# Lecture 9

# Java SE Network Programming

presentation

**Java Programming – Software App Development**

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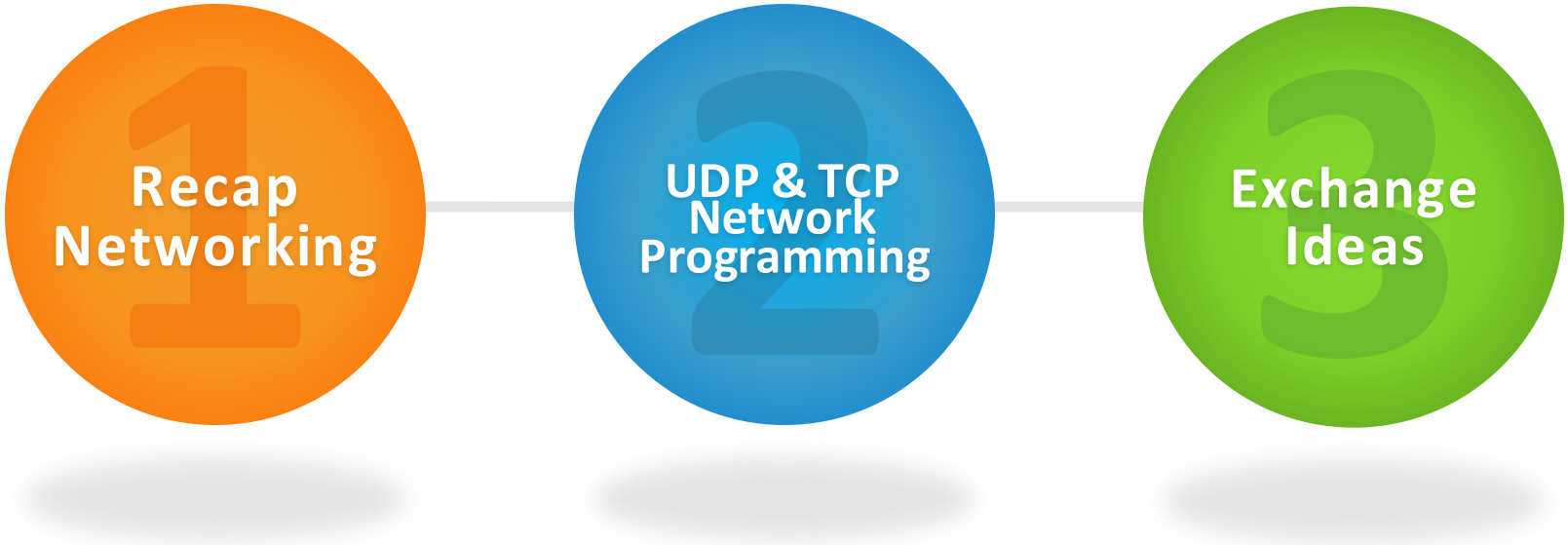
www.dice.ase.ro

# **Cristian Toma** – Business Card

# **Agenda** for Lecture 9

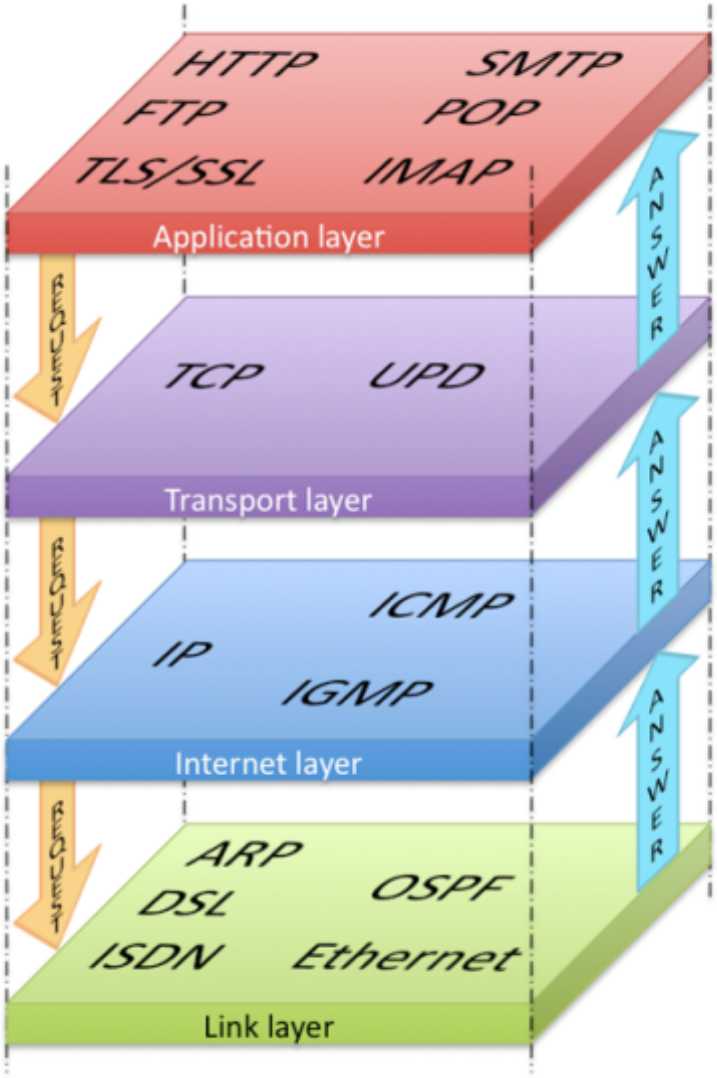


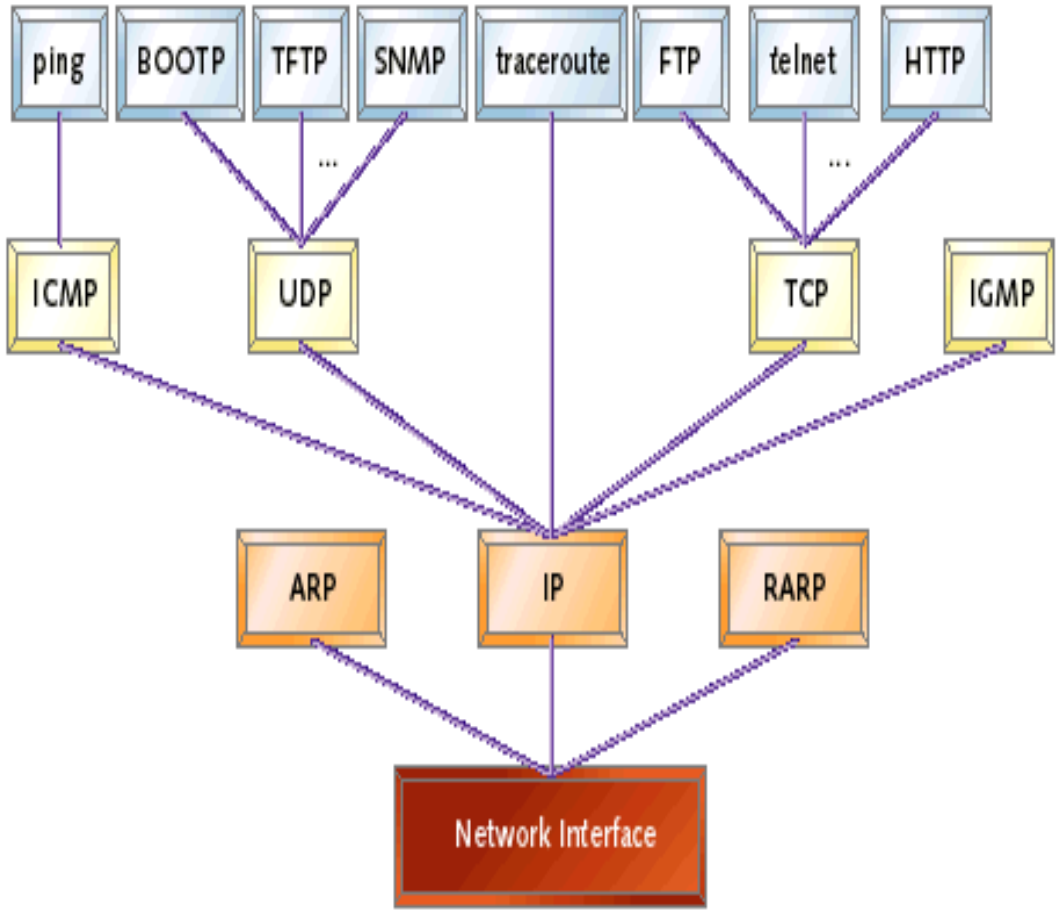
Networking IP, UDP and TCP programming, TCP/IP state machine

