15213 Recitation Section C

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Outline

- Extending echo server
- HTTP
- Broken pipe error
- Feedback and evaluation

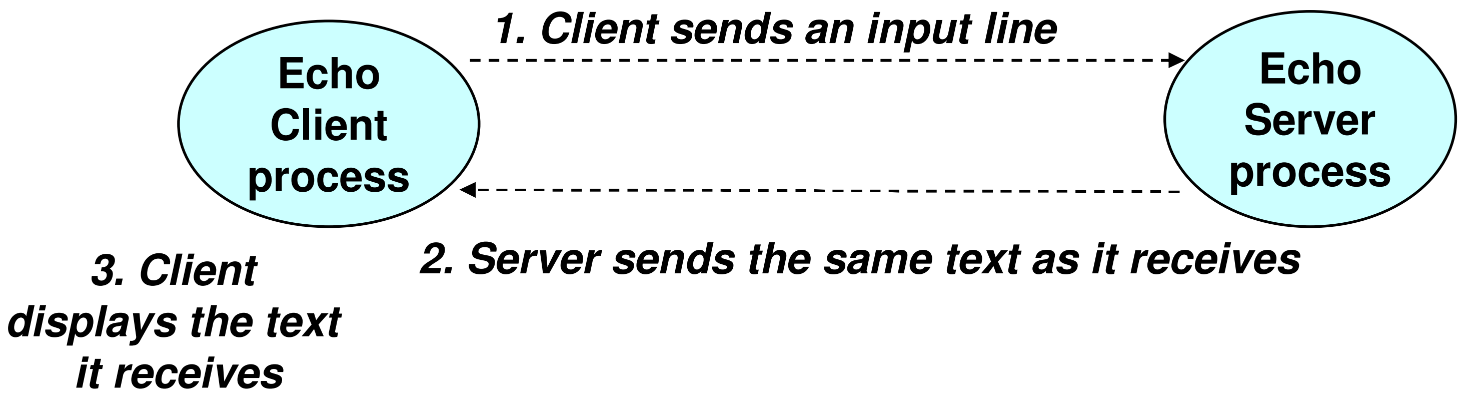
Important Dates

- Lab 7 *Proxy:* due on Thursday, Dec 5
- Final Exam: Tuesday, Dec 17

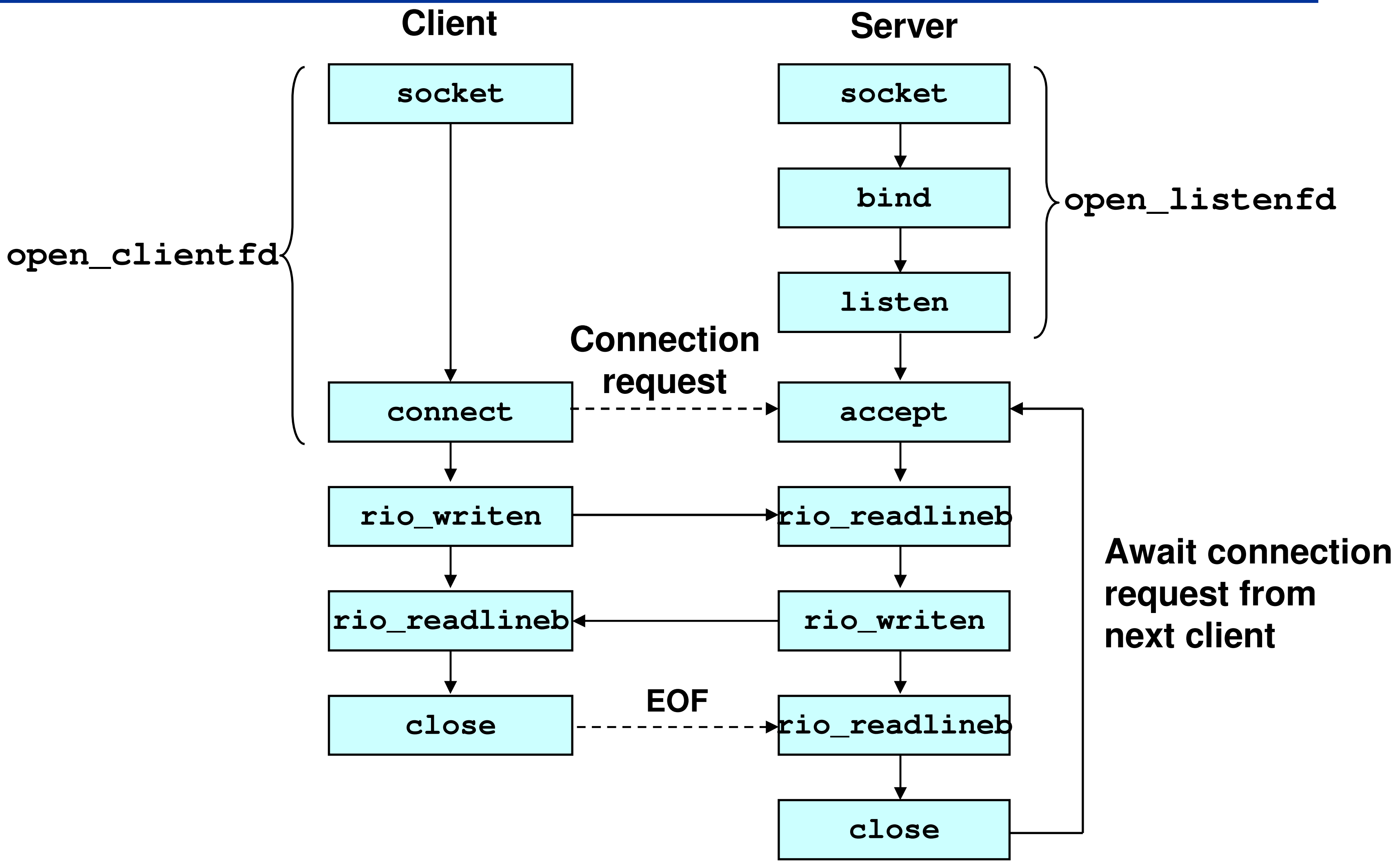
Extending Echo Server

- We will recap the echo client and server taught in the last lecture
- Then we will extend the echo server to build an echo proxy

An Echo Client-Server Transaction


1. Client sends an input line
Echo Client process
Echo Server process
2. Server sends the same text as it receives
3. Client displays the text it receives

Review of the Sockets Interface



Echo Client Main Routine

```c
#include "csapp.h"

/* usage: ./echoclient host port */
int main(int argc, char **argv)
{
    int clientfd, port;
    char *host, buf[MAXLINE];
    rio_t rio;

    host = argv[1];
    port = atoi(argv[2]);

    clientfd = Open_clientfd(host, port);
    Rio_readinitb(&rio, clientfd);

    while (Fgets(buf, MAXLINE, stdin) != NULL) {
        Rio_writen(clientfd, buf, strlen(buf));
        Rio_readlineb(&rio, buf, MAXLINE);
        Fputs(buf, stdout);
    }
    Close(clientfd);
    exit(0);
}
```

Echo Client: `open_clientfd`

```
int open_clientfd(char *hostname, int port)
{
  int clientfd;
  struct hostent *hp;
  struct sockaddr_in serveraddr;

  if ((clientfd = socket(AF_INET, SOCK_STREAM, 0)) < 0)
    return -1; /* check errno for cause of error */

  /* Fill in the server's IP address and port */
  if ((hp = gethostbyname(hostname)) == NULL)
    return -2; /* check h_errno for cause of error */
