockets in Java: Practical Guide for Programmers, Second Edition, Kenneth L. Calvert and Michael J. Donahoo, ISBN: 978-0-12-374255-1
  - "All About Sockets" http://java.sun.com/docs/books/tutorial/networking/sockets/