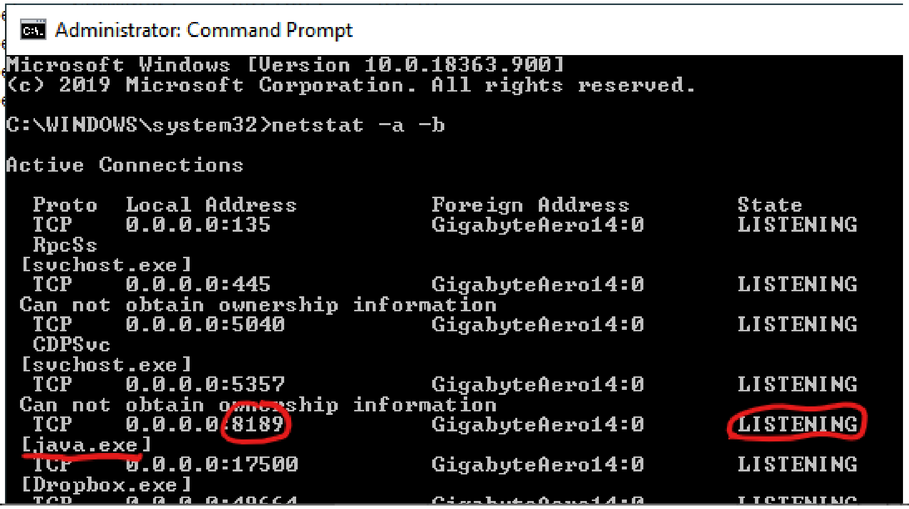
Application Design Using Java

Lecture 11

Port binding

```
java.net.BindException: Address already in use: bind
        at java.base/sun.nio.ch.Net.bind0(Native Method)
        at java.base/sun.nio.ch.Net.bind(Net.java:479)
        at java.base/sun.nio.ch.Net.bind(Net.java:468)
        at java.base/sun.nio.ch.NioSocketImpl.bind(NioSocketImpl.java:643)
        at java.bas
        at java.bas
        at java.bas
        at EchoServe
```