# **Networking** Recapitulation

# 1. Networking TCP/IP Stack

## HOW TCP/IP Works:



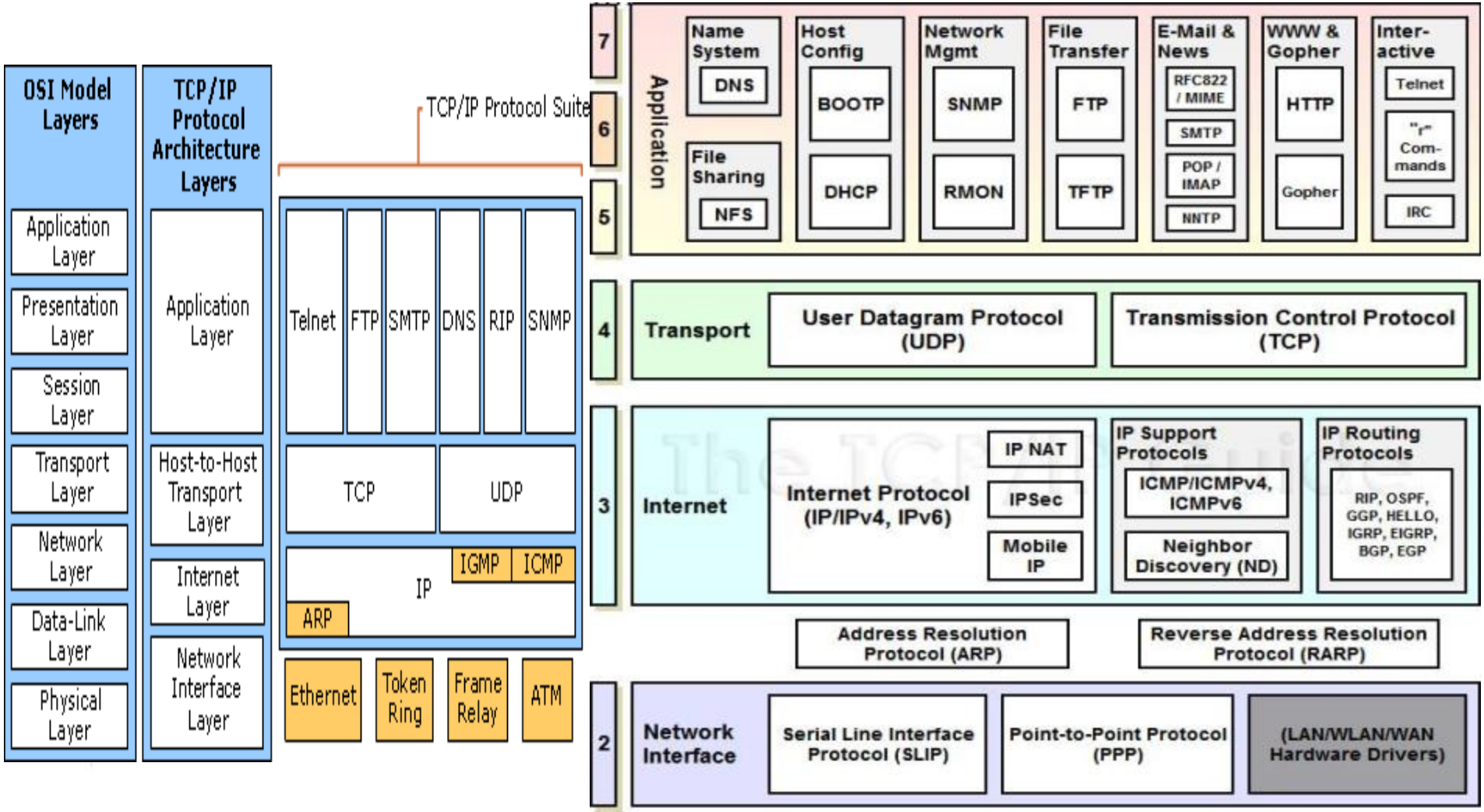




http://buildingautomationmonthly.com/tcpip-an-overview/

http://www.barrgroup.com/Embedded-Systems/How-To/Embedded-TCP-IP

# 1. Networking TCP/IP Stack

## TCP/IP Stack Model:




http://technet.microsoft.com/en-us/library/cc786128(v=ws.10).aspx

http://talktoanit.com/c/?p=78

# 1. Networking TCP/IP Stack

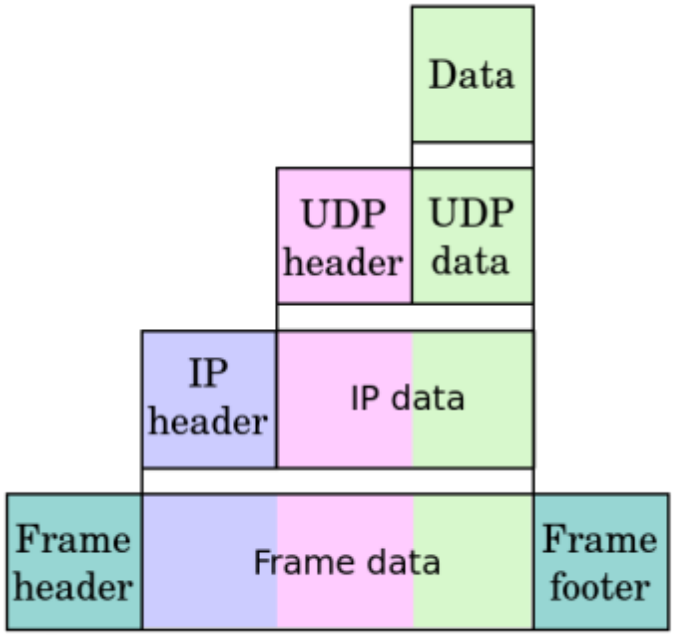
## ISO/OSI Model vs. TCP/IP:

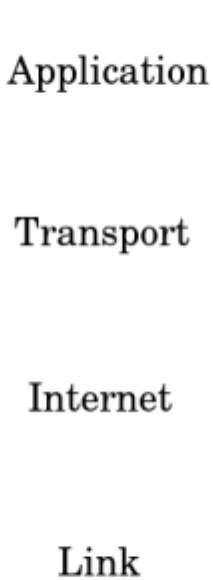
| TCP/IP DoD Model | | | OSI Model |
|---|---|---|---|
| Application Layer<br>(Services Layers 5,6,7)<br>**PDU: Data** | HTTP: port **80**<br>HTTPS/TLS/SSL: port **443**<br>NNTP: port **119**<br>FTP: port **21, 20**<br>Telnet: port **23**<br>SSH: port **22**<br>POP3: port **110**<br>IMAP4: port **143**<br>SMTP: port **25** | DNS: port **53**<br>TFTP: port **69**<br>DHCP/BootP: port **67,68**<br>SNMP: port **162, 161**<br>NTP: port **123**<br>Syslog: port **514** | Application Layer (7)<br>**Scribe.** APIs, network services<br>Serves the King/User<br>Presentation Layer (6)<br>**Translator.** Reformats, encrypts/de-crypts, compress/de-compress<br>Session Layer (5)<br>**Negotiator.** Establishes, manages and ends sessions. |
| Transport Layer<br>(Host to Host Layer 4)<br>**PDU: Segments** | TCP: protocol 6 | UDP: protocol 17 | Transport Layer (4)<br>**Middle Manager.**<br>Segment ID/Assembly |
| Internet Layer<br>(Network Layer 3)<br>**PDU: Packets** | IP | IP | Network Layer (3)<br>**Mail Room Guy.**<br>IP Addressing/Routing |
| Network Acces Layer 1 & 2<br>**PDU: Frame** | Ethernet, PPP<br>Frame Relay<br>MAC addresses, ARP | Ethernet, PPP<br>Frame Relay<br>MAC addresses, ARP | Data-Link Layer (2)<br>**Envelope Stuffer.**<br>Organizes bits into frames |
| Network Access Layer 1 & 2<br>**PDU: Bits or Data Stream** | Electrons, RF<br>or Light | Electrons, RF<br>or Light | Physical Layer (1)<br>**The Truck.** Movement of bits. |

