Week 7: Transport Layer

Internet Technologies COMP90007

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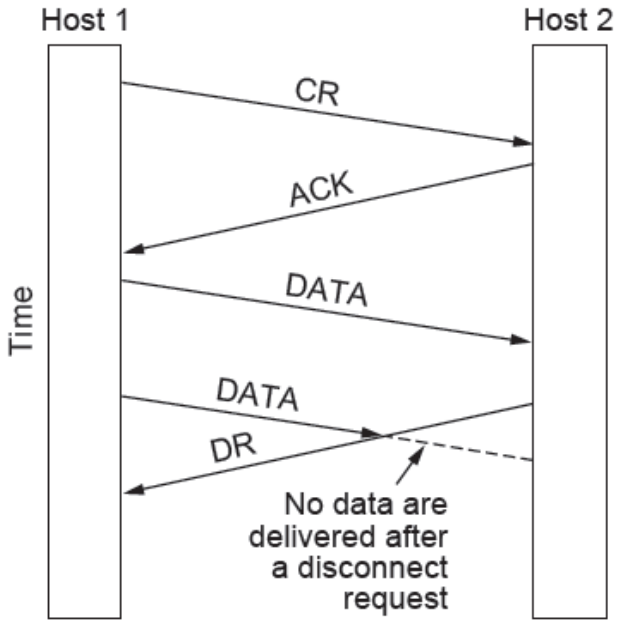
Connection Release

- Asymmetric Disconnection
  - Either party can issue a DISCONNECT, which results in DISCONNECT TPDU and transmission end in both directions
- Symmetric Disconnection
  - Both parties issue DISCONNECT, closing only one direction at a time – allows flexibility to remain in receive mode

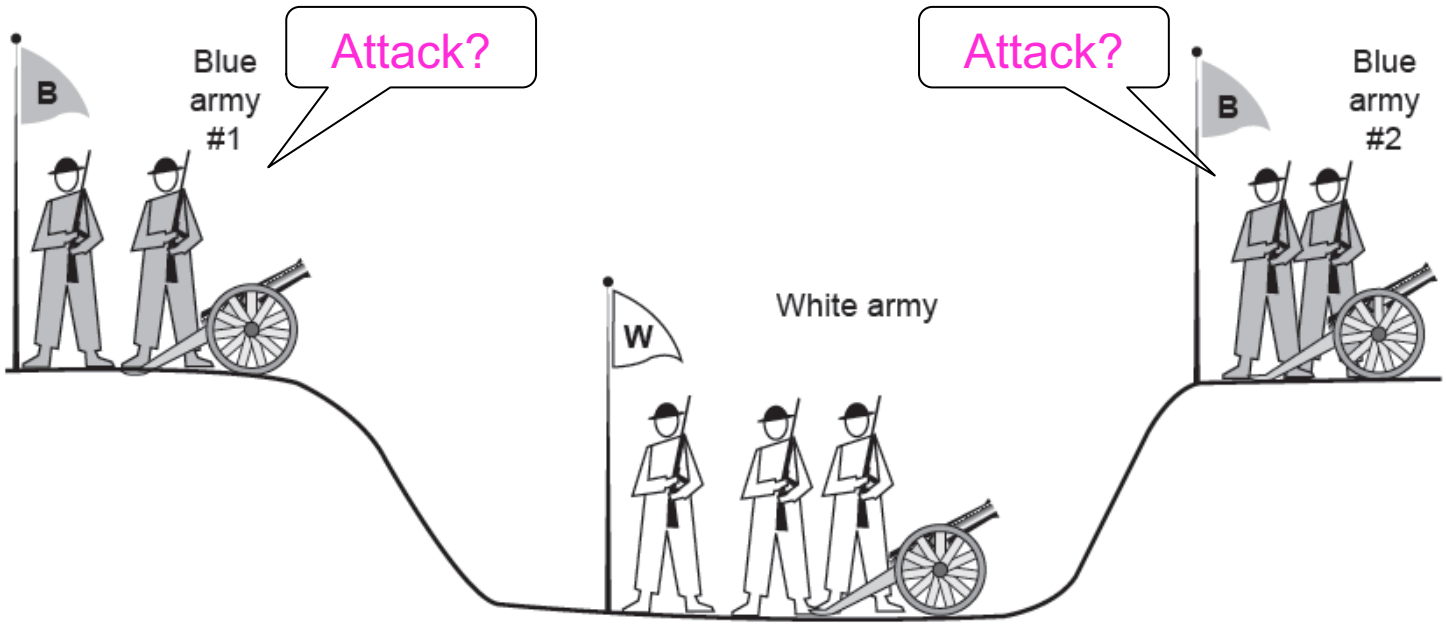
Connection Release (Cont.)