Administrator: Command Prompt

```
Microsoft Windows [Version 10.0.18363.900]
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C:\WINDOWS\system32>netstat -a -b

Active Connections

  Proto  Local Address          Foreign Address        State
  TCP    0.0.0.0:135            GigabyteAero14:0       LISTENING
  RpcSs
 [svchost.exe]
  TCP    0.0.0.0:445            GigabyteAero14:0       LISTENING
 Can not obtain ownership information
  TCP    0.0.0.0:5040           GigabyteAero14:0       LISTENING
  CDPSvc
 [svchost.exe]
  TCP    0.0.0.0:5357           GigabyteAero14:0       LISTENING
 Can not obtain ownership information
  TCP    0.0.0.0:8189           GigabyteAero14:0       LISTENING
 [java.exe]
  TCP    0.0.0.0:17500          GigabyteAero14:0       LISTENING
 [Dropbox.exe]
  TCP    0.0.0.0:49664          GigabyteAero14:0       LISTENING
```
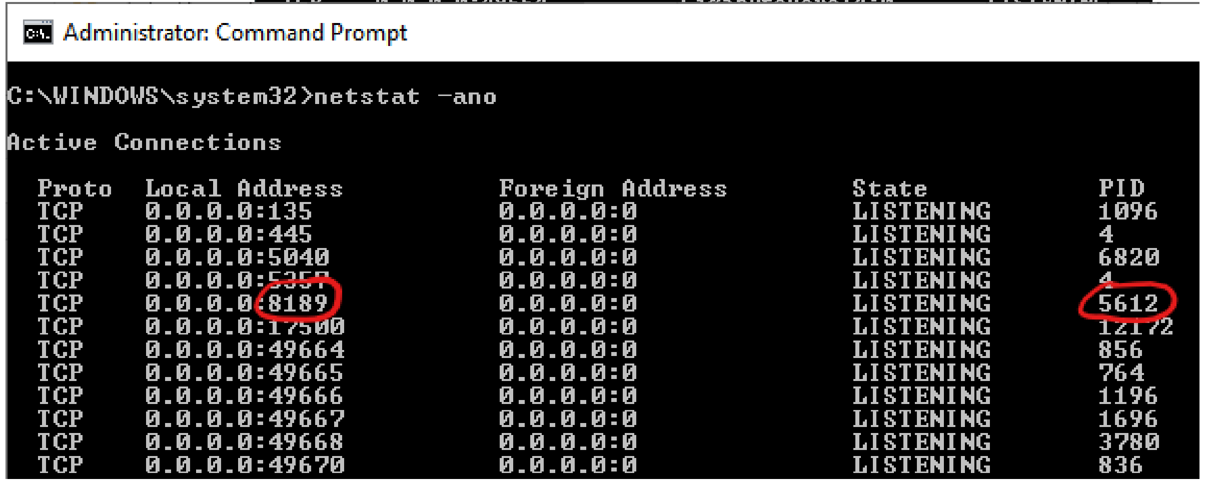
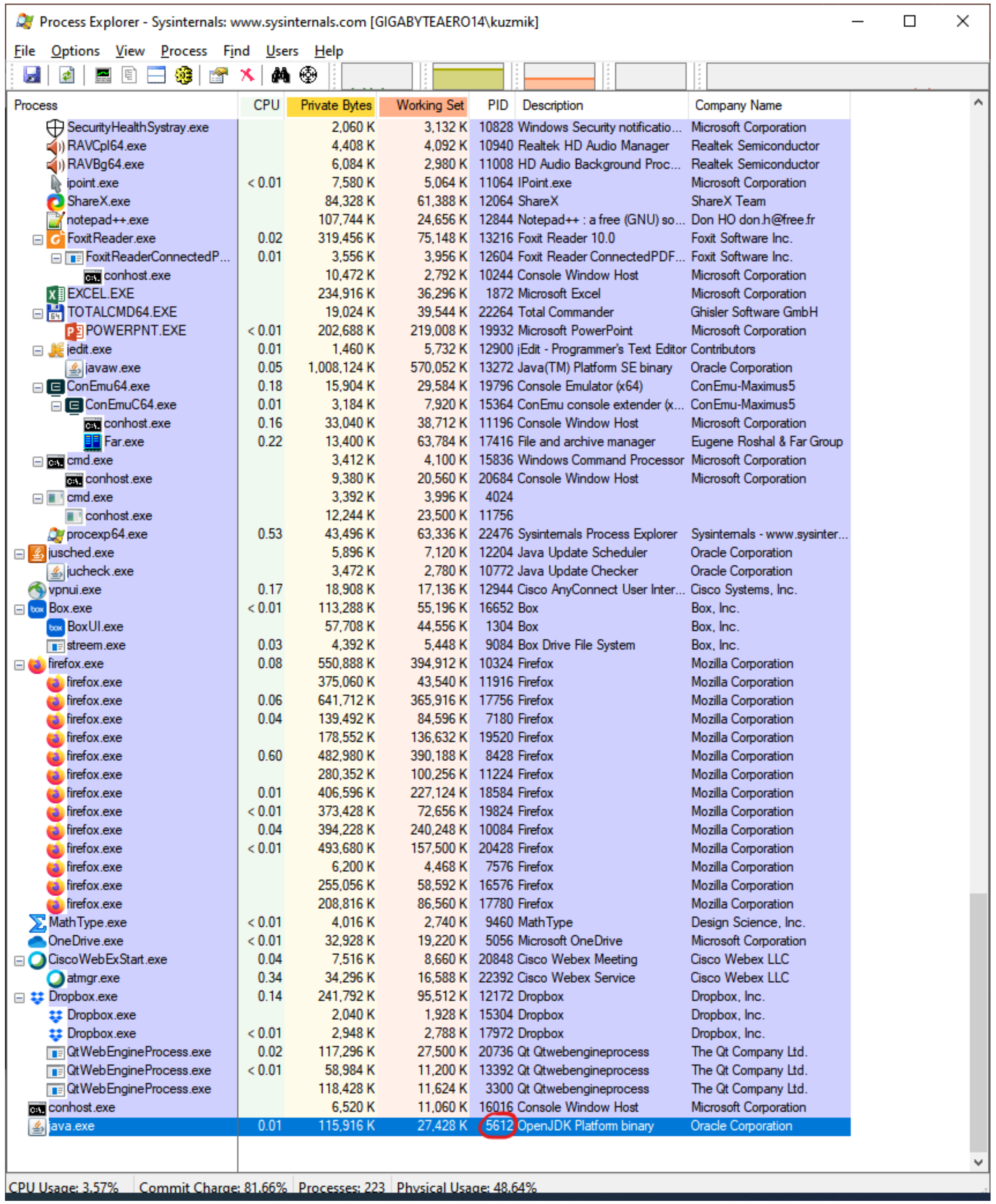