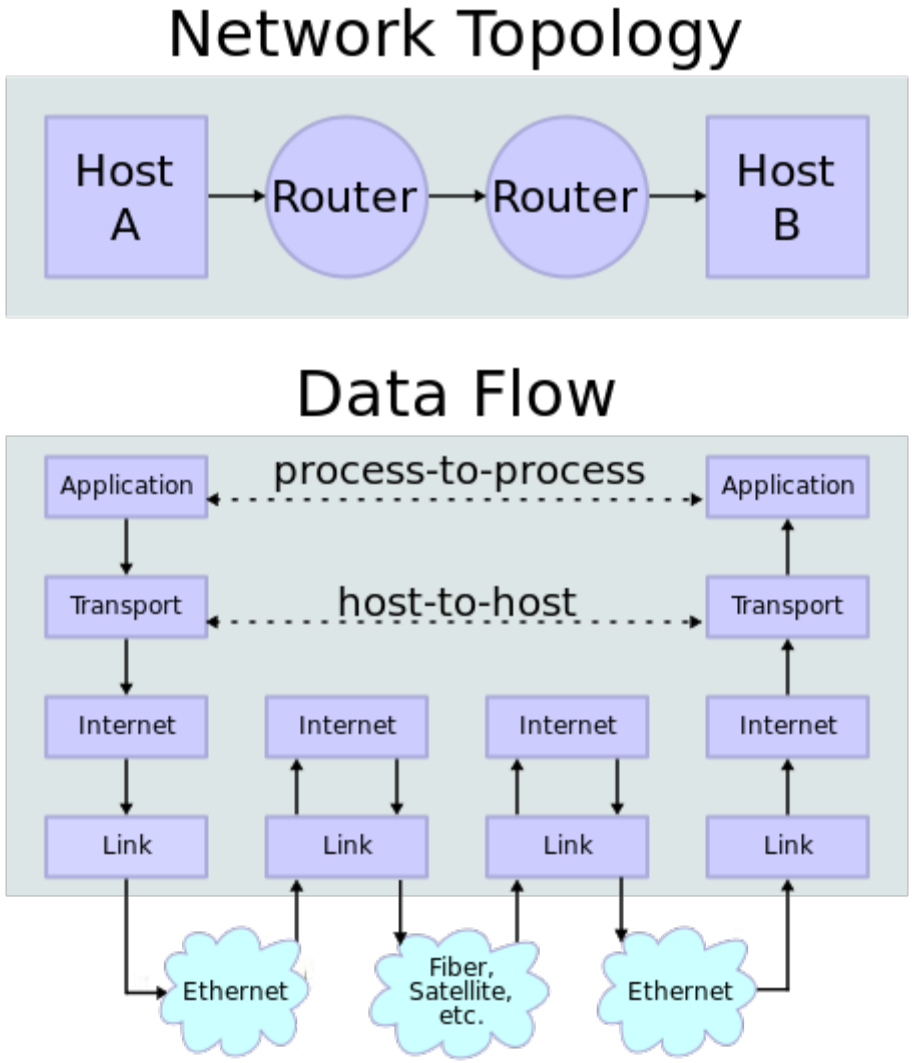
http://buildingautomationmonthly.com/tcpip-an-overview/

