Introduction to Network Programming using Java

Starting Point Using Java

IDE

- Unix/Linux available in the department
- Alternative: MS Windows workstations
- Using Sun JDK

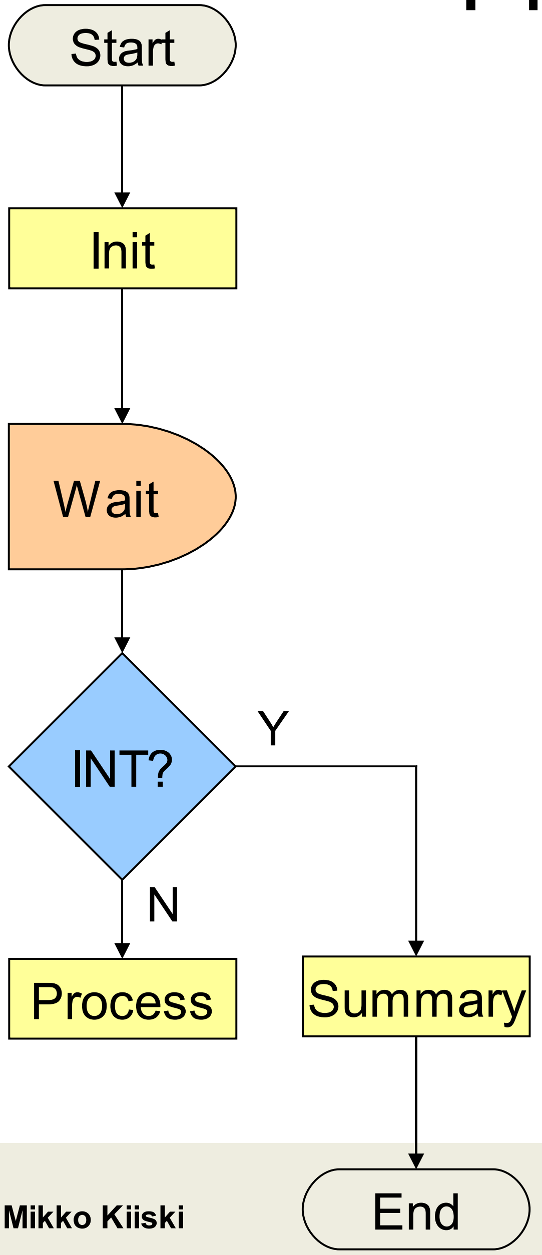
Information sources

- Today’s slides and examples
- Details on the web page
- javadoc, Google
- Send mail to assistants (if everything else has failed)

The Goals in the assignments

- Workable software
  - Remember that you will need to build upon this later
  - Compiled and tested on the department workstations (Unix/Linux)
  - Learning: how to get there
  - Functionality: to actually arrive at a working solution
- Documentation
  - Inline
  - Shows that you understood the problem and the solutions
  - Helps you to remember what you were thinking today in two months from now
  - Helps us to understand what you meant to do
  - → There should be no “wrong” solutions (only malfunctioning ones)
- Working with development tools
  - ant, javac, svn
  - Using IDE (Eclipse, NetBeans, JCreator ...)

Program Structure



Initialization

- Parse the command line arguments
- Resolve hostnames
- Prepaire Socket instances

Main thread

- Manage Socket instances
- Read data from receiving sockets
- Handle received input

Clean-up

- Close all Socket instances
- Terminate threads

Parse Command Line in Java

```
public static void main(String[] args)
```

```
// String array containing the program arguments

// Example iterating through array
for (int i = 0; i < args.length; i++) {
    String type = args[i++];
    String value = args[i];
    if(type.equalsIgnoreCase("-l")){
        // use value
        setExampleParameter( value );
    }
}
```

Resolve hostname

Transform a symbolic name into a protocol-specific address
  Attention: different address formats and lengths!

