Sockets Programming

CS144 Review Session 1

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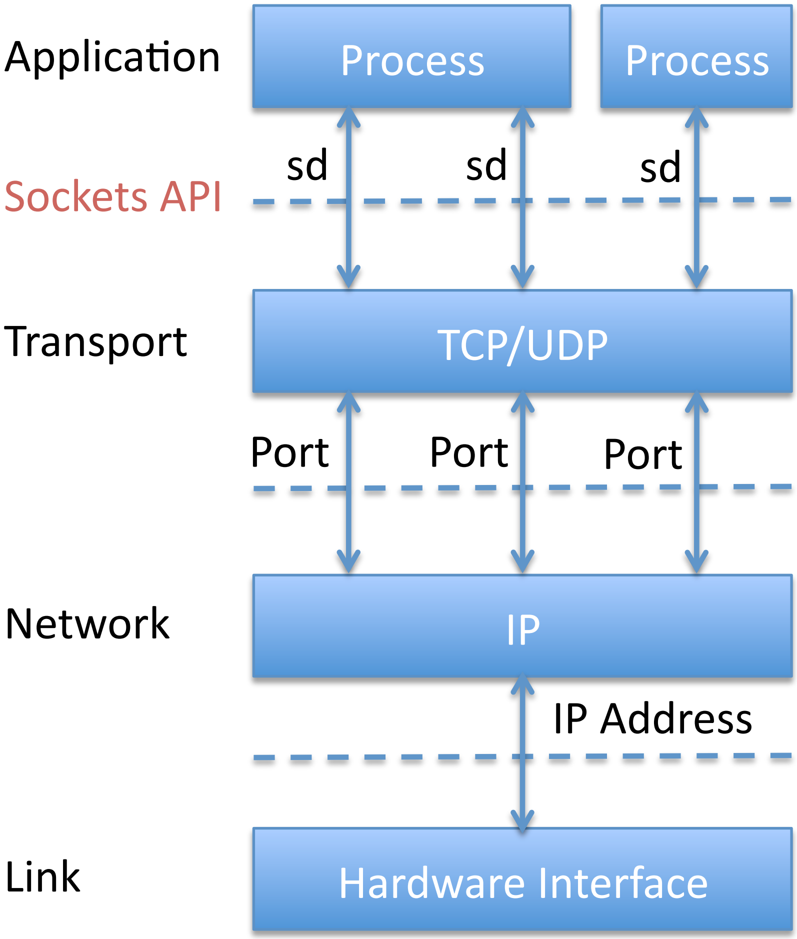
Announcements

- New classroom for lecture
  - 200-034, MW 4:15-5:30
- Simple client assignment due Wednesday, 4/9
- Use newsgroup for general questions
  - su.class.cs144
  - Refresh your newsgroup list from the server if you can't find it

Simple Client Overview

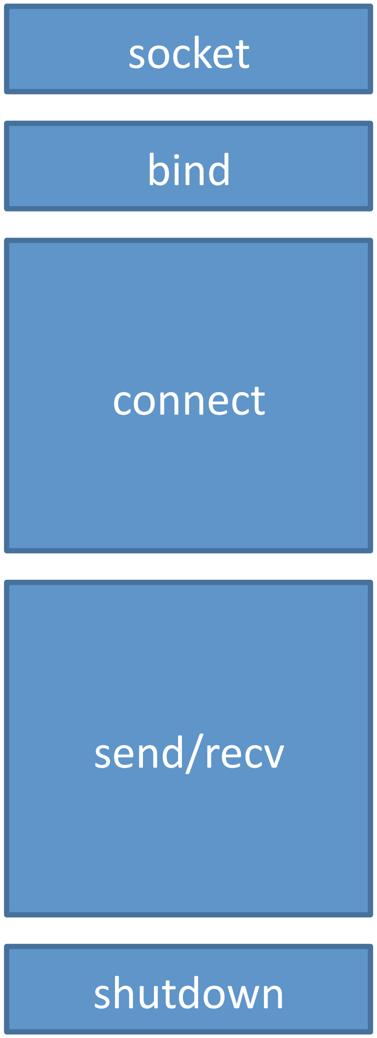
- Opens TCP socket to other host
  - Does DNS lookup if necessary
- Reads request from command line, appending "\r\n", and sends it through the socket
- Echoes response to stdout
- Demo: Sending HTTP request to SCS homepage
  - ./sc www.scs.stanford.edu 80 "GET /"