Administrator: Command Prompt

```
C:\WINDOWS\system32>netstat -ano

Active Connections

  Proto  Local Address          Foreign Address        State           PID
  TCP    0.0.0.0:135            0.0.0.0:0              LISTENING       1096
  TCP    0.0.0.0:445            0.0.0.0:0              LISTENING       4
  TCP    0.0.0.0:5040           0.0.0.0:0              LISTENING       6820
  TCP    0.0.0.0:5357           0.0.0.0:0              LISTENING       4
  TCP    0.0.0.0:8189           0.0.0.0:0              LISTENING       5612
  TCP    0.0.0.0:17500          0.0.0.0:0              LISTENING       12172
  TCP    0.0.0.0:49664          0.0.0.0:0              LISTENING       856
  TCP    0.0.0.0:49665          0.0.0.0:0              LISTENING       764
  TCP    0.0.0.0:49666          0.0.0.0:0              LISTENING       1196
  TCP    0.0.0.0:49667          0.0.0.0:0              LISTENING       1696
  TCP    0.0.0.0:49668          0.0.0.0:0              LISTENING       3780
  TCP    0.0.0.0:49670          0.0.0.0:0              LISTENING       836
```


Process Explorer - Sysinternals: www.sysinternals.com [GIGABYTEAERO14\kuzmik]

