FTP: File Transfer Protocol

EE 122: Intro to Communication Networks

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File Transfer Protocol (FTP)

- Allows a user to copy files to/from remote hosts
  - Client program connects to FTP server
  - … provides a login id and password
  - … allows the user to explore the directories
  - … and download and upload files with the server
- A predecessor of the Web (RFC 959 in 1985)
  - Requires user to know the name of the server machine
  - … and have an account on the machine
  - … and find the directory where the files are stored
  - … and know whether the file is text or binary
  - … and know what tool to run to render and edit the file
- That is, no URL, hypertext, and helper applications

How Do You Transfer Files Today?

- HTTP - the usual Web transfer mechanism (http://)
- FTP
  - You may not have realized that you use it
  - ftp:// links in web pages (e.g.: in www.kernel.org)
- sftp
  - E.g.: to upload your project files to EECS inst. machines
- BitTorrent and other file-sharing software
- scp
- Any others?

Why Study FTP?

- Helps cement familiarity with text/status-code based protocols (similar to SMTP)
- Illustrates use of multiple concurrent connections
  - One for control (commands & replies)
  - Depending on command, can be additional one for data
- Illustrates reversal of roles
  - For data connection, FTP user’s process plays the server role, FTP server plays the client role
- We’ll later use FTP as an example when looking at issues with Network Address Translation (NAT)

Example Commands

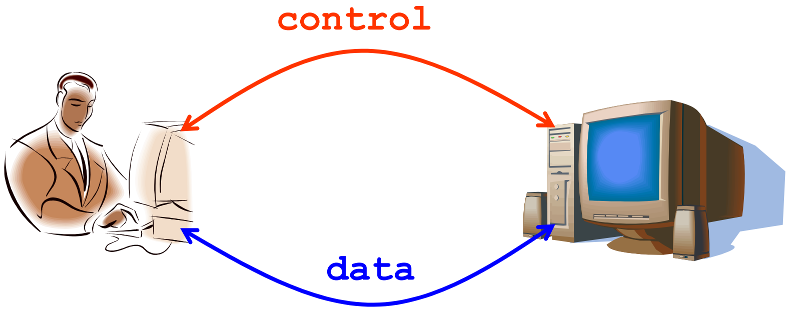
- Authentication
  - USER: specify the user name to log in as
  - PASS: specify the user’s password
- Exploring the files
  - LIST: list the files for the given file specification
  - CWD: change to the given directory
- Downloading and uploading files
  - TYPE: set type to ASCII (A) or binary image (I)
  - RETR: retrieve the given file
  - STOR: upload the given file
- Closing the connection
  - QUIT: close the FTP connection

Server Response Codes

- 1xx: positive preliminary reply
  - The action is being started, but expect another reply before sending the next command.
- 2xx: positive completion reply
  - The action succeeded and a new command can be sent.
- 3xx: positive intermediate reply
  - The command was accepted but another command is now required.
- 4xx: transient negative completion reply
  - The command failed and should be retried later.
- 5xx: permanent negative completion reply
  - The command failed and should not be retried.

FTP Data Transfer

- Separate data connection
  - To send lists of files (LIST)
  - To retrieve a file (RETR)
  - To upload a file (STOR)

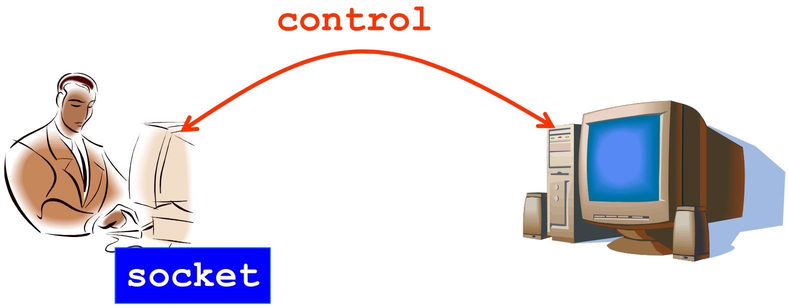


control

data

Creating the Data Connection

- Client acts like a server
  - Creates a socket
    - Assigned an ephemeral port number by the kernel
  - Listens on socket
  - Waits to hear from FTP server

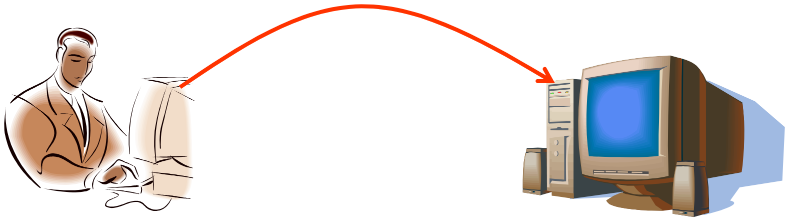


control

socket

Creating Data Connection (cont.)