  bzero((char *) &serveraddr, sizeof(serveraddr));
  serveraddr.sin_family = AF_INET;
  bcopy((char *)hp->h_addr,
        (char *)&serveraddr.sin_addr.s_addr, hp->h_length);
  serveraddr.sin_port = htons(port);

  /* Establish a connection with the server */
  if (connect(clientfd, (SA *)&serveraddr, sizeof(serveraddr))<0)
    return -1;
  return clientfd;
}
```

This function opens a connection from the client to the server at `hostname:port`

Echo Server: Main Routine

```
int main(int argc, char **argv) {
    int listenfd, connfd, port, clientlen;
    struct sockaddr_in clientaddr;
    struct hostent *hp;
    char *haddrp;

    port = atoi(argv[1]); /* the server listens on a port passed
                             on the command line */
    listenfd = open_listenfd(port);

    while (1) {
      clientlen = sizeof(clientaddr);
      connfd = Accept(listenfd, (SA *)&clientaddr, &clientlen);
      hp = Gethostbyaddr((const char *)&clientaddr.sin_addr.s_addr,
                        sizeof(clientaddr.sin_addr.s_addr), AF_INET);
      haddrp = inet_ntoa(clientaddr.sin_addr);
      printf("server connected to %s (%s)\n", hp->h_name, haddrp);
      echo(connfd);
      Close(connfd);
    }
}
```

Echo Server: `open_listenfd`

```
int open_listenfd(int port)
{
    int listenfd, optval=1;
    struct sockaddr_in serveraddr;

    /* Create a socket descriptor */
    if ((listenfd = socket(AF_INET, SOCK_STREAM, 0)) < 0)
        return -1;

    /* Eliminates "Address already in use" error from bind. */
    if (setsockopt(listenfd, SOL_SOCKET, SO_REUSEADDR,
                   (const void *)&optval , sizeof(int)) < 0)
        return -1;

... (more)
```

Echo Server: `open_listenfd` (cont)

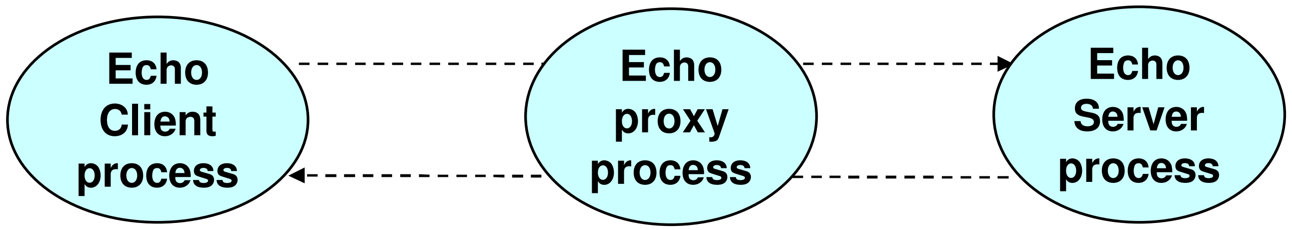
```
...

  /* Listenfd will be an endpoint for all requests to port
       on any IP address for this host */
    bzero((char *) &serveraddr, sizeof(serveraddr));
    serveraddr.sin_family = AF_INET;
    serveraddr.sin_addr.s_addr = htonl(INADDR_ANY);
    serveraddr.sin_port = htons((unsigned short)port);
    if (bind(listenfd,(SA *)&serveraddr,sizeof(serveraddr))<0)
        return -1;

    /* Make it a listening socket ready to accept
       connection requests */
    if (listen(listenfd, LISTENQ) < 0)
        return -1;

   return listenfd;
}
```

Echo Server: **echo**

```
void echo(int connfd)
{
    size_t n;
    char buf[MAXLINE];
    rio_t rio;

    Rio_readinitb(&rio, connfd);
    while((n = Rio_readlineb(&rio, buf, MAXLINE)) != 0) {
        printf("server received %d bytes\n", n);
        Rio_writen(connfd, buf, n);
    }
}
```

Proxy

- A *proxy* is an intermediary between a *client* and an *origin server*.
  - To the client, the proxy acts like a server.
  - To the server, the proxy acts like a client.



Changing "`echo`" procedure

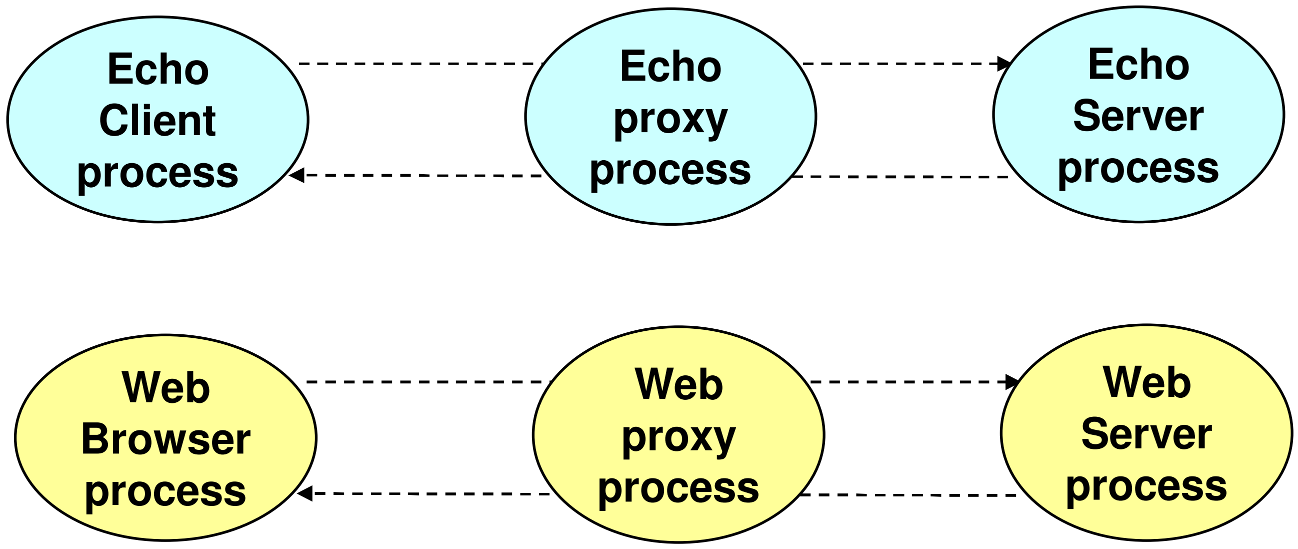
```
void echo_forward(int connfd, char *server, int server_port)
{
    int   forwardfd;
    rio_t rio_conn, rio_forward;
    ssize_t n;
    char buf[MAXLINE];

    /* connect to the server */
    forwardfd = Open_clientfd(server, server_port);
    Rio_readinitb(&rio_forward, forwardfd);

    Rio_readinitb(&rio_conn, connfd);
    while (1) {
      if ((n = Rio_readlineb(&rio_conn, buf, MAXLINE)) == 0)
        break;
      Rio_writen(forwardfd, buf, n);

      if ((n = Rio_readlineb(&rio_forward, buf, MAXLINE)) == 0)
        break;
      Rio_writen(connfd, buf, n);
    }
    Close(forwardfd);
}
```

Changing **`main`**

```
int main(int argc, char **argv)
{
    int listenfd, connfd, port, clientlen, server_port;
    struct sockaddr_in clientaddr;
    struct hostent *hp;
    char *haddrp, *server;

    port = atoi(argv[1]);
    server = argv[2];
    server_port = atoi(argv[3]);

    listenfd = Open_listenfd(port);
    while (1) {
        clientlen = sizeof(clientaddr);
        connfd = Accept(listenfd, (SA *)&clientaddr, &clientlen);

          . . .

        echo_forward(connfd, server, server_port);
        Close(connfd);
    }
    exit(0);
}
```

L7 Proxy

- Different request and response (HTTP)
- Concurrency



HTTP Request and Response

- Let’s use telnet to examine a simple HTTP request and response
- More details in Tuesday’s lecture

HTTP Request and Response

```
[chensm@bass ~]$ telnet www.cmu.edu 80
Trying 128.2.11.43...
Connected to WEB3.andrew.cmu.edu.
Escape character is '^]'.
GET / HTTP/1.1
host: www.cmu.edu

HTTP/1.1 200 OK
Date: Sun, 24 Nov 2002 21:52:53 GMT
Server: Apache/1.3.26 (Unix) PHP/4.2.2 mod_pubcookie/a5/1.76-009
   mod_ssl/2.8.10 OpenSSL/0.9.6d
Last-Modified: Thu, 21 Nov 2002 15:28:47 GMT
ETag: "d3226-38b1-3ddcfbaf"
Accept-Ranges: bytes
Content-Length: 14513
Content-Type: text/html


<HTML>
        <HEAD>
                <TITLE> Carnegie Mellon University </TITLE>
        </HEAD>
. . . . . .
```

HTTP Request

Request line: <method> <uri> <version>

```
GET / HTTP/1.1
host: www.cmu.edu
```

Request headers: <header name>: <header data>

‘\r\n’ to mark the end of the request

HTTP Response

Response line: <version> <status code> <status msg>

Response headers: <header name>: <header data>

```
HTTP/1.1 200 OK
Date: Sun, 24 Nov 2002 21:52:53 GMT
Server: Apache/1.3.26 (Unix) PHP/4.2.2 mod_pubcookie/a5/1.76-009
   mod_ssl/2.8.10 OpenSSL/0.9.6d
Last-Modified: Thu, 21 Nov 2002 15:28:47 GMT
ETag: "d3226-38b1-3ddcfbaf"
Accept-Ranges: bytes
Content-Length: 14513
Content-Type: text/html
```

'\r\n'

Response body: Web page

```
<HTML>
        <HEAD>
                <TITLE> Carnegie Mellon University </TITLE>
        </HEAD>
. . . . . .
```

Broken Pipe Error

- When reading or writing to a socket
- If the socket has already been closed at the other end
  - e.g. click “stop” on web browser
- SIGPIPE signal and EPIPE errno
- Don’t want to terminate the web server

Details

- Write to a broken pipe
  - For the first write, return -1 and set EPIPE
  - For subsequent writes,
    - Send SIGPIPE signal, which terminates process
    - If the signal is blocked or handled, return -1 and set EPIPE.
- Example of broken pipe with echo server

How to deal with broken pipe?

- Block SIGPIPE signal
- Ignore EPIPE error in Rio wrappers of csapp.c

- Example of how we handle broken pipe in echo server
  - In server main(), we block SIGPIPE signal
  - In csapp.c, we ignore EPIPE error in Rio wrappers
  - In echo(), deal with cases when return value is -1

Feedback and Evaluation

Thank you!