Process	CPU	Private Bytes	Working Set	PID	Description	Company Name
SecurityHealthSystray.exe		2,060 K	3,132 K	10828	Windows Security notificatio...	Microsoft Corporation
RAVCpl64.exe		4,408 K	4,092 K	10940	Realtek HD Audio Manager	Realtek Semiconductor
RAVBg64.exe		6,084 K	2,980 K	11008	HD Audio Background Proc...	Realtek Semiconductor
ipoint.exe	< 0.01	7,580 K	5,064 K	11064	IPoint.exe	Microsoft Corporation
ShareX.exe		84,328 K	61,388 K	12064	ShareX	ShareX Team
notepad++.exe		107,744 K	24,656 K	12844	Notepad++ : a free (GNU) so...	Don HO don.h@free.fr
FoxitReader.exe	0.02	319,456 K	75,148 K	13216	Foxit Reader 10.0	Foxit Software Inc.
FoxitReaderConnectedP...	0.01	3,556 K	3,956 K	12604	Foxit Reader ConnectedPDF...	Foxit Software Inc.
conhost.exe		10,472 K	2,792 K	10244	Console Window Host	Microsoft Corporation
EXCEL.EXE		234,916 K	36,296 K	1872	Microsoft Excel	Microsoft Corporation
TOTALCMD64.EXE		19,024 K	39,544 K	22264	Total Commander	Ghisler Software GmbH
POWERPNT.EXE	< 0.01	202,688 K	219,008 K	19932	Microsoft PowerPoint	Microsoft Corporation
jedit.exe	0.01	1,460 K	5,732 K	12900	jEdit - Programmer's Text Editor	Contributors
javaw.exe	0.05	1,008,124 K	570,052 K	13272	Java(TM) Platform SE binary	Oracle Corporation
ConEmu64.exe	0.18	15,904 K	29,584 K	19796	Console Emulator (x64)	ConEmu-Maximus5
ConEmuC64.exe	0.01	3,184 K	7,920 K	15364	ConEmu console extender (x...	ConEmu-Maximus5
conhost.exe	0.16	33,040 K	38,712 K	11196	Console Window Host	Microsoft Corporation
Far.exe	0.22	13,400 K	63,784 K	17416	File and archive manager	Eugene Roshal & Far Group
cmd.exe		3,412 K	4,100 K	15836	Windows Command Processor	Microsoft Corporation
conhost.exe		9,380 K	20,560 K	20684	Console Window Host	Microsoft Corporation
cmd.exe		3,392 K	3,996 K	4024		
conhost.exe		12,244 K	23,500 K	11756		
procexp64.exe	0.53	43,496 K	63,336 K	22476	Sysinternals Process Explorer	Sysinternals - www.sysinter...
jusched.exe		5,896 K	7,120 K	12204	Java Update Scheduler	Oracle Corporation
jucheck.exe		3,472 K	2,780 K	10772	Java Update Checker	Oracle Corporation
vpnui.exe	0.17	18,908 K	17,136 K	12944	Cisco AnyConnect User Inter...	Cisco Systems, Inc.
Box.exe	< 0.01	113,288 K	55,196 K	16652	Box	Box, Inc.
BoxUI.exe		57,708 K	44,556 K	1304	Box	Box, Inc.
streem.exe	0.03	4,392 K	5,448 K	9084	Box Drive File System	Box, Inc.
firefox.exe	0.08	550,888 K	394,912 K	10324	Firefox	Mozilla Corporation
firefox.exe		375,060 K	43,540 K	11916	Firefox	Mozilla Corporation
firefox.exe	0.06	641,712 K	365,916 K	17756	Firefox	Mozilla Corporation
firefox.exe	0.04	139,492 K	84,596 K	7180	Firefox	Mozilla Corporation
firefox.exe		178,552 K	136,632 K	19520	Firefox	Mozilla Corporation
firefox.exe	0.60	482,980 K	390,188 K	8428	Firefox	Mozilla Corporation
firefox.exe		280,352 K	100,256 K	11224	Firefox	Mozilla Corporation
firefox.exe	0.01	406,596 K	227,124 K	18584	Firefox	Mozilla Corporation
firefox.exe	< 0.01	373,428 K	72,656 K	19824	Firefox	Mozilla Corporation
firefox.exe	0.04	394,228 K	240,248 K	10084	Firefox	Mozilla Corporation
firefox.exe	< 0.01	493,680 K	157,500 K	20428	Firefox	Mozilla Corporation
firefox.exe		6,200 K	4,468 K	7576	Firefox	Mozilla Corporation
firefox.exe		255,056 K	58,592 K	16576	Firefox	Mozilla Corporation
firefox.exe		208,816 K	86,560 K	17780	Firefox	Mozilla Corporation
MathType.exe	< 0.01	4,016 K	2,740 K	9460	MathType	Design Science, Inc.
OneDrive.exe	< 0.01	32,928 K	19,220 K	5056	Microsoft OneDrive	Microsoft Corporation
CiscoWebExStart.exe	0.04	7,516 K	8,660 K	20848	Cisco Webex Meeting	Cisco Webex LLC
atmgr.exe	0.34	34,296 K	16,588 K	22392	Cisco Webex Service	Cisco Webex LLC
Dropbox.exe	0.14	241,792 K	95,512 K	12172	Dropbox	Dropbox, Inc.
Dropbox.exe		2,040 K	1,928 K	15304	Dropbox	Dropbox, Inc.
Dropbox.exe	< 0.01	2,948 K	2,788 K	17972	Dropbox	Dropbox, Inc.
QtWebEngineProcess.exe	0.02	117,296 K	27,500 K	20736	Qt Qtwebengineprocess	The Qt Company Ltd.
QtWebEngineProcess.exe	< 0.01	58,984 K	11,200 K	13392	Qt Qtwebengineprocess	The Qt Company Ltd.
QtWebEngineProcess.exe		118,428 K	11,624 K	3300	Qt Qtwebengineprocess	The Qt Company Ltd.
conhost.exe		6,520 K	11,060 K	16016	Console Window Host	Microsoft Corporation
java.exe	0.01	115,916 K	27,428 K	5612	OpenJDK Platform binary	Oracle Corporation

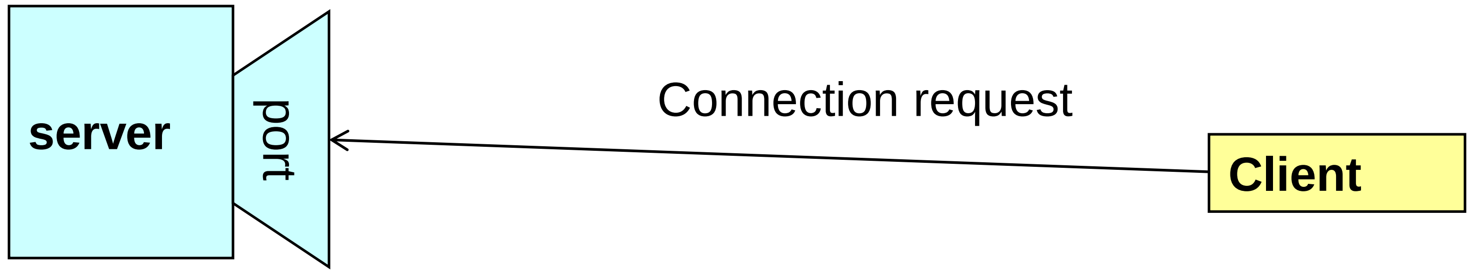
CPU Usage: 3.57% Commit Charge: 81.66% Processes: 223 Physical Usage: 48.64%

Sockets

- Sockets provide an interface for programming networks at the transport layer.
- Network communication using Sockets is very much similar to performing file I/O
    - In fact, socket handle is treated like file handle.
    - The streams used in file I/O operation are also applicable to socket-based I/O
- Socket-based communication is programming language independent.
    - That means, a socket program written in Java language can also communicate to a program written in Java or non-Java socket program.

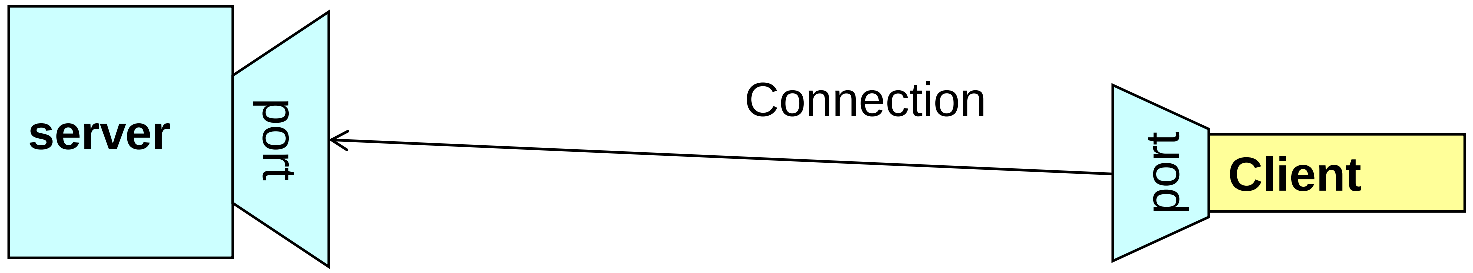
Socket Communication

- A server (program) runs on a specific computer and has a socket that is bound to a specific port. The server waits and listens to the socket for a client to make a connection request.



Socket Communication

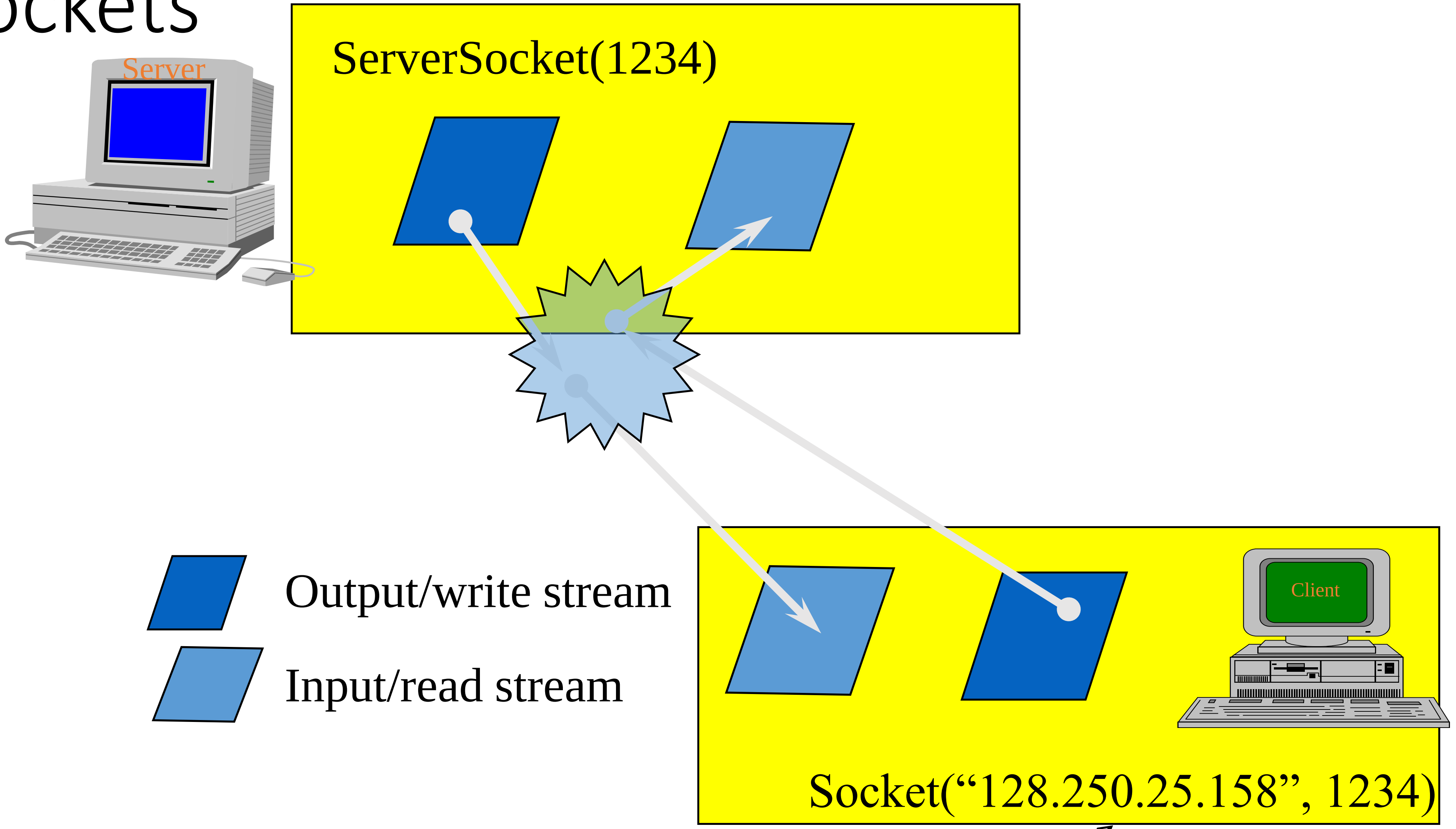
- If everything goes well, the server accepts the connection. Upon acceptance, the server gets a new socket bound to the same port.



Sockets and Java Socket Classes

- A socket is an endpoint of a two-way communication link between two programs running on the network.
- A socket is bound to a port number so that the TCP layer can identify the application that data destined to be sent.
- Java's .net package provides two classes:
  - Socket – for implementing a client
  - ServerSocket – for implementing a server

Java Sockets



It can be host_name like "gol.cs.rpi.edu"

Implementing a Server

1. Open the Server Socket:

```
   ServerSocket server;
   DataOutputStream os;
   DataInputStream is;
   server = new ServerSocket(PORT);
```

2. Wait for the Client Request:

```
   Socket client = server.accept();
```

3. Create I/O streams for communicating to the client

```
   is = new DataInputStream(client.getInputStream());
   os = new DataOutputStream(client.getOutputStream());
```

4. Perform communication with client

```
   Receive from client: String line = is.readLine();
   Send to client: os.writeBytes("Hello\n");
```

5. Close sockets: `client.close();`

For multithreaded server:

```
  while(true) {
        i. wait for client requests (step 2 above)
        ii. create a thread with “client” socket as parameter (the thread creates streams (as in step (3) and does
            communication as stated in (4).
            Remove thread once service is provided.
   }
```

Implementing a Client

1. Create a Socket Object:

```
client = new Socket(server, port_id);
```

2. Create I/O streams for communicating with the server:

```
is = new DataInputStream(client.getInputStream());
os = new DataOutputStream(client.getOutputStream());
```

3. Perform I/O or communication with the server:
   - Receive data from the server:

     ```
     String line = is.readLine();
     ```
   - Send data to the server:

     ```
     os.writeBytes("Hello\n");
     ```

4. Close the socket when done:

```
client.close();
```

Socket Exceptions

```
try {
   Socket client = new Socket(host, port);
}
catch(UnknownHostException uhe) { System.out.println("Unknown host: " + host);
   uhe.printStackTrace();
}
catch(IOException ioe) {
System.out.println("IOException: " + ioe); ioe.printStackTrace();
}
```