Sockets and TCP/IP



- In TCP/IP:
  - Endpoint has unique (TCP port, IP address) pair
  - Connection between two endpoints is identified by the pair [(IP, port)$_{src}$, (IP, port)$_{dst}$]
- All Unix I/O streams are referenced by descriptors
  - Socket maps a descriptor to an endpoint
  - Connecting sockets allows us to connect endpoints and do I/O

Socket API for Client



```
int socket(int domain, int type, int protocol)
```

- Returns a descriptor associated with a new endpoint

```
int bind(int sd, struct sockaddr *addr,
   u_int addr_len)
```

- Set addr/port of endpoint for socket descriptor sd
- Optional for client (lets the kernel choose some available port with the default IP address)

```
int connect(int sd, struct sockaddr *addr,
   u_int addr_len)
```

- Connect to destination address + port endpoint

```
int send(int sd, void *buf, int len, int flags)
int recv(int sd, void *buf, int len, int flags)
```

- Two-way communication

```
int shutdown(int sd, int how)
```

- Partial or complete connection teardown

Sockets API for Server

```
int socket(int, int, int)
```

```
int bind(int, struct sockaddr *,
   u_int)
```

```
int listen(int sd, int backlog)
```

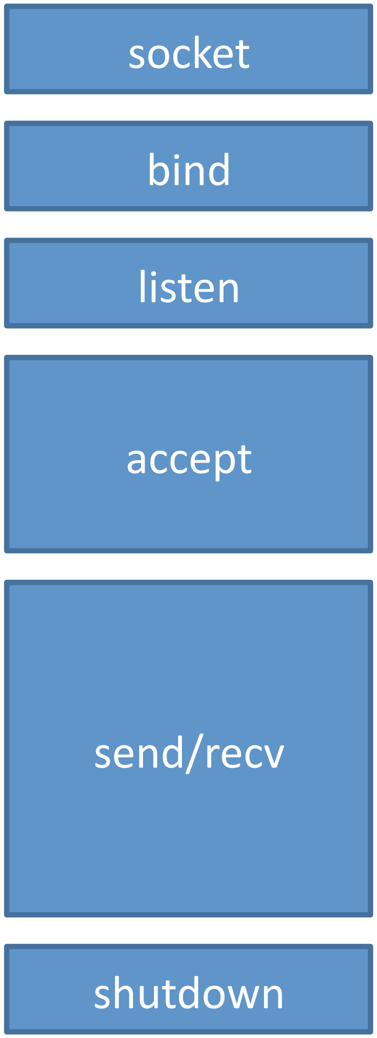
- Wait for a client to connect to this port

```
int accept(int sd, struct sockaddr
   *addr, u_int *addr_len)
```