# 1. Networking TCP/IP Stack

## TCP/IP Message Encapsulation:



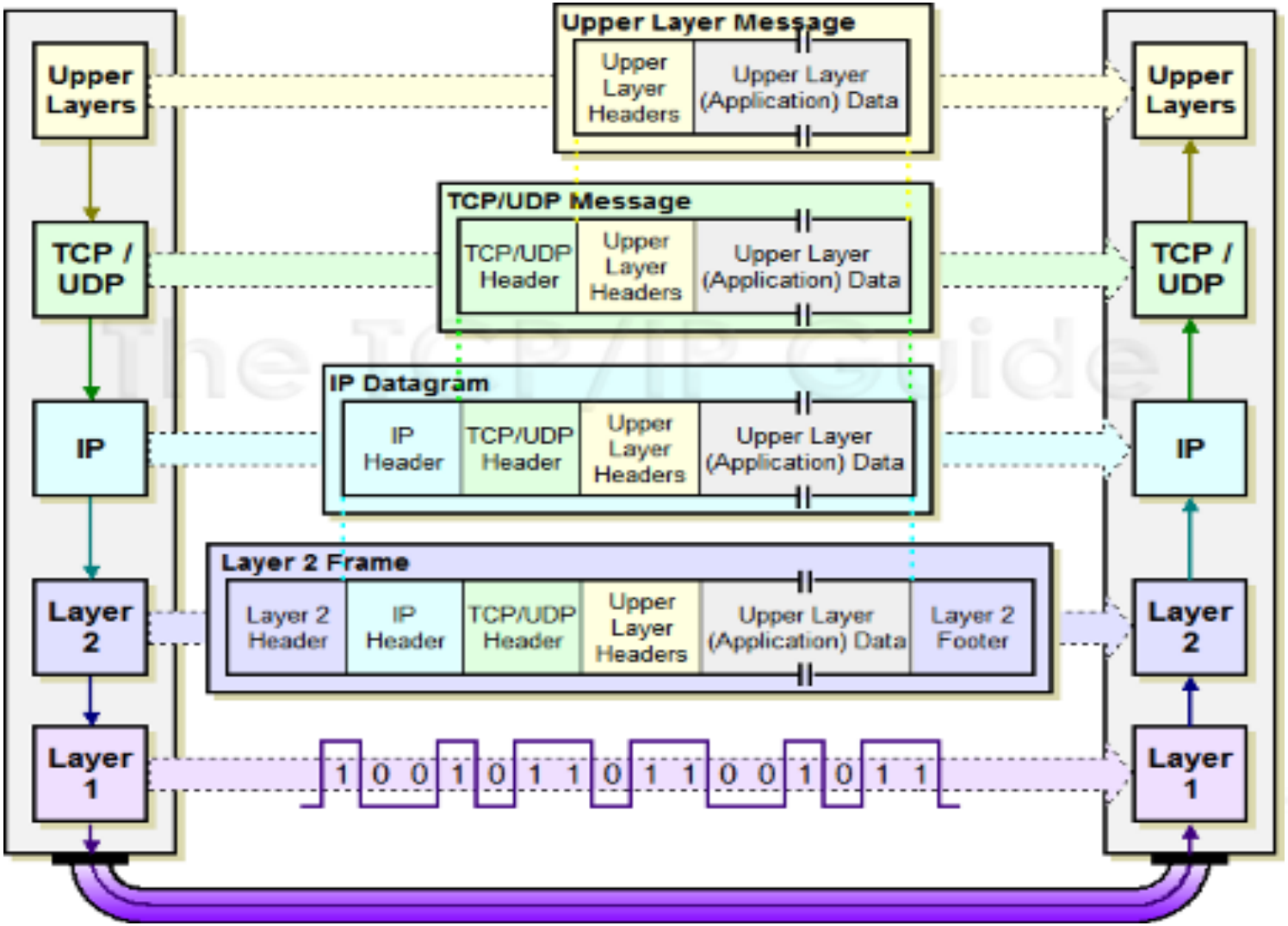




http://en.wikipedia.org/wiki/Internet_protocol_suite

# 1. Networking TCP/IP Stack

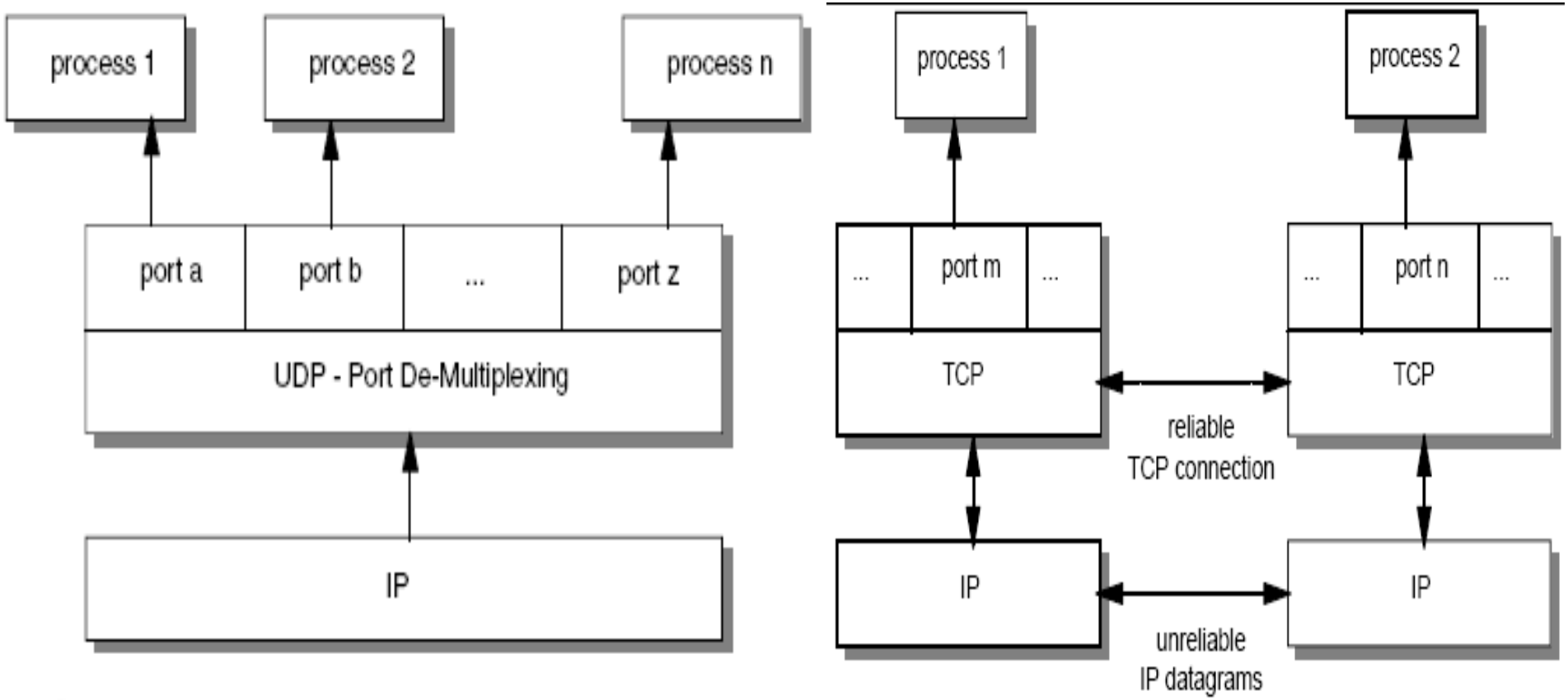
## TCP/IP Message Flow:




http://buildingautomationmonthly.com/tcpip-an-overview/

# 1. Networking TCP/IP Stack

## TCP/IP App/Port Multiplexing:

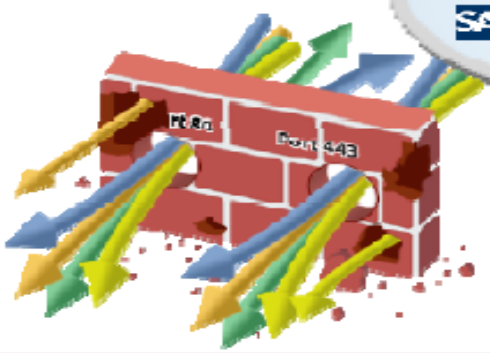


# 1. Networking TCP/IP Stack

**What is running on port 80?**


## Applications Have Changed – Firewalls Have Not

- The gateway at the trust border is the right place to enforce policy control
  - Sees all traffic
  - Defines trust boundary

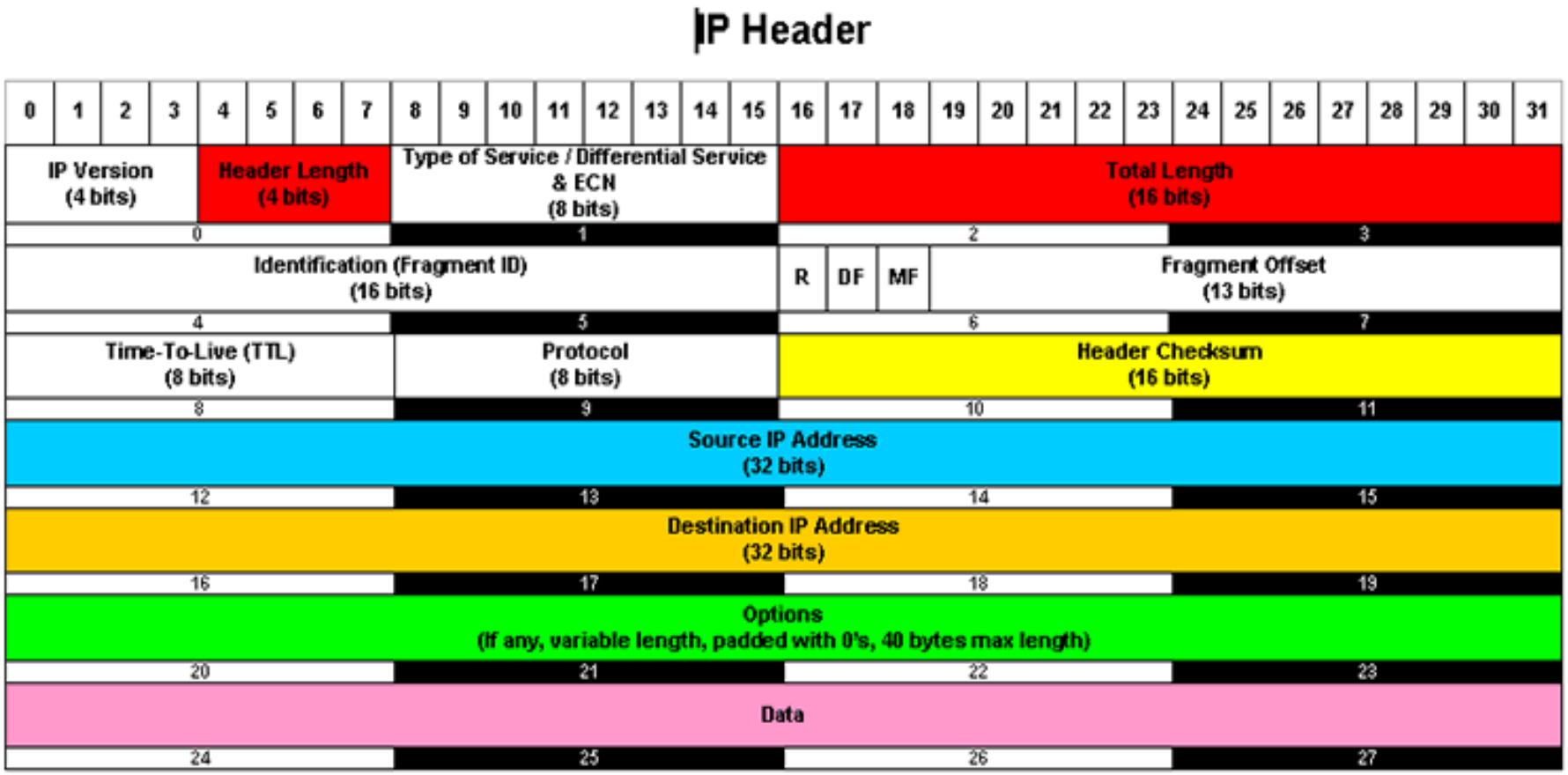




- BUT…Applications Have Changed
  - Ports ≠Applications
  - IP Addresses ≠Users
  - Packets ≠Content