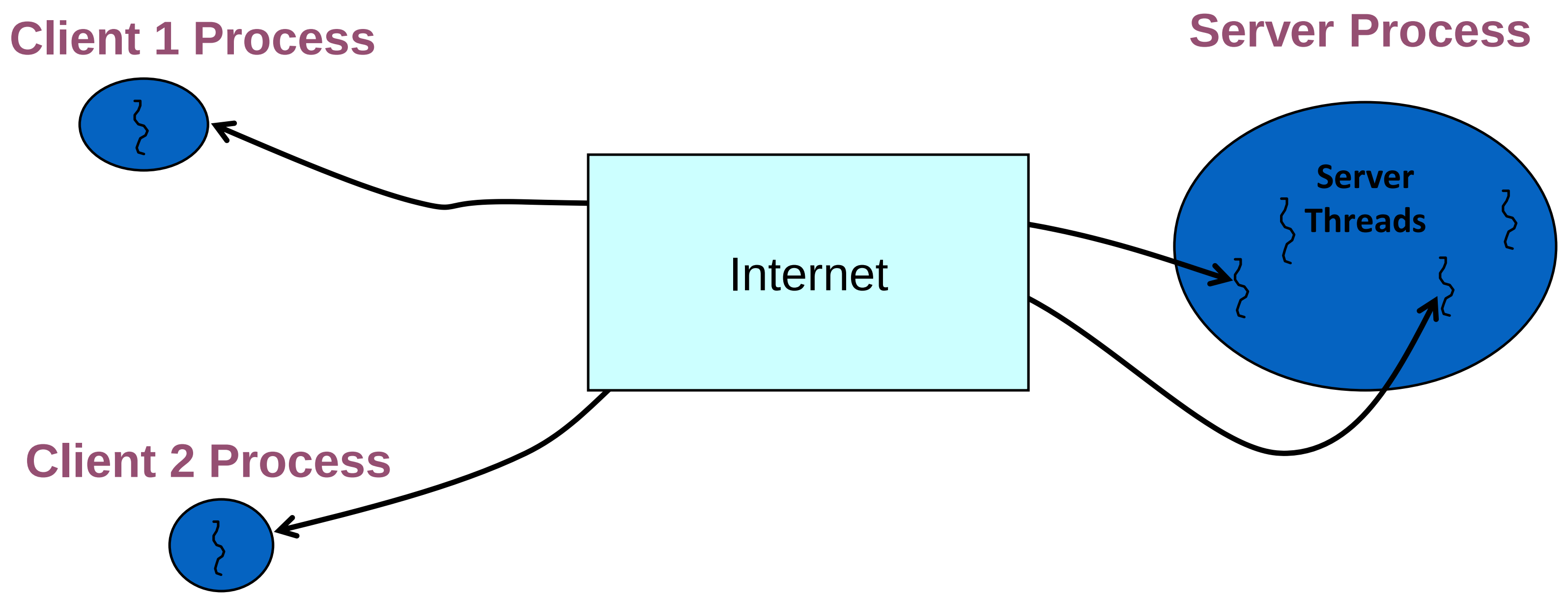
ServerSocket & Exceptions

- public **ServerSocket**(int port) throws IOException
  - Creates a server socket on a specified port.
  - A port of 0 creates a socket on any free port. You can use **getLocalPort**() to identify the (assigned) port on which this socket is listening.
  - The maximum queue length for incoming connection indications (a request to connect) is set to 50. If a connection indication arrives when the queue is full, the connection is refused.
- Throws:
  - IOException - if an I/O error occurs when opening the socket.
  - SecurityException - if a security manager exists and its checkListen method doesn't allow the operation.

Server in Loop: Always up

```
// SimpleServerLoop.java: a simple server program that runs forever in a single thread
import java.net.*;
import java.io.*;
public class SimpleServerLoop {
  public static void main(String args[]) throws IOException {
    // Register service on port 1234
    ServerSocket s = new ServerSocket(1234);
    while(true) {
            Socket s1 = s.accept(); // Wait and accept a connection
            // Get a communication stream associated with the socket
            OutputStream s1out = s1.getOutputStream();
            DataOutputStream dos = new DataOutputStream (s1out);
            // Send a string!
            dos.writeUTF("Hi there");
            // Close the connection, but not the server socket
            dos.close();
            s1out.close();
            s1.close();
    }
  }
}
```

Multithreaded Server: For Serving Multiple Clients Concurrently



Logging

- The global logger object
- Custom loggers
- Logging levels
    - SEVERE
    - WARNING
    - INFO
    - CONFIG
    - FINE
    - FINER
    - FINEST
- Log manager configuration in jre/lib/logging.properties
- Handlers
- Filters
- Formatters

//TODO before next lecture:

- Homework 3 was posted. It is due on 3/19 at 11:59 pm EDT. Must be submitted on Submitty.
- Practice problems.