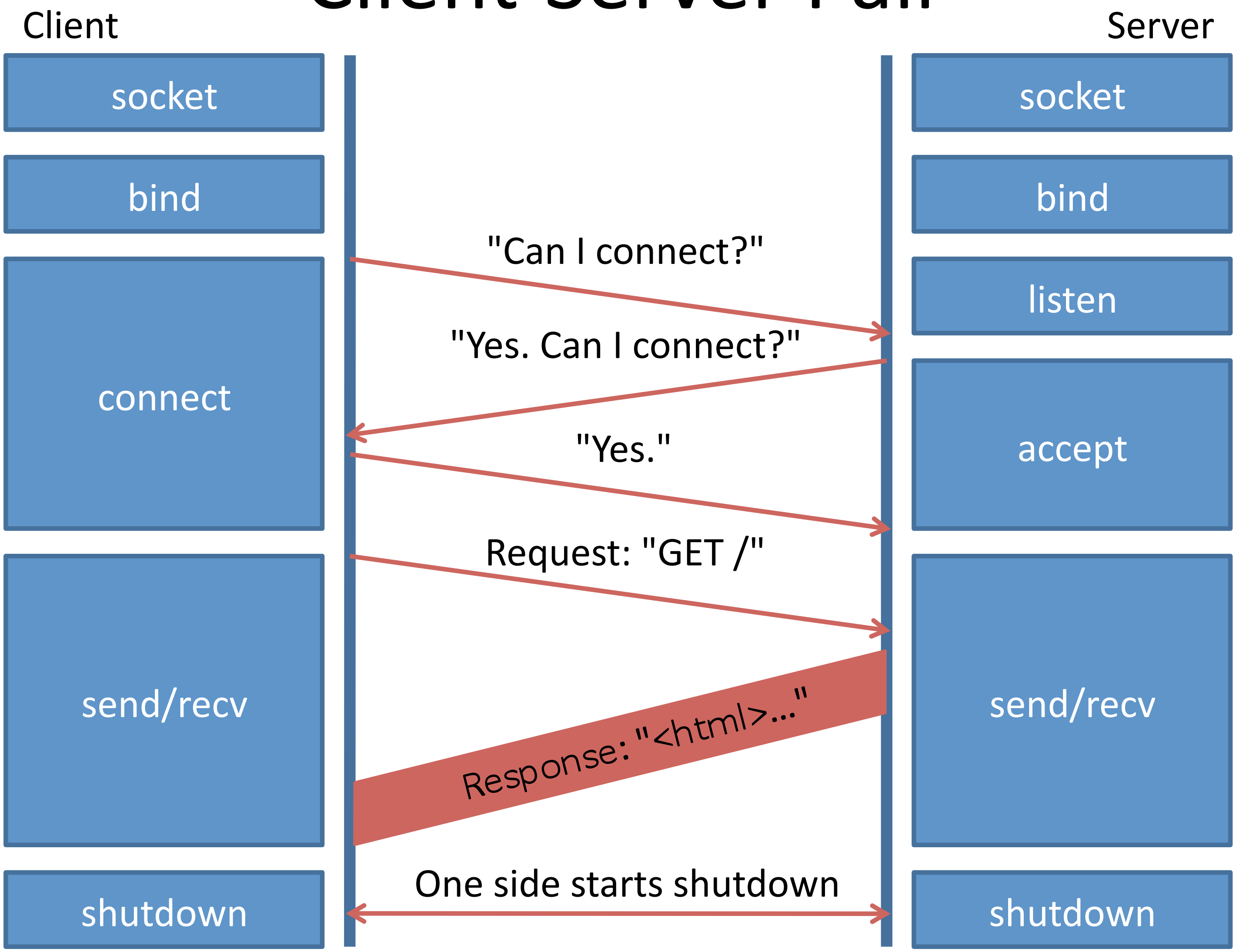
- Accept connection, returning a new descriptor for this (IP, port)$_{\text{src}}$ – (IP, port)$_{\text{dst}}$ pair

```
int send(int, void *, int)
int recv(int, void *, int)
```

```
int shutdown(int, int)
```



Typical Request-Response Client-Server Pair



Client

socket

bind

connect

send/recv

shutdown

Server

socket

bind

listen

accept

send/recv

shutdown

"Can I connect?"

"Yes. Can I connect?"