**Need to Restore Visibility and Control in the Firewall**

# 1. Networking TCP/IP Stack

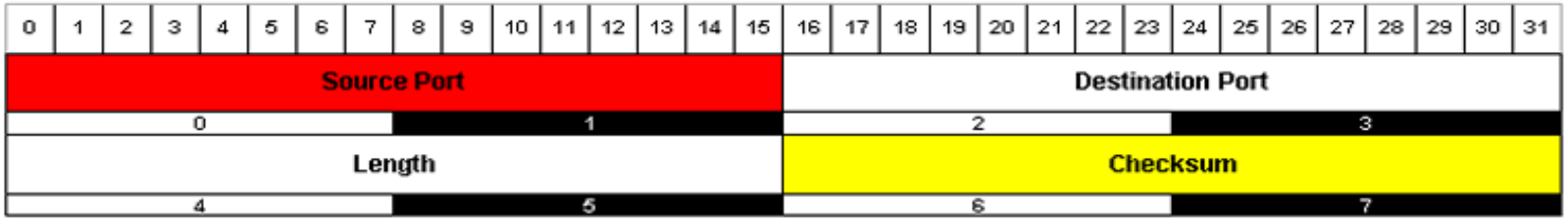
## IP Header - RFC 791 – Submasking + Routing + NAT:



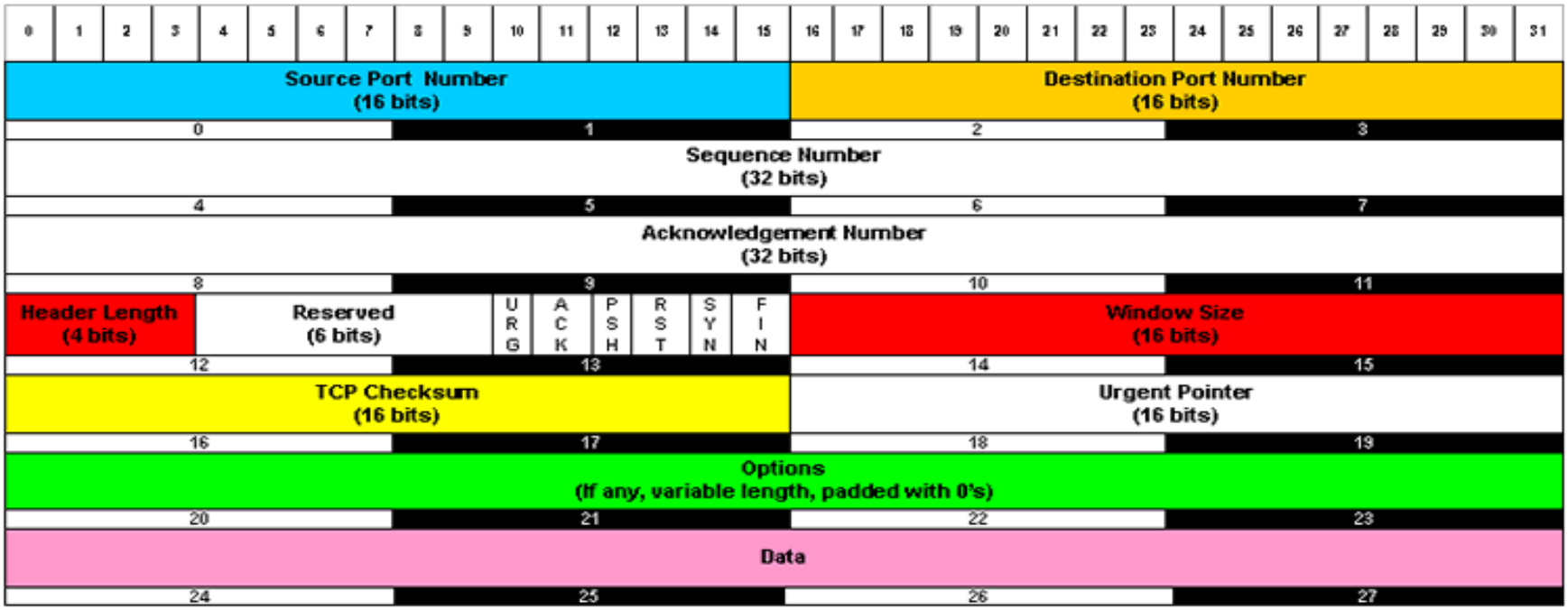
# 1. Networking TCP/IP Stack

## UDP Header – RFC 768 – Connection-less vs. TCP Header – RFC 793 – Connection-oriented

### UDP Header

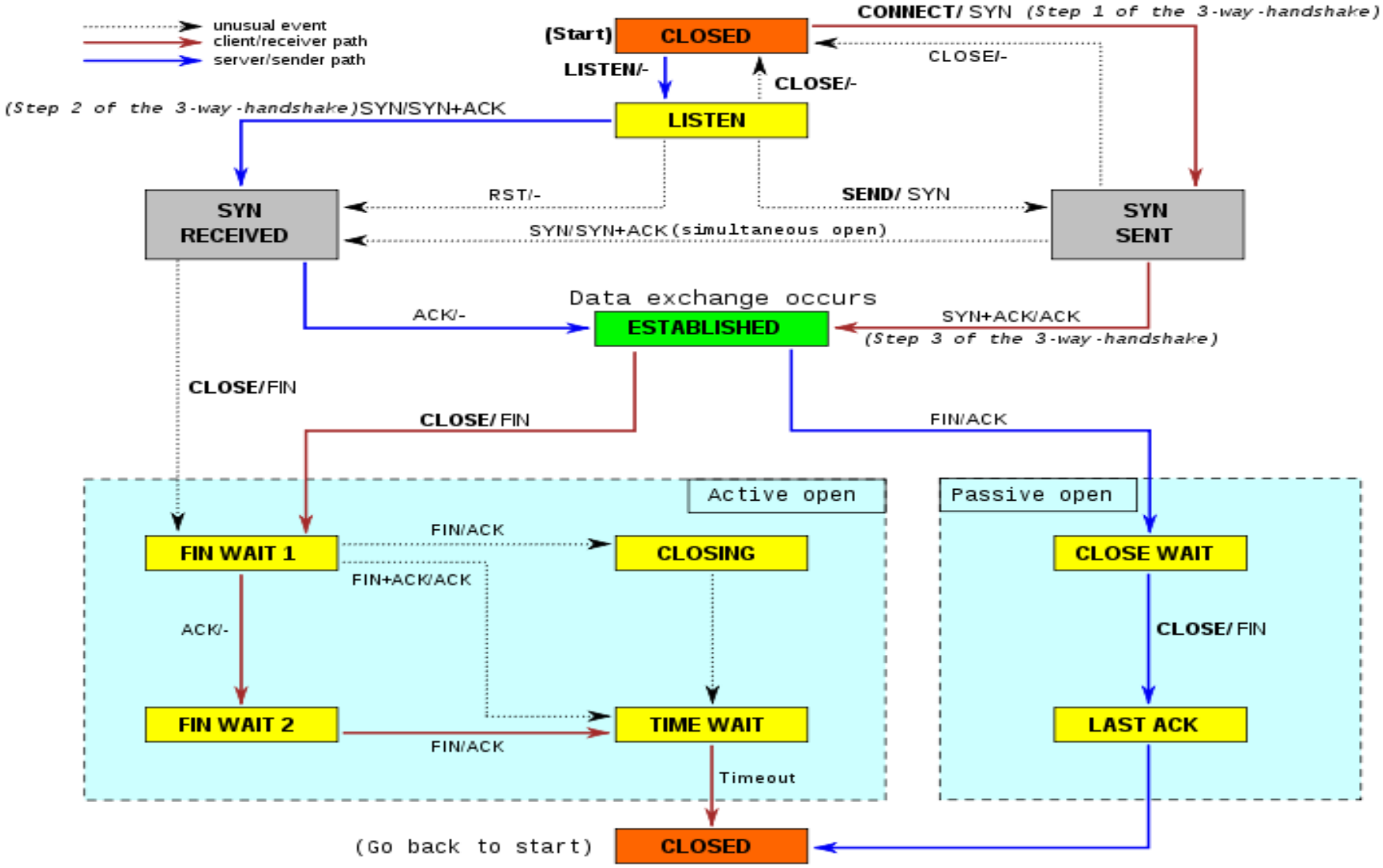



### TCP Header



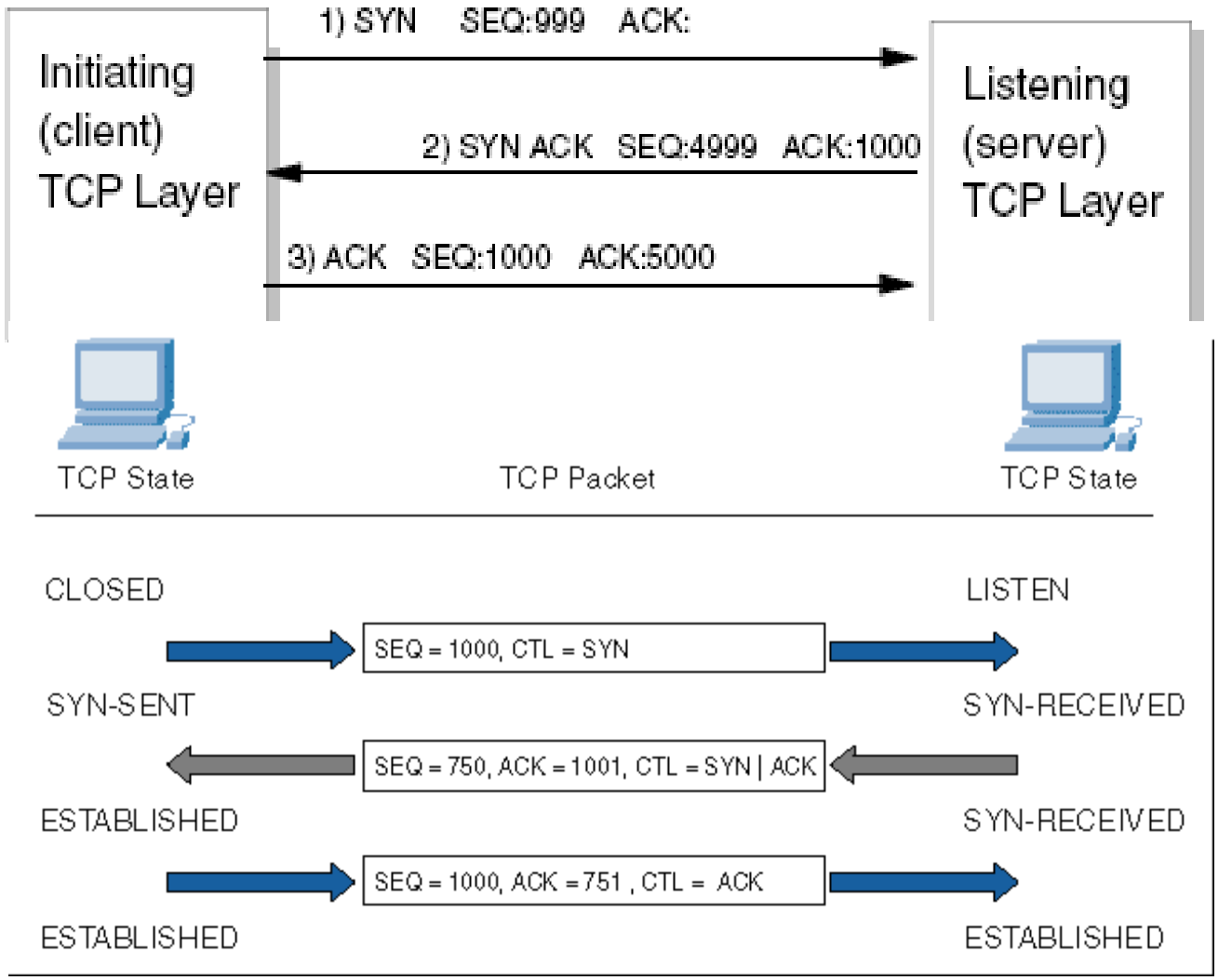
# 1. Networking TCP/IP Stack

## TCP State Machine – RFC 793:



# 1.2 TCP/IP Networking Programming

## TCP Handshake:




http://www.cisco.com/web/about/ac123/ac147/ac174/ac196/about_cisco_ipj_archive_article09186a00800c8417.html

# Section Conclusion

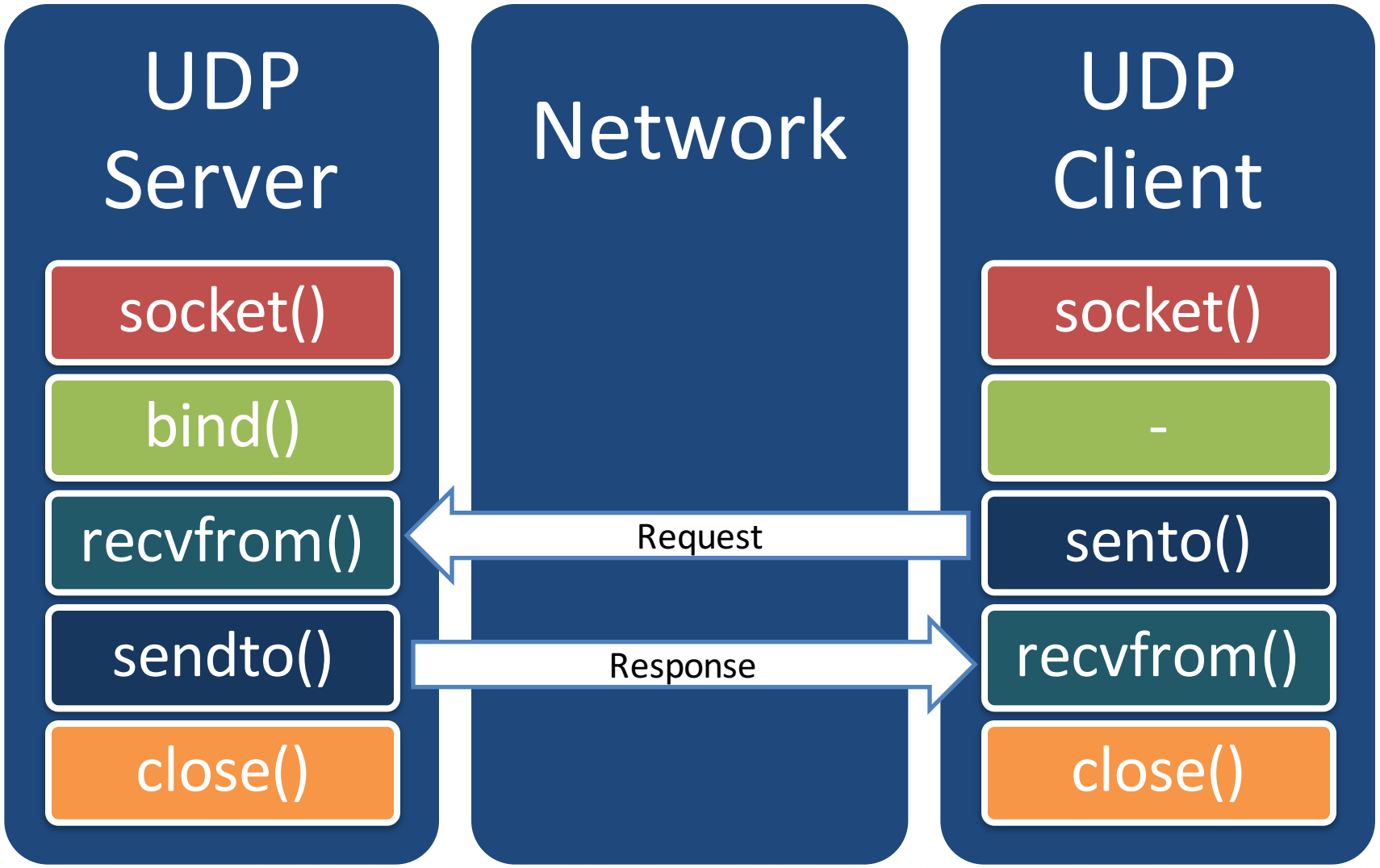
## Fact: Java is suitable for Networking