Select the most suitable implementation for the specific task

APIs

```
java.net.InetAddress
public static InetAddress getByName(String host)
public static InetAddress getByAddress(byte[] addr)
java.net.InetSocketAddress
```

J2SE 1.5.0 API Documentation
http://java.sun.com/j2se/1.5.0/docs/api/index.html

Get Detailed Address Info

Get detailed address info using java.net.InetAddress subclasses java.net.Inet4Address or java.net.Inet6Address for example following methods are available

- boolean isMCGlobal()
  - Utility routine to check if the multicast address has global scope.
- boolean isMCLinkLocal()
  - Utility routine to check if the multicast address has link scope.
- boolean isMCNodeLocal()
  - Utility routine to check if the multicast address has node scope.
- boolean isMCOrgLocal()
  - Utility routine to check if the multicast address has organization scope.
- boolean isMCSiteLocal()
  - Utility routine to check if the multicast address has site scope.
- boolean isMulticastAddress()
  - Utility routine to check if the InetAddress is an IP multicast address.

Socket Creation

```
java.net.Socket
java.net.ServerSocket
java.net.DatagramSocket
java.net.MulticastSocket
```

java.net.Socket()

Creates an unconnected socket, with the system-default type of SocketImpl.

java.net.Socket(InetAddress address, int port)

Creates a stream socket and connects it to the specified port number at the specified IP address.

java.net.ServerSocket()

Creates an unbound server socket.

java.net.ServerSocket(int port)

Creates a server socket, bound to the specified port.

java.net.ServerSocket(int port, int backlog, InetAddress bindAddr)

Create a server with the specified port, listen backlog, and local IP address to bind to.

Sending Data

Connection-oriented (TCP)

```
java.net.Socket(InetAddress address, int port)
  Creates a stream socket and connects it to the
  specified port number at the specified IP address.
java.net.Socket.getOutputStream()
  Write into OutputStream using suitable classes
```

Connectionless (UDP)

```
java.net.DatagramSocket(int port)
 Constructs a datagram socket and binds it to the
 specified port on the local host machine.
java.net.DatagramPacket(byte[] buf, int length, InetAddress
address, int port)
  Constructs a datagram packet for sending packets of length
  length to the specified port number on the specified host.
java.net.DatagramSocket.send(DatagramPacket p)
  Sends a datagram packet from this socket.
```

Receiving Data

Data reception (UDP) using DatagramSocket

DatagramSocket.receive(DatagramPacket pPacket)
Receives a datagram packet from this socket. The DatagramPacket contains the bytes transmitted.

Data reception (TCP) using Socket

InputStream Socket.getInputStream()
Read InputStream using suitable classes

To modify socket behaviour check the setter methods of the specified implementation

Multicast reception

Joining the multicast group

```
 try {
     java.net.MulticastSocket msocket =
           new java.net.MulticastSocket(port);
     java.net.InetAddress group =
           java.net.InetAddress.getByName(groupName);
     msocket.joinGroup(group);
 } catch (IOException e) {
 }
```

Leaving the multicast group

```
try {
     msocket.leaveGroup(group);
 } catch (IOException e) {
 }
```

Hints (1)

Try to group a certain set of functionalities into a specified class

Use desing patterns to get a controlled structure for your program

- For example Observer – Observable pattern can be used to deliver the received data for multiple users

Use the *java.io* with *java.net* to achieve simplier program structure than by using the *java.nio* package.

- The lower performance of *java.io* package isn't an issue here

Hints (2)

Use worker threads to receive multiple connections for a single server socket

```
while(serverIsRunning){
  // ConnectionHandler is own class implementing the Runnable interface
  ConnectionHandler worker;
  try{
        //server.accept returns a client connection
        worker = new ConnectionHandler(server.accept());
        Thread t = new Thread(worker);
        t.start();
  } catch (IOException e) {
        // handle the exceptions
  }
}
```

Hints (3)

To handle shutdown signal use addShutdownHook() method for Runtime class

```
Runtime.getRuntime().addShutdownHook(new Thread() {
            public void run() {
               System.out.println ("Called at shutdown.");
            }
        });
```

Other alternative is to use handle() method in sun.misc.Signal class to catch signals

```
public static void main(String[] args) throws Exception {
   Signal.handle(new Signal("INT"), new SignalHandler () {
     public void handle(Signal sig) {
       System.out.println(
         "Received a interrupt!!");
     }
   });
  //
  }
```