CSE 333

Lecture 17 -- server sockets

Hal Perkins

Department of Computer Science & Engineering

University of Washington

Administrivia

It's crunch time!

- HW3 due tomorrow, but lots of work to do still, so...
- Let's give everyone a 5th late day to work with
  - Cutoff for HW3 is still Sat. night (otherwise we'll be in real trouble when the quarter ends in a couple of weeks), but...
  - Most groups should have 2 late days or more per person to use now
- HW4 out this Friday or Saturday, due last Wed. of quarter but with late days, however 2nd exam is last Friday of the summer qtr.

Office hours today, 3:30, Perkins in CSE 548

Sections tomorrow: optional help session - no new topics

Today

Network programming

- server-side programming

Remember from client sockets

We had a client open a TCP connection to a server using the sockets API

- there were five steps:
  1. figure out the address and port to which to connect
  2. create a socket
  3. connect the socket to the remote server
  4. read and write data using the socket
  5. close the socket

Servers

Pretty similar to clients, but with additional steps

- there are seven steps:
  1. figure out the **address and port** on which to listen
  2. create a **socket**
  3. **bind** the socket to the address and port on which to listen
  4. indicate that the socket is a **listen**ing socket
  5. **accept** a connection from a client
  6. **read** and **write** to that connection
  7. **close** the connection

Accepting a connection from a client

Step 1. Figure out the address and port on which to listen.

Step 2. Create a socket.

Step 3. **Bind** the socket to the address and port on which to listen.

Step 4. Indicate that the socket is a **listening** socket.

Servers

Servers can have multiple IP addresses

- "multihomed"
- usually have at least one externally visible IP address, as well as a local-only address (127.0.0.1)

When you bind a socket for listening, you can:

- specify that it should listen on all addresses
  - by specifying the address "INADDR_ANY" -- a.k.a. 0.0.0.0
- specify that it should listen on a particular address

bind( )

The “bind( )” system call associates with a socket:

- an address family
  - AF_INET: IPv4
  - AF_INET6: IPv6
- a local IP address
  - the special IP address INADDR_ANY (also known as “0.0.0.0”) means “all local IP addresses of this host”
- a local port number

listen( )

The “listen( )” system call tells the OS that the socket is a listening socket to which clients can connect

- you also tell the OS how many pending connections it should queue before it starts to refuse new connections
  - you pick up a pending connection with “accept( )”
- when listen returns, remote clients can start connecting to your listening socket
  - you need to “accept( )” those connections to start using them

Server socket, bind, listen

see server_bind_listen.cc

Accepting a connection from a client

Step 5. **Accept** a connection from a client.

Step 6. read( ) and write( ) to the client.

Step 7. close( ) the connection.

accept( )

The “accept( )” system call waits for an incoming connection, or pulls one off the pending queue

- it returns an active, ready-to-use socket file descriptor connected to a client
- it returns address information about the peer
  - use inet_ntop( ) to get the client’s printable IP address
  - use getnameinfo( ) to do a **reverse DNS lookup** on the client

Server accept, read/write, close

see server_accept_rw_close.cc

Something to note...

Our server code is not concurrent

- single thread of execution
- the thread blocks waiting for the next connection
- the thread blocks waiting for the next message from the connection

A crowd of clients is, by nature, concurrent

- while our server is handling the next client, all other clients are stuck waiting for it

A few tools

Some useful linux commands

- dig – dns lookup
- nc – netcat swiss army knife (nc -l to listen, nc to send, much else)
- telnet – simple remote terminal program
- ping – check whether remote host is alive, get timings
- traceroute – show hops to ip address
- netstat -i – lots of info about network ports

Some resources

Online tutorials (among many...)

- http://beej.us/guide/bgnet/output/html/singlepage/bgnet.html
- http://www.alandix.com/academic/tutorials/tcpip/TCP-IP-complete.pdf

Books

- Unix Network Programming, Stevens et al, 3rd ed, A-W 2004
- Linux Programming Interface, Kerrisk
  - *everything* you might want to know about Linux, including sockets
  - If you want a copy, go to author's web site http://man7.org/tlpi/ to get discount code, then order from publisher. Paper and ebook versions.

Exercise 1

Write a program that:

- creates a listening socket, accepts connections from clients
  - reads a line of text from the client
  - parses the line of text as a DNS name
  - does a DNS lookup on the name
  - writes back to the client the list of IP addresses associated with the DNS name
  - closes the connection to the client

Exercise 2

Write a program that:

- creates a listening socket, accepts connections from clients
  - reads a line of text from the client
  - parses the line of text as a DNS name
  - connects to that DNS name on port 80
  - writes a valid HTTP request for "/"
    - see next slide for what to write
  - reads the reply, returns the reply to the client

Exercise 2 continued

Here's a valid HTTP request to server www.foo.com

- note that lines end with '\r\n', not just '\n'

```
GET / HTTP/1.0\r\n
Host: www.foo.com\r\n
Connection: close\r\n
\r\n
```

See you next time!