

CS 580 Client-Server Programming
Spring Semester, 2007
Doc 3 Intro to Client-Server
Jan 30, 2006

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Network Overview

UDP

Messages divided into packets

Fast

Each packet routed separately

Packets are treated individually
Packets may arrive out of order
Packets may be lost

Routing Issues

Client & Server must handle resulting problems

Overhead issues

Used by:

Games
NFS

TCP

Handles lost packets

Handles packet order

TCP has delays

Starting of connection
Closing of connection
Resending packets

IP Addresses

IP address is currently a 32-bit number

130.191.3.100 (Four 8 bit numbers)

IPv6 uses 128 bit numbers for addresses

105.220.136.100.0.0.0.0.0.0.18.128.140.10.255.255

69DC:8864:0:0:0:1280:8C0A:FFFF

69DC:8864::1280:8C0A:FFFF

Machines on a network need a unique IP address

What is the difference between
MAC address
IP address

Domain Name System (DNS)

Maps machine names to IP addresses

Internet Corporation for Assigned Names and Numbers (ICANN <http://www.icann.org/>) oversees assigning TLDs

Unix "host" command

Shows mapping between machine names and IP address

```
->host rohan.sdsu.edu
```

```
rohan.sdsu.edu has address 130.191.3.100
```

```
->host 130.191.3.100
```

```
100.3.191.130.IN-ADDR.ARPA domain name pointer rohan.sdsu.edu
```

Ports

TCP/IP supports multiple logical communication channels called ports

Ports are numbered from 0 - 65535

A connection between two machines is uniquely defined by:

- Protocol (TCP or UDP)

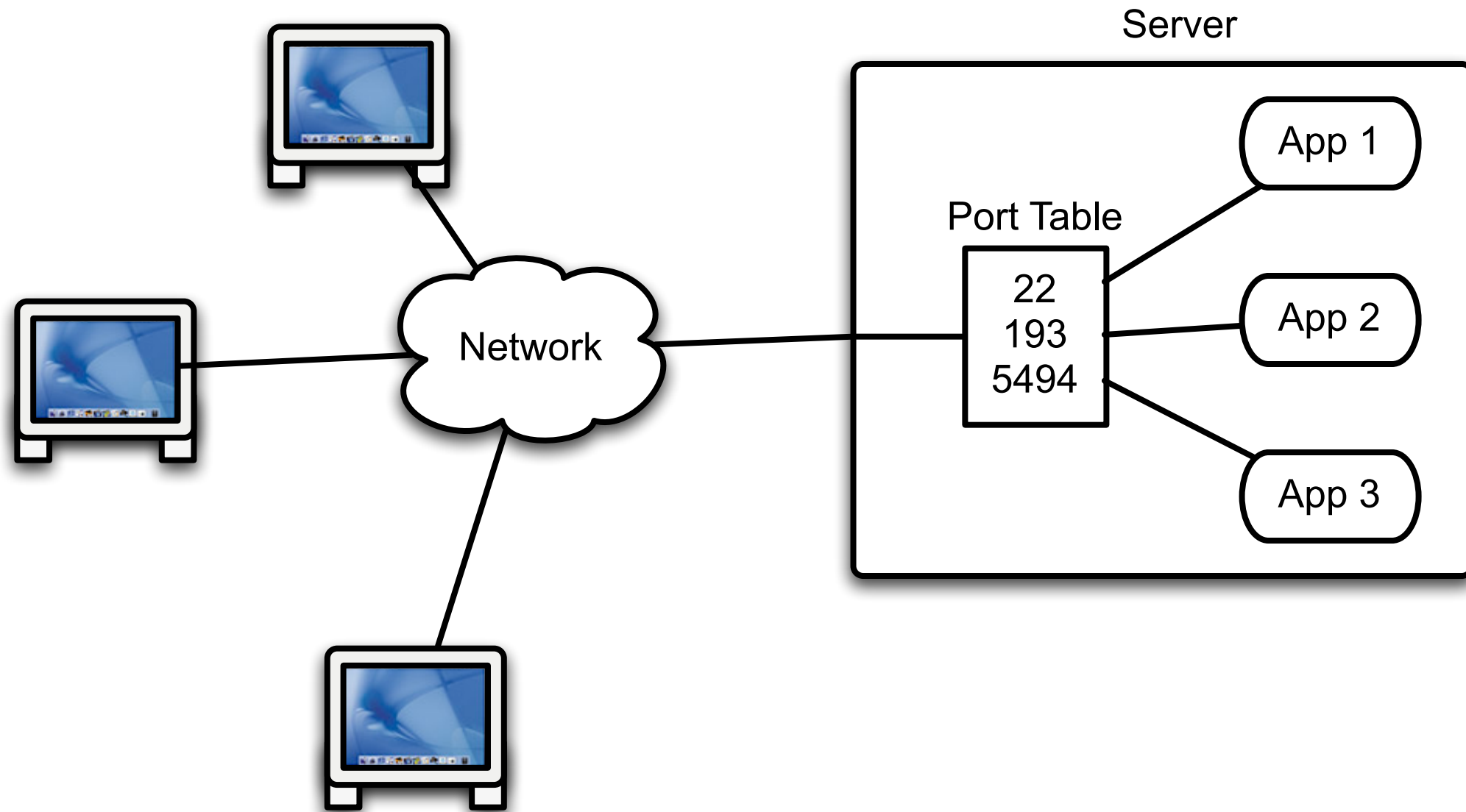
- IP address of local machine

- Port number used on the local machine

- IP address of remote machine

- Port number used on the remote machine

How Ports Work



Some Port Numbers

Well known Ports	1-1023
Registered Ports	1024-49151
Dynamic/Private Ports	49152-65535

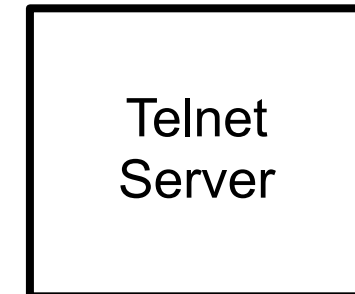
For a local list of services
`file://rohan.sdsu.edu/etc/services`

For a complete list see:
<http://www.iana.org/assignments/port-numbers>

See IANA numbers page <http://www.iana.org/numbers.html> for more information about protocol numbers and assignment of services

Service	Port
echo	7
discard	9
ftp	21
ssh	22
telnet	23
smtp	25
time	37
http	80
pop	110
https	443
doom	666
mysql	3306
postgresql	5432
gnutella	6346 6347

What is Telnet?



Protocol

Send text between client & server

Server

Requests login

Sends text to shell to be executed

Returns result of commands

Client

Transfers text between user and server

Telnet & Other Text-based Protocols

```
rohan 37 -> telnet www.eli.sdsu.edu 80
GET /courses/spring06/cs580/index.html HTTP/1.0 <CR>
<CR>
```

Note <CR> indicates where you need to hit return

```
rohan 38->telnet cs.sdsu.edu 110
Trying 130.191.226.116...
Connected to cs.sdsu.edu.
Escape character is '^]'.
+OK QPOP (version 3.1.2) at sciences.sdsu.edu starting.
USER whitney
+OK Password required for whitney.
PASS typeYourPasswordHere
+OK whitney has 116 visible messages (0 hidden) in 640516 octets.
```

Simple Date Example - Protocol

Client Commands	Server Response
"date" ended by line feed "date\n"	current date ended by line feed "January 30, 2007\n"
"time" ended by line feed "time\n"	Current time ended by line feed "6:58 pm\n"

Server listens for an incoming request

On request

- reads command
- returns response
- closes connection

On client errors - action not specified

Beware

Can only send bytes across network

Client & server maybe different hardware platforms

What is a newline?

End-of-file indicates connection is closed

Sample Java Client

```
import java.io.*;
import java.net.Socket;

class DateClient {
    String server;
    int port;

    public DateClient(String serverAddress, int port) {
        server = serverAddress;
        this.port = port;
    }

    public String date() {
        return send("date\n");
    }

    public String time() {
        return send("time\n");
    }
}
```

Java Client Continued

```
private String send(String text) {
    try {
        Socket connection = new Socket(server, port);
        OutputStream rawOut = connection.getOutputStream();
        PrintStream out = new PrintStream(new BufferedOutputStream(rawOut));
        InputStream rawIn = connection.getInputStream();
        BufferedReader in = new BufferedReader(new InputStreamReader
(rawIn));

        out.print(text);
        out.flush();
        String answer = in.readLine();
        out.close();
        in.close();
        return answer;
    }
    catch (IOException e) {
        return "Error in connecting to server";
    }
}
}
```

Running the Client

```
System.out.println("hi");  
DateClient client = new DateClient("127.0.0.1", 4444);  
System.out.println( client.date());  
System.out.println( client.time());
```

Issue - Avoid Small Packets

```
OutputStream rawOut = connection.getOutputStream();  
PrintStream out = new PrintStream(new BufferedOutputStream(rawOut));
```


Issue - Actually Send the request

```
out.flush();
```

Issue - Client will not work on all platforms

```
String answer = in.readLine();
```

Don't Do this

```
String answer = in.readLine();
```

Issue - Close the connection when done

```
out.close();  
in.close();
```

Issue - Testing

How does one test the client?

Issue - Background material

Java

Streams

Read Chapter 4

Sockets

Read Chapter 10

Java Network Programming, Harold 3rd Ed

Ruby Client

Running the client

```
require 'socket'

class DateClient
  def initialize(serverAddress, port)
    @server = serverAddress
    @port = port
  end

  def date()
    send("date\n")
  end

  def time()
    send("time\n")
  end

  private
  def send(text)
    connection = TCPSocket.new(@server, @port)
    connection.send(text, 0)
    answer = connection.gets("\n")
    connection.close
    answer
  end
end
```

```
client = DateClient.new("127.0.0.1", 4444)
puts client.date
puts client.time
```

Issues - Using Standard IO Methods

```
def send(text)
  connection = TCPSocket.new(@server, @port)
  connection.print(text)
  connection.flush
  answer = connection.gets("\n")
  connection.close
  answer
end
```


Ruby Background

Sockets

Read IPSocket & TCPSocket in Appendix A

IO

Chapter 10 Basic Input & Output
Class IO documentation (pp 503-515)

Programming Ruby, Thomas, 2'ed

Server

Basic Algorithm

```
while (true) {  
    Wait for an incoming request;  
    Perform whatever actions are requested;  
}
```

Basic Server Issues

- How to wait for an incoming request?
- How to know when there is a request?
- What happens when there are multiple requests?
- How do clients know how to contact server?
- How to parse client request?
- How do we know when the server has the entire request?

Java Date Server

```
public class DateServer {
    private static Logger log = Logger.getLogger("dateLogger");

    public static void main (String args[]) throws IOException {
        ProgramProperties flags = new ProgramProperties( args);
        int port = flags.getInt( "port" , 8765);
        new DateServer().run(port);
    }

    public void run(int port) throws IOException {
        ServerSocket input = new ServerSocket( port );
        log.info("Server running on port " + input.getLocalPort());

        while (true) {
            Socket client = input.accept();
            log.info("Request from " + client.getInetAddress());
            processRequest(
                client.getInputStream(),
                client.getOutputStream());
            client.close();
        }
    }
}
```

Java Date Server Continued

```
void processRequest(InputStream in,OutputStream out)
    throws IOException {

    BufferedReader parsedInput =
        new BufferedReader(new InputStreamReader(in));

    boolean autoflushOn = true;
    PrintWriter parsedOutput = new PrintWriter(out,autoflushOn);

    String inputLine = parsedInput.readLine();

    if (inputLine.startsWith("date")) {
        Date now = new Date();
        parsedOutput.println(now.toString());
    }
}
}
```

This server needs work

Starting the Server

```
rohan 16-> java -jar DateServer.jar  
Feb 19, 2004 10:56:59 AM DateServer run  
INFO: Server running on port 8765
```

Ruby Date Server

```
require 'socket'
```

```
class DateServer
```

```
  def initialize(port)
```

```
    @port = port
```

```
  end
```

```
  def run()
```

```
    server = TCPServer.new( @port)
```

```
    puts("start " + @port.to_s)
```

```
    while (session = server.accept)
```

```
      Thread.new(session) do |connection|
```

```
        process_request_on(connection)
```

```
        connection.close
```

```
      end
```

```
    end
```

```
  end
```

```
  private
```

```
  def process_request_on(socket)
```

```
    request = canonical_form( socket.gets("\n") )
```

```
    now = Time.now
```

```
    answer = case request
```

```
      when 'time'
```

```
        now.strftime("%X")
```

```
      when 'date'
```

```
        now.strftime("%X")
```

```
      else
```

```
        "Invalid request"
```

```
      end
```

```
      socket.send(answer + "\n",0)
```

```
    end
```

```
  def canonical_form(string)
```

```
    string.lstrip.rstrip.downcase
```

```
  end
```

```
end
```

Issue - Date Format

What format does the server use for time and date?

Clients need to know so can parse them