In few **samples** it is simple to understand: UDP and TCP programming is useful for HTC – High Throughput Computing (Distributed Computing), .

UDP Client-Server programming, TCP Client-Server programming, FTP Server

# **Network** UDP & TCP Programming

# 2.1 TCP/IP Networking Programming – UDP Programming – Socket Primitives:



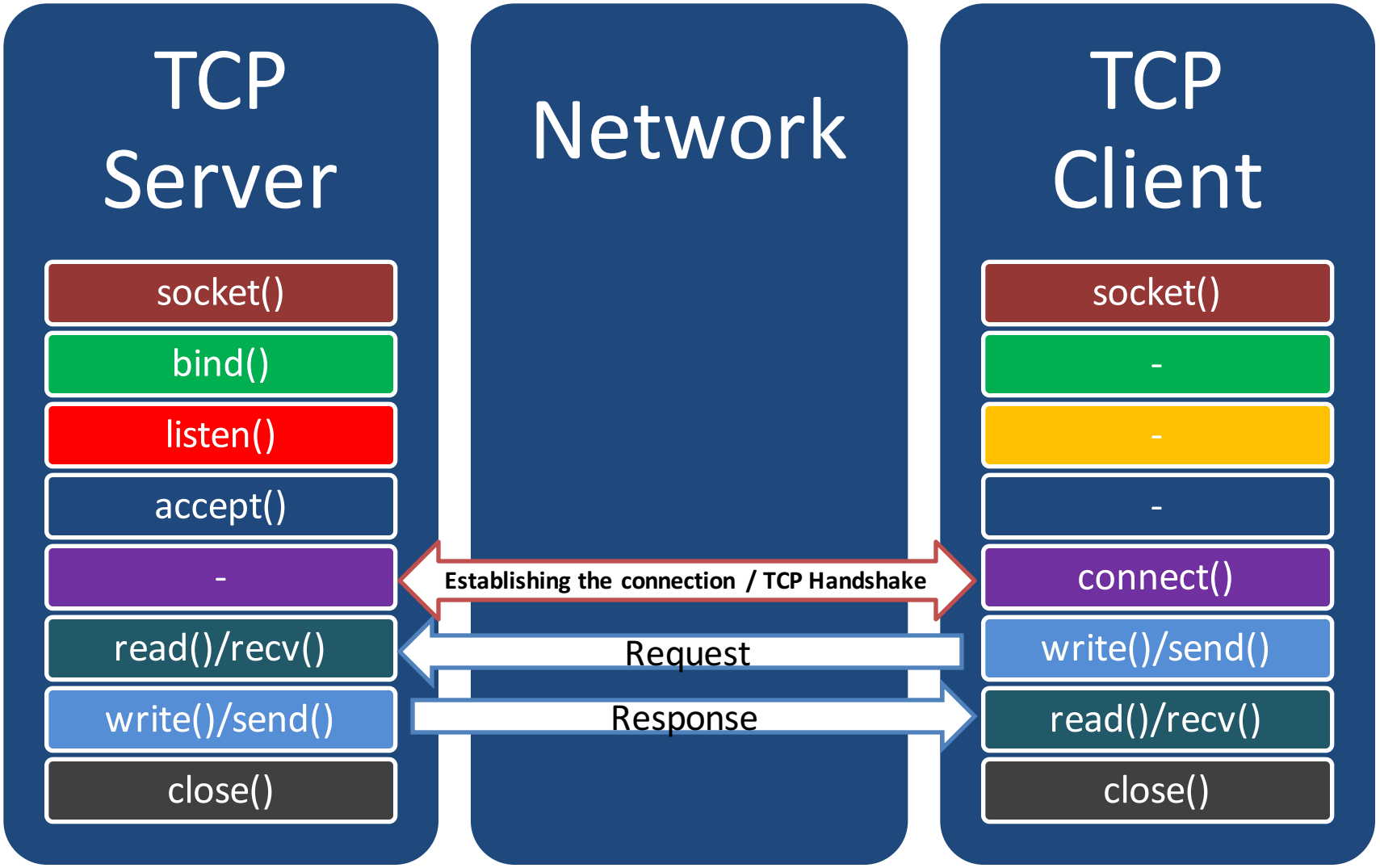
# 2.1 TCP/IP Networking Programming – UDP Programming – Socket Primitives:

```
package eu.ase.net.udp;
import java.io.*;
import java.net.*;
public class UDPServer {
    public static void main(String[] args) {
        // get a datagram socket
        DatagramSocket socket = null;
        byte[] bufResp = null;
        byte[] bufRecv = null;
        try {
         socket = new DatagramSocket(778);//it is correct because this constructor executes "bind"
         while(true) {
            bufRecv = new byte[256];
            // receive request
            DatagramPacket packet = new DatagramPacket(bufRecv, bufRecv.length);
            socket.receive(packet);

            // figure out response
            String respString = new String("OK");
            bufResp = respString.getBytes();

            // send the response to the client at "address" and "port"
            InetAddress address = packet.getAddress();
            int port = packet.getPort();
            packet = new DatagramPacket(bufResp, bufResp.length, address, port);
            socket.send(packet);
         }
        } catch(IOException ioe) {
```

# 2.1 TCP/IP Networking Programming – UDP Programming – Socket Primitives:

```
package eu.ase.net.udp;
import java.io.*;
import java.net.*;
public class UDPClient {
    public static void main(String[] args) throws IOException {
        // get a datagram socket
        DatagramSocket socket = new DatagramSocket();

        // send request
        byte[] buf = new byte[256];
        InetAddress address = InetAddress.getByName("127.0.0.1");
        DatagramPacket packet = new DatagramPacket(buf, buf.length, address, 778);
        socket.send(packet);

        // get response
        byte[] bufResp = new byte[256];
        packet = new DatagramPacket(bufResp, bufResp.length);
        socket.receive(packet);

        // display response
        String received = new String(packet.getData());
        System.out.print("Client de la server: " + received);

        // close socket
        socket.close();
    }
}
```