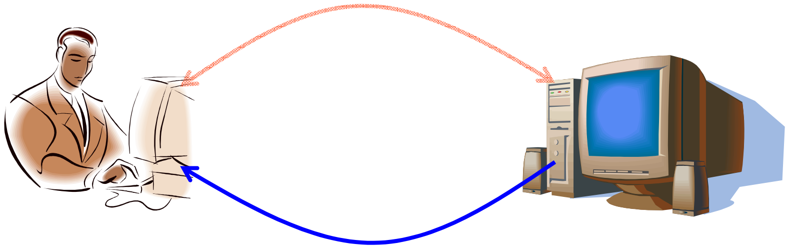
- But, the server doesn't know the port number
  - So after listening, client tells it to the server
  - Using the PORT command on the control connection



```
PORT <IP address, port #>
```

Creating Data Connection (cont)

- Then, the server initiates the data connection
  - Connects to the socket on the client machine
  - … and the client accepts to complete the connection
- Data now flows along second connection; first connection remains open for more commands/replies



Why Out-of-Band Control?

- Avoids need to mark the end of the data transfer
  - Data transfer ends by closing of data connection
  - Yet, the control connection stays up
- Aborting a data transfer
  - Can abort a transfer without killing the control connection
  - … which avoids requiring the user to log in again
  - Done with an ABOR on the control connection
- Third-party file transfer between two hosts
  - Data connection could go to a different host
  - … by sending a different client IP address to the server
  - E.g., user coordinates transfer between two servers
  - But: this is rarely needed, and presents security issues

Example

- Traffic captured using

```
tcpdump -s 0 -w ftp.trace host ftp.ee.lbl.gov
```

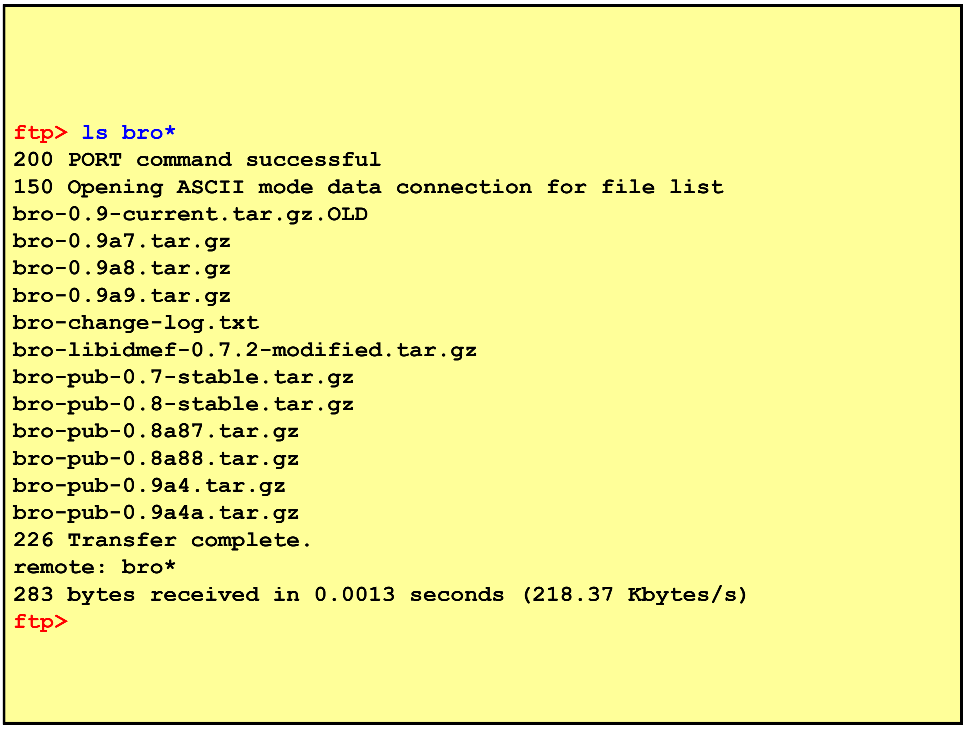
- Issue command

```
ftp ftp.ee.lbl.gov
```

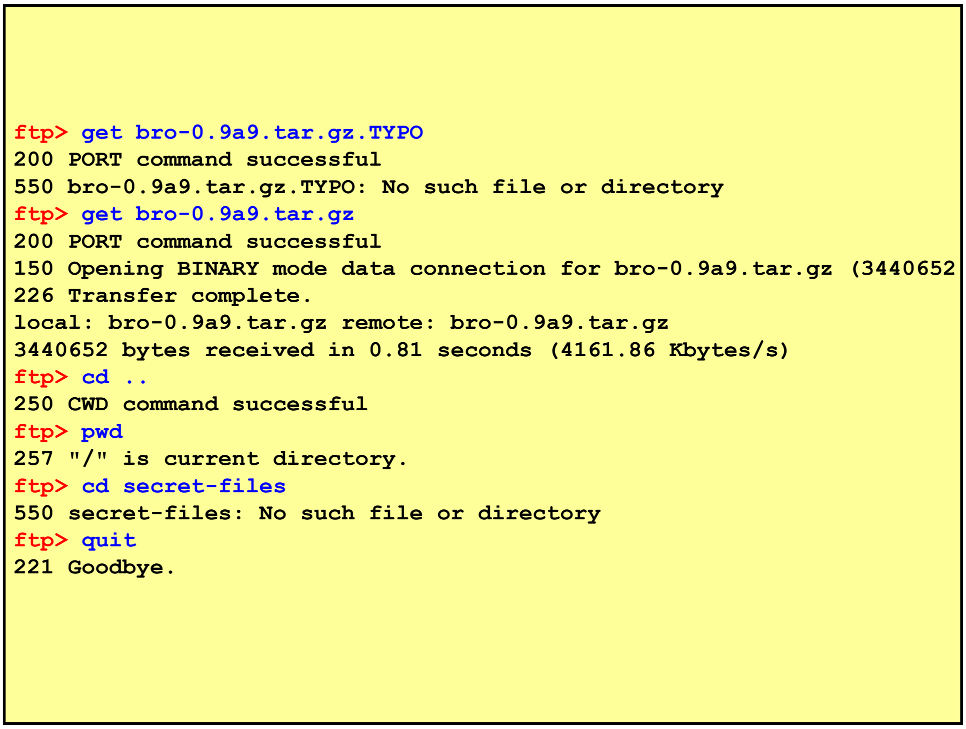
What It Looks Like to the User

```
% ftp ftp.ee.lbl.gov
Connected to ee.lbl.gov.
220-
                        NOTICE TO USERS

     This computer is a Federal computer system and is the property
     of the United States Government. It is for authorized use only.
     Users (authorized or unauthorized) have no explicit or implicit
     expectation of privacy.
[…]
     LOG OFF IMMEDIATELY if you do not agree to the conditions stated
     in this warning.

     Your ip address is 128.32.48.169
     The local time is Wed Sep 27 15:04:44 2006

220 131.243.1.10 FTP server ready
Name (ftp.ee.lbl.gov:ee122): anonymous
331 Anonymous login ok, send your complete email address as your pass
```

```
Password:
230 Anonymous access granted, restrictions apply.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> pwd
257 "/" is current directory.
ftp>
```



```
ftp> ls bro*
200 PORT command successful
150 Opening ASCII mode data connection for file list
bro-0.9-current.tar.gz.OLD
bro-0.9a7.tar.gz
bro-0.9a8.tar.gz
bro-0.9a9.tar.gz
bro-change-log.txt
bro-libidmef-0.7.2-modified.tar.gz
bro-pub-0.7-stable.tar.gz
bro-pub-0.8-stable.tar.gz
bro-pub-0.8a87.tar.gz
bro-pub-0.8a88.tar.gz
bro-pub-0.9a4.tar.gz
bro-pub-0.9a4a.tar.gz
226 Transfer complete.
remote: bro*
283 bytes received in 0.0013 seconds (218.37 Kbytes/s)
ftp>
```



```
ftp> get bro-0.9a9.tar.gz.TYPO
200 PORT command successful
550 bro-0.9a9.tar.gz.TYPO: No such file or directory
ftp> get bro-0.9a9.tar.gz
200 PORT command successful
150 Opening BINARY mode data connection for bro-0.9a9.tar.gz (3440652
226 Transfer complete.
local: bro-0.9a9.tar.gz remote: bro-0.9a9.tar.gz
3440652 bytes received in 0.81 seconds (4161.86 Kbytes/s)
ftp> cd ..
250 CWD command successful
ftp> pwd
257 "/" is current directory.
ftp> cd secret-files
550 secret-files: No such file or directory
ftp> quit
221 Goodbye.
```

What It Looks Like “On The Wire”

% ftp ftp.ee.lbl.gov

Server sends exactly this text:

```
< 220-
<              NOTICE TO USERS
<
<    This computer is a Federal computer system and is the property
[…]
<    LOG OFF IMMEDIATELY if you do not agree to the conditions stated
<    in this warning.
<
<    Your ip address is 128.32.48.169
<    The local time is Wed Sep 27 15:04:44 2006
<
< 220 131.243.1.10 FTP server ready
Name (ftp.ee.lbl.gov:ee122): anonymous
```

Client sends:

```
> USER anonymous
```

Server replies with exactly this text:

```
< 331 Anonymous login ok, send your complete email address as your pa
```

```
Password:
> PASS ee122@c199.eecs.berkeley.edu
< 230 Anonymous access granted, restrictions apply.
> SYST
< 215 UNIX Type: L8
Remote system type is UNIX.
> TYPE I
< 200 Type set to I
Using binary mode to transfer files.
ftp> pwd
> PWD
< 257 "/" is current directory.
ftp>
ftp> ls bro*
> PORT 128,32,48,169,189,39
< 200 PORT command successful
> TYPE A
< 200 TYPE set to A
> NLST bro*
< 150 Opening ASCII mode data connