CSCE 463/612
Networks and Distributed Processing
Fall 2024

Preliminaries II

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August 22, 2024

Agenda

- Homework #1
  - HTTP basics
  - Windows sockets

HTTP Basics

1) Find # using strchr() and truncate
2) Find ?, extract query, truncate
3) Find /, extract path, truncate
4) Find :, extract port, truncate, obtain host

- General URL format:
  - Optional elements shown in square brackets

```
scheme://[user:pass@]host[:port][/path][?query][#fragment]
```

- No need to parse username/password in this homework, but you have to strip off the fragment and extract the port number from the host
  - If the path is not present, must use root "/" in its place
- HTTP request is [/path][?query]

```
URL = http://google.com
```

```
Request /
```

```
URL = http://tamu.edu:8080/cs/in:dex.php?test=1#something
```

```
Request /cs/in:dex.php?test=1
```

```
URL = http://tamu.edu?test=1/blah
```

```
Request /?test=1/blah
```

```
URL = http://tamu.edu?tes:t=1/blah
```

```
Request /?tes:t=1/blah
```

HTTP Basics 2

minimal request

```
METHOD request HTTP/version\r\n
\r\n
```

- HTTP request message
  - Begins with the method line, followed by (field: value) pairs
  - Ends with an empty line
- Methods in hw1
  - GET and HEAD, same syntax
- HTTP responses
  - Status line begins with HTTP/
  - Status codes are 3-digit integers

```
GET /courses/ HTTP/1.0\r\n
Host: irl.cs.tamu.edu\r\n
Connection: close\r\n
\r\n
```

status line →

HTTP header

empty line →

object

```
HTTP/1.1 200 OK\r\n
Cache-Control: private\r\n
Content-Type: text/html\r\n
Server: Microsoft-IIS/7.0\r\n
X-Powered-By: ASP.NET\r\n
MicrosoftOfficeWebServer: 5.0_Pub\r\n
MS-Author-Via: MS-FP/4.0\r\n
Date: Thu, 17 Jan 2013 09:22:34 GMT\r\n
Connection: close\r\n
Content-Length: 16367\r\n
\r\n
<html>
<head>
<meta http-equiv="Content-Language"
content="en-us"> <meta http-
equiv="Content-Type"
content="text/html; charset=windows-
1252">...
```

Agenda

- Homework #1
  - HTTP basics
  - Windows Sockets

Windows Sockets

- Sockets are interfaces to the TCP/IP protocol stack
  - More on TCP and IP later in the semester
  - HTTP (hw1) uses TCP
  - Sockets identified by their handle
- Communication using sockets is accomplished by a set of system calls to Winsock
  - Winsock is the Windows implementation of sockets
  - Parts are identical to Berkeley sockets on Unix
- TCP sockets can be used in two modes:
  - Client (socket actively establishes outgoing connections)
  - Server (socket listens for incoming connections)

Windows Sockets 2

- IP address: uniquely identifies the host to be contacted
  - 4-byte number, often written with a dot between each byte
  - How to assign IP 128.194.135.60 to an integer in C++?
- Localhost has IP address 127.0.0.1
- What if multiple network applications need to be run simultaneously on one host?
- Solution: ports
  - Each socket can be bound to a unique port
  - Socket = OS handle, port = externally visible identifier
  - The OS forwards incoming messages to sockets based on ports they are bound to

Windows Sockets 3

- Ports are 2-byte unsigned integers
  - Port 0 reserved, 1-1023 are system; 1024-65535 user
- Some well-known ports
  - HTTP: 80 (sometimes also 8000 or 8080)
  - Telnet: 23
  - SSH: 22
  - SMTP: 25 (encrypted SMTP on 465, 587)
- See http://www.iana.org/assignments/port-numbers
- When issuing a connect, the OS implicitly binds the socket to the next available port
  - Clients do not need to worry about their port numbers
  - But explicit binding is mandatory for servers

Example (Windows)

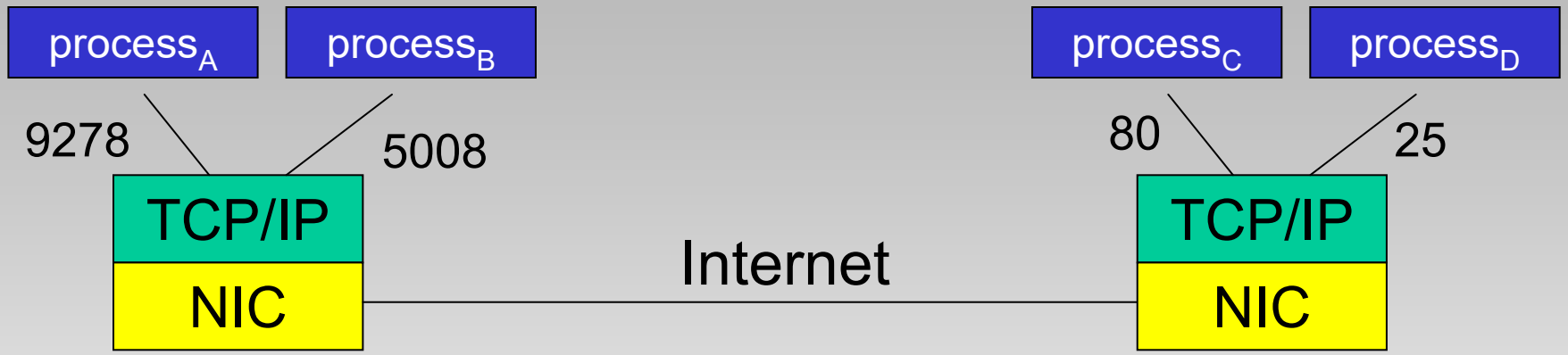
- Use “netstat –a” to see open ports on your host

```
Proto  Local Address          Foreign Address                State
TCP    viper:echo             viper:0                        LISTENING
TCP    viper:discard          viper:0                        LISTENING
TCP    viper:daytime          viper:0                        LISTENING
TCP    viper:qotd             viper:0                        LISTENING
TCP    viper:chargen          viper:0                        LISTENING
TCP    viper:epmap            viper:0                        LISTENING
TCP    viper:microsoft-ds     viper:0                        LISTENING
TCP    viper:netbios-ssn      viper:0                        LISTENING
TCP    viper:3713             imap.cs.tamu.edu:pop3          TIME_WAIT
TCP    viper:3717             google.com:http                ESTABLISHED
TCP    viper:3718             google.com:http                ESTABLISHED

TCP    viper:38209            nyc-113-77-11-99.comcast.com:12876   ESTABLISHED
```

P2P application (BitTorrent) or possibly hacker

Windows Sockets 4



- Winsock requires initialization (unlike Unix)
  - This should be done before any other winsock calls
  - Once per program execution

```
#include <windows.h>
WSADATA wsaData;
WORD wVersionRequested = MAKEWORD(2,2);
if (WSAStartup(wVersionRequested, &wsaData) != 0)
{
    printf("WSAStartup error %d\n", WSAGetLastError());
    exit(-1);
}
```

Agenda

- HTTP basics
- Windows sockets
  - Clients

Clients

See the 463-sample.zip project on course website

- Steps to writing a TCP client:
  - Open a socket
  - Determine the IP address of the server in URL
  - Initiate connection with the server
  - Send request
  - Receive response
  - Close socket
- Task 1: open/close a TCP socket
  - Sockets are initially unbound (i.e., no port associated)

```
SOCKET sock = socket(AF_INET, SOCK_STREAM, IPPROTO_TCP);
if (sock == INVALID_SOCKET)
{
    printf("socket() error %d\n", WSAGetLastError());
    exit(-1);
}
...
closesocket (sock);
```

Clients 2

http://128.194.135.72/page.htm
http://irl.cs.tamu.edu/page.htm

- Task 2: determine the IP address of the server in URL
- First assume the server is specified by an IP address
  - Try converting to 4-byte int using `inet_addr(host);`
- If this fails, then the server is given by its hostname
  - Use the domain name system (DNS)
  - DNS resolves fully-qualified domain names (FQDN) such as www.tamu.edu to their IP addresses (165.91.22.70)
- DNS lookup performed through a system call
  - `struct hostent* remote = gethostbyname(host);`
  - Returns 4-byte IP addresses inside the structure

Clients 3

- Task 3: connect socket to server on given port

```
struct sockaddr_in server;

server.sin_family = AF_INET;            // IPv4
server.sin_addr = ...                   // from inet_addr or gethostbyname
server.sin_port = ...                   // port #

if (connect (sock, (struct sockaddr*) &server,
                    sizeof(struct sockaddr_in)) == SOCKET_ERROR)
{
          printf ("Connection error: %d\n", WSAGetLastError());
          return;
}
```

- Main caveat is that all numbers must be in network byte order (MSB first)
  - Forward (host-to-network): `htons(), htonl()`
  - Reverse (network-to-host): `ntohs(), ntohl()`
- inet_addr and gethostbyname internally perform this, so usually only port # needs explicit conversion

Clients 4

- Task 4: send request conforming to correct protocol

```
char *sendBuf = new char [requestLength + 1];  // +1 for NULL
// place request into buf (e.g., sprintf)
if (send (sock, sendBuf, requestLen, 0) == SOCKET_ERROR)
{
          printf ("Send error: %d\n", WSAGetLastError());
          return;
}
```

- Task 5: receive response into recvBuf
  - Data arrives in chunks from function recv(), needs to be appended to a character buffer
- Size of message and each chunk is unknown a-priori
  - Recv() must be called repeatedly until it returns 0 bytes
  - Use a pointer that moves along receive buffer
  - Buffer starts from 4-8 KB and is resized dynamically to accommodate longer messages