# 2.2 TCP/IP Networking Programming – TCP Programming – Socket Primitives:



# 2.2 TCP/IP Networking Programming – TCP Programming – Socket Primitives:

Server

Client

```
ServerSocket serverSocket = null;
Socket clientSocket = null;

boolean listening = true;

OutputStream os = null; PrintWriter out = null;
InputStream is = null; BufferedReader in = null;
String inputLine = null, outputLine = null;


//SEVERSOCKET = SOCKET+BIND+LISTEN
serverSocket = new ServerSocket(4801);
clientSocket = serverSocket.accept();          //ACCEPT


//STABILIREA CONEXIUNII
is = clientSocket.getInputStream();
in = new BufferedReader(new InputStreamReader(is));

os = clientSocket.getOutputStream();
out = new PrintWriter(os, true);


 while ((inputLine = in.readLine()) != null) {
         System.out.println(inputLine);
         outputLine = new String("OK");
         out.println(outputLine);
         out.flush();
         if (outputLine.compareTo("La revedere!") == 0) {break;}
 }
```

in <- outC

out -> inC

```
Socket clientSocket = null;
PrintWriter outC = null;
BufferedReader inC = null;


clientSocket = new Socket(args[0],
Integer.parseInt(args[1]));//SOCKET


//STABILIREA CONEXIUNII
//CONNECT = OUT2SERVER + INfromSERVER

//OUT2SERVER
outC = new PrintWriter(clientSocket.getOutputStream(), true);

//INfromSERVER
inC = new BufferedReader(new
InputStreamReader(clientSocket.getInputStream()));


String lin = "";
outC.println("As vrea sa ma conectez.");//SEND
lin = inC.readLine();                    //RECV
System.out.println("Sever: " + lin);
```

# 2. TCP/IP Network Programming

## HTTP Programming – RFC 2616:

```
Request       = Request-Line              ; Section 5.1
                *(( general-header        ; Section 4.5
                 | request-header         ; Section 5.3
                 | entity-header ) CRLF)  ; Section 7.1
                CRLF
                [ message-body ]          ; Section 4.3
```

5.1 Request-Line

The Request-Line begins with a method token, followed by the Request-URI and the protocol version, and ending with CRLF. The elements are separated by SP characters. No CR or LF is allowed except in the final CRLF sequence.

```
Request-Line   = Method SP Request-URI SP HTTP-Version CRLF
```

# 2. TCP/IP Network Programming

## HTTP Programming – RFC 2616:

5.1.1 Method

The Method token indicates the method to be performed on the resource identified by the Request-URI. The method is case-sensitive.

```
    Method          = "OPTIONS"                ; Section 9.2
                    | "GET"                    ; Section 9.3
                    | "HEAD"                   ; Section 9.4
                    | "POST"                   ; Section 9.5
                    | "PUT"                    ; Section 9.6
                    | "DELETE"                 ; Section 9.7
                    | "TRACE"                  ; Section 9.8
                    | "CONNECT"                ; Section 9.9
                    | extension-method
    extension-method = token
```

# 2. TCP/IP Network Programming

## HTTP Programming – RFC 2616:

| No. | Time | Source | Destination | Protocol | Info |
|---|---|---|---|---|---|
| 1 | 0.000000 | 10.10.10.66 | 72.14.221.104 | TCP | ttyinfo > http [SY |
| 2 | 0.046480 | 72.14.221.104 | 10.10.10.66 | TCP | http > ttyinfo [SY |
| 3 | 0.046535 | 10.10.10.66 | 72.14.221.104 | TCP | ttyinfo > http [AC |
| 4 | 0.100161 | 10.10.10.66 | 72.14.221.104 | HTTP | GET / HTTP/1.1 |
| 5 | 0.148781 | 72.14.221.104 | 10.10.10.66 | TCP | http > ttyinfo [AC |
| 6 | 0.156888 | 72.14.221.104 | 10.10.10.66 | TCP | [TCP segment of a |
| 7 | 0.157715 | 72.14.221.104 | 10.10.10.66 | TCP | [TCP segment of a |
| 8 | 0.157759 | 10.10.10.66 | 72.14.221.104 | TCP | ttyinfo > http [AC |
| 9 | 0.185421 | 72.14.221.104 | 10.10.10.66 | TCP | [TCP segment of a |
| 10 | 0.201321 | 72.14.221.104 | 10.10.10.66 | TCP | [TCP segment of a |
| 11 | 0.201368 | 10.10.10.66 | 72.14.221.104 | TCP | ttyinfo > http [AC |
| 12 | 0.201518 | 72.14.221.104 | 10.10.10.66 | TCP | [TCP segment of a |

```
⊞ Frame 4 (255 bytes on wire, 255 bytes captured)
⊞ Ethernet II, Src: Fujitsu_70:75:14 (00:17:42:70:75:14), Dst: Intel_e9:94:62 (00:02:b3:e9
⊞ Internet Protocol, Src: 10.10.10.66 (10.10.10.66), Dst: 72.14.221.104 (72.14.221.104)
⊞ Transmission Control Protocol, Src Port: ttyinfo (2012), Dst Port: http (80), Seq: 1, Ac
⊞ Hypertext Transfer Protocol
```

```
0000   00 02 b3 e9 94 62 00 17   42 70 75 14 08 00 45 00    .....b.. Bpu...E.
0010   00 f1 34 4f 40 00 80 06   8b f5 0a 0a 0a 42 48 0e    ..4O@... .....BH.
0020   dd 68 07 dc 00 50 1a 46   ca 97 b6 63 68 6e 50 18    .h...P.F ...chnP.
0030   ff ff 3a a6 00 00 47 45   54 20 2f 20 48 54 54 50    ..:...GE T / HTTP
0040   2f 31 2e 31 0d 0a 55 73   65 72 2d 41 67 65 6e 74    /1.1..Us er-Agent
0050   3a 20 4a 61 76 61 2f 31   2e 35 2e 30 5f 30 39 0d    : Java/1 .5.0_09.
0060   0a 48 6f 73 74 3a 20 77   77 77 2e 67 6f 6f 67 6c    .Host: w ww.googl
0070   65 2e 72 6f 0d 0a 41 63   63 65 70 74 3a 20 74 65    e.ro..Ac cept: te
0080   78 74 2f 68 74 6d 6c 2c   20 69 6d 61 67 65 2f 67    xt/html,  image/g
0090   69 66 2c 20 69 6d 61 67   65 2f 6a 70 65 67 2c 20    if, imag e/jpeg,
00a0   2a 3b 20 71 3d 2e 32 2c   20 2a 2f 2a 3b 20 71 3d    *; q=.2,  */*; q=
00b0   2e 32 0d 0a 43 6f 6e 6e   65 63 74 69 6f 6e 3a 20    .2..Conn ection:
00c0   6b 65 65 70 2d 61 6c 69   76 65 0d 0a 43 6f 6e 74    keep-ali ve..Cont
00d0   65 6e 74 2d 74 79 70 65   3a 20 61 70 70 6c 69 63    ent-type : applic
00e0   61 74 69 6f 6e 2f 78 2d   77 77 77 2d 66 6f 72 6d    ation/x- www-form
00f0   2d 75 72 6c 65 6e 63 6f   64 65 64 0d 0a 0d 0a       -urlenco ded....
```

Java Network Programming
for easy sharing

# Section Conclusions

Java Network Programming uses for UDP:

DatagramSocket and DatagramPacket classes on both server and client side.

Java Network Programming uses for TCP:

ServerSocket and Socket classes on server side.

Only Socket class on client side.

For both server and client, it is necessary to create byte/char Input (socket.getInputStream()) and Output (socket.getOutputStream()) streams between the Random Access Memory – RAM and the network communications channel.


Network Programming & Java Sockets

# Communicate & Exchange Ideas

Questions & Answers!

# But wait…

There's More!

# Thanks!

Java SE
End of Lecture 9 – Summary of Java SE & Network Programming