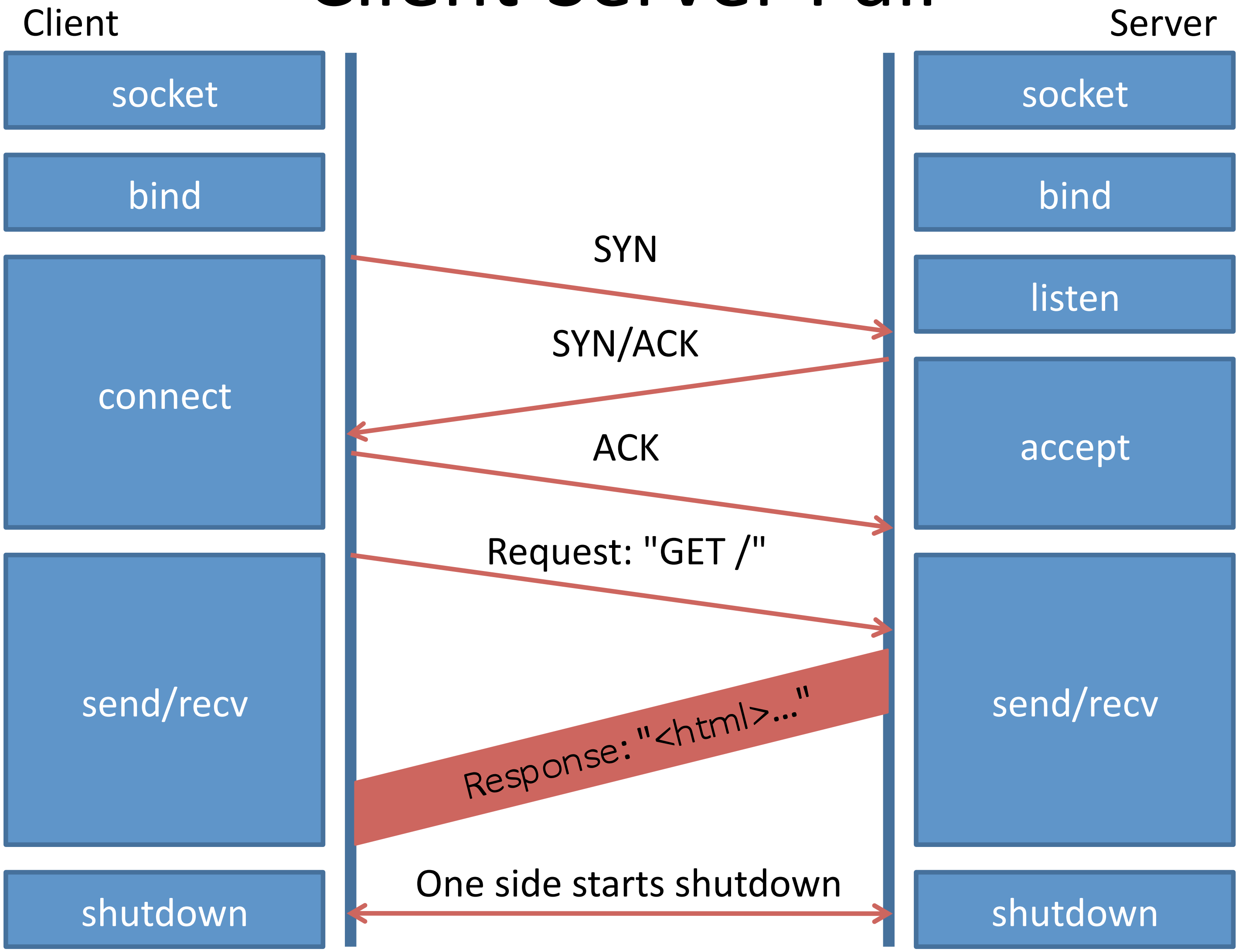
"Yes."

Request: "GET /"

Response: "<html>..."

One side starts shutdown

Typical Request-Response Client-Server Pair



Example Daytime Server

- See the posted daytime.c
- Problems
  - Doesn’t check return values of system calls
    - You should check the return value and use perror() or fprintf(stderr, strerror(errno)) to print out an informative error message
  - Doesn’t handle multiple clients simultaneously
  - Problems with re-using the same port (use setsockopt—covered in next review session)

Main Structures

- Generic socket address

```
struct sockaddr {
  u_short sa_family;
  char sa_data[14];
};
```

- TCP/UDP + IPv4 specific address – convenience parallel struct for sockaddr

```
struct sockaddr_in {
  u_short sa_family;       // usually AF_INET
  u_short sin_port;
  struct in_addr sin_addr; // see below
  char sin_zero[8];        // zero out
};
```

- IP Address

```
struct in_addr {
  u_long s_addr;           // Network byte order
};
```

Next two slides by Clay Collier

Useful Functions

```
struct hostent *gethostbyname(const char *name)
```

- Converts domain names and dotted-quad IP addresses into numerical IP addresses via DNS

```
struct servent *getservbyname(const char *name,
const char *proto)
```

- Query /etc/services to find expected protocol and port for a service
- Example: getservbyname("http", NULL) to find it resides on tcp port 80

```
getsockname(...), getpeername(...)
```

- Gets IP address and port for source/destination

More Notes

- Partial sends and receives
  - Receive might not return with all the bytes requested
- Endian issues
  - All shorts/ints going over the wire must be encoded using htons/htonl
  - All shorts/ints being read from the wire must be decoded using ntohs/ntohl
  - Why don't we have to worry about endianness for text? For arbitrary binary data?

Grading

- No set rubric yet
- Mostly functionality
  - Test yourself by sending (for example) http requests
- Some style points
  - Don’t write everything in main
  - Handle partial receives and other edge cases
  - Check return values of system calls

Resources

- IPC tutorial
- Man pages
- Outside references
  - Beej’s Sockets Tutorial: http://beej.us/guide/bgnet/
  - *Unix Network Programming* by Stevens
- Newsgroup
- Office hours