- Asymmetric vs Symmetric connection release types
- Asymmetric release may result in data loss hence symmetric release is more attractive
- Symmetric release works well where each process has a set amount of data to transmit and knows it has been sent



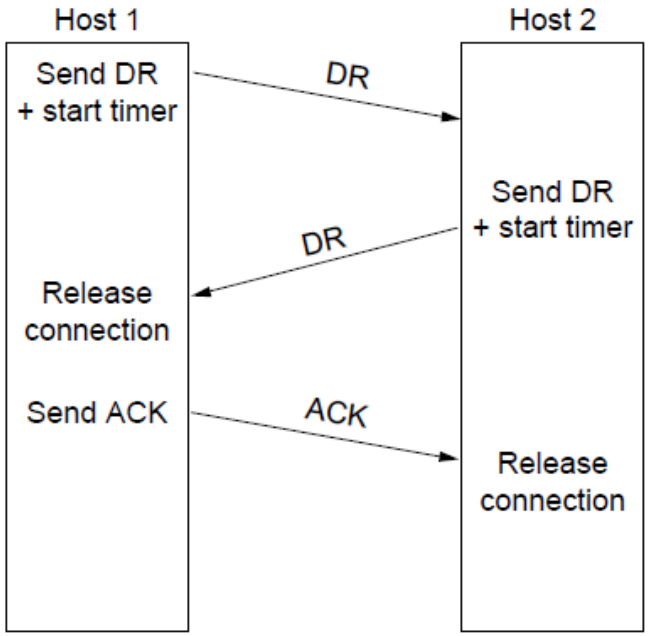
Generalizing the Connection Release Problem

- How do we decide the importance of the last message? Is it essential or not?
- No protocol exists which can resolve this ambiguity
  – Two-army problem shows pitfall of agreement



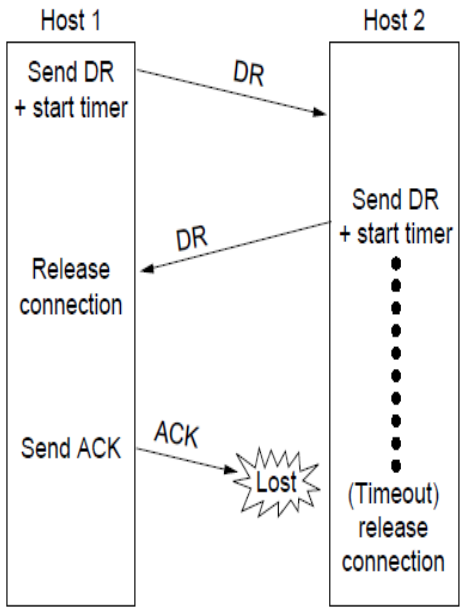
Strategies for Connection Release

- 3 way handshake
- Finite retry
- Timeouts
- Normal release sequence, initiated by transport user on Host 1
  - DR=Disconnect Request
  - Both DRs are ACKed by the other side

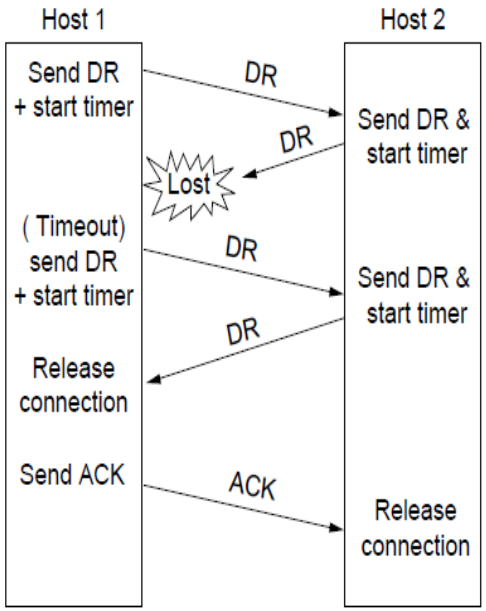


Connection Release (Error Cases)

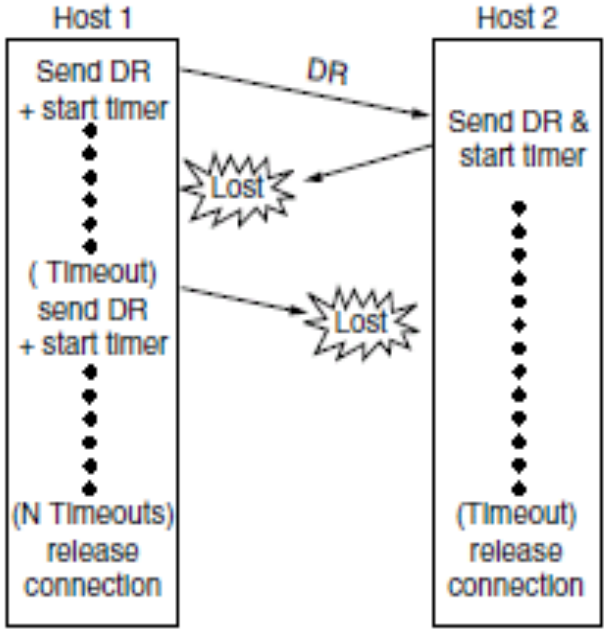
- Error cases are handled with timers and retransmission



Final ACK lost, Host 2 times out



Lost DR causes retransmissions

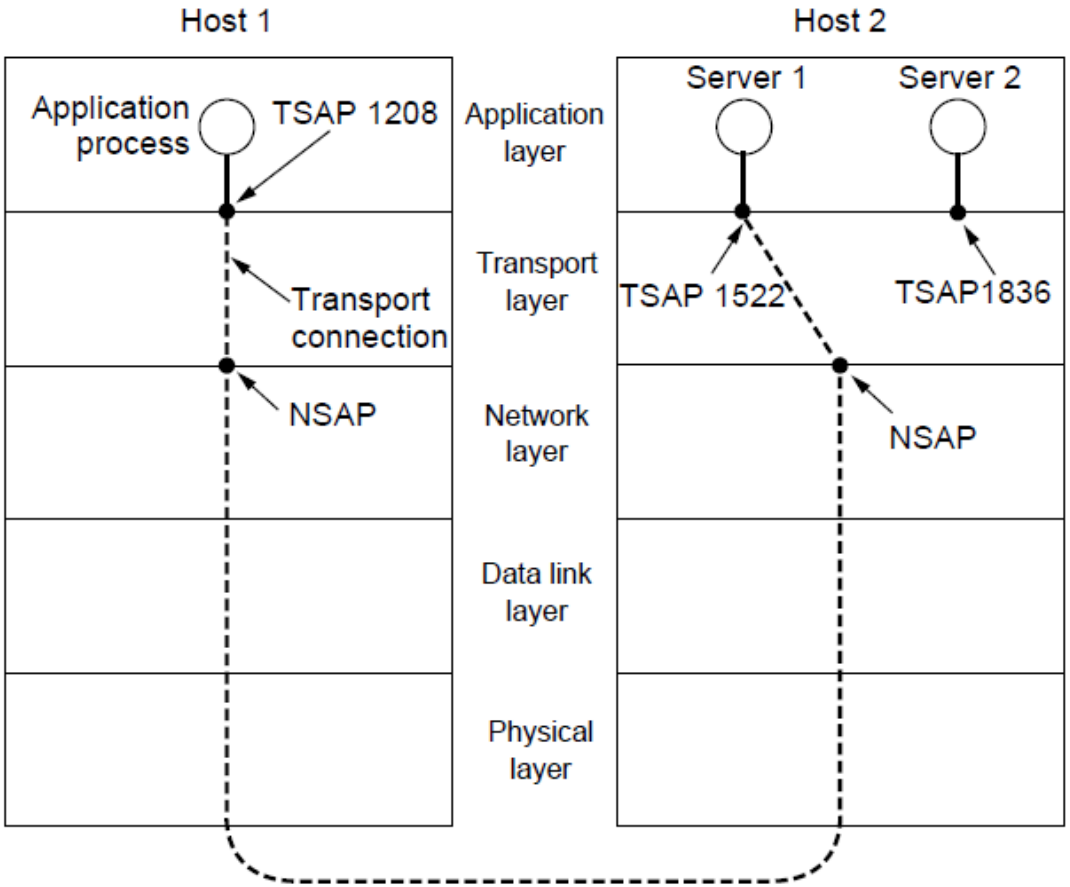


Extreme: Many lost DRs cause both hosts to timeout

Addressing

- Specification of **remote process to connect to** is required at application and transport layers
- Addressing in transport layer is typically done using **Transport Service Access Points** (TSAPs)
  - on the Internet, a TSAP is commonly referred to as a port (e.g. ***port*** 80)
- Addressing in the network layer is typically done using **Network Service Access Points** (NSAPs)
  - on the Internet, the concept of an NSAP is commonly interpreted as simply an ***IP address***

TSAPs, NSAPs and Transport Layer Connections Illustrated



Types of TSAP Allocation

1. Static
   - Well known services have standard allocated TSAPs/ports, which are embedded in OS
2. Directory Assistance – Port-mapper
   - A new service must register itself with the portmapper, giving both its service name and TSAP
3. Mediated
   - A process server intercepts inbound connections and spawns requested server and attaches inbound connection
   - cf. Unix /etc/(x)inetd

Programming using Sockets

- Sockets widely used for interconnections
  - “Berkeley" sockets are predominant in internet applications
  - Notion of “sockets” as transport endpoints
  - Like the simple set plus SOCKET, BIND, and ACCEPT

Primitive	Meaning
SOCKET	Create a new communication end point
BIND	Associate a local address with a socket
LISTEN	Announce willingness to accept connections; give queue size
ACCEPT	Passively establish an incoming connection
CONNECT	Actively attempt to establish a connection
SEND	Send some data over the connection
RECEIVE	Receive some data from the connection
CLOSE	Release the connection

Recall Example Pseudo Code

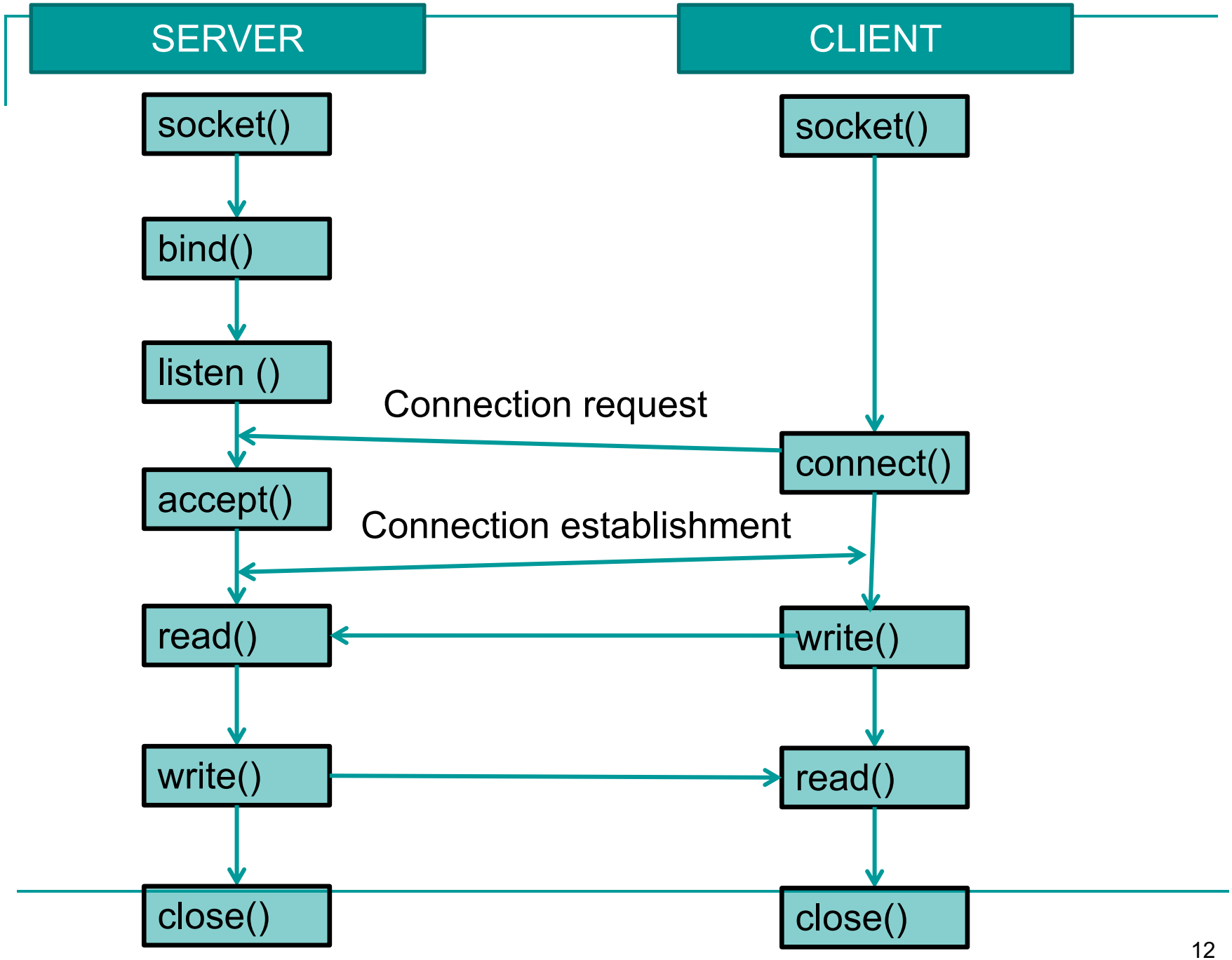
```
Socket A_Socket = createSocket("TCP");

connect(A_Socket, 128.255.16.0, 80);

send(A_socket, “My first message!”);

disconnect(A_socket);
```

… there is also a server component for this client that runs on another host…


SERVER
CLIENT
socket()
socket()
bind()
listen ()
Connection request
connect()
accept()
Connection establishment
read()
write()
write()
read()
close()
close()

Let's Look at the Code from the book (in a specific language)

Example from the book has more details but the essence is the same… This is the case in most languages…

```
s = socket(PF_INET, SOCK_STREAM, IPPROTO_TCP);
if (s <0) fatal("socket");
memset(&channel, 0, sizeof(channel));
channel.sin_family= AF_INET;
memcpy(&channel.sin_addr.s_addr, h->h_addr, h->h_length);
channel.sin_port= htons(SERVER_PORT);

c = connect(s, (struct sockaddr *) &channel, sizeof(channel));
```

Socket Example – Server Side

Server code. . .

```
memset(&channel, 0, sizeof(channel));
channel.sin_family = AF_INET;
channel.sin_addr.s_addr = htonl(INADDR_ANY);
channel.sin_port = htons(SERVER_PORT);

s = socket(AF_INET, SOCK_STREAM, IPPROTO_TCP);
if (s < 0) fatal("socket failed");
setsockopt(s, SOL_SOCKET, SO_REUSEADDR, (char *) &on, sizeof(on));
b = bind(s, (struct sockaddr *) &channel, sizeof(channel));
if (b < 0) fatal("bind failed");
l = listen(s, QUEUE_SIZE);
if (l < 0) fatal("listen failed");
```

Assign address

Prepare for incoming connections

. . .

Server Code Contd

Block waiting for the next connection

```
while (1) {
    sa = accept(s, 0, 0);
    if (sa < 0) fatal("accept failed");

    read(sa, buf, BUF_SIZE);

    /* Get and return the file. */
    fd = open(buf, O_RDONLY);
    if (fd < 0) fatal("open failed");

    .....
```

Read (receive) request

The server can also create a new thread to handle the connection on the new socket and go back to waiting for the next connection on the original socket…

An Example on Multi-Threading

```
ServerSocket serverSocket = new ServerSocket([parameters]);

While (true) {
        Socket socket = serverSocket.accept();
        MultiThreadMyServer server = new MultiThreadMyServer();
        server.setMyService([some more parameters]);
        server.setSocket(socket);
        new Thread(server).start();
    ....
```

- *(Code from OO Programming with Java; Chp. 14)*

More info on threads…

```
class MultiThreadMyServer extends Thread {
        int somedata;
        MultiThreadMyServer() {
            this.somedata = …;
            …
        }

            … more methods here

        public void run() {
             . . .
        }
    }
```

Looking under the hood for Transport Layer Services…

- The **most basic** is actually connectionless:
  - Called: **User Datagram Protocol (UDP)**
  - Does **not add much to the Network Layer** functionality
  - TCP we just does the real-deal for this layer, *reliability*…
  - For UDP: Just remove connection primitives to use it in a program
  - **UDP good for?:**
    - It is used for apps like video streaming/gaming regularly
  - **The reliability issue is left to?:**
    - the application layer… retransmission decisions as well as congestion control

New Code: UDP Client…

```
public static void main(String args[]) {
        ….
        DatagramSocket mySocket = new
                DatagramSocket();
        mySocket.send([data,address, etc
                parameters]);
        …
}
```

Server Side: UDP Example Contd

```
public static void main(String args[]) {
        ….
        DatagramSocket server = new
                DatagramSocket(port);
        while (true) {
                server.receive([parameters]);
                …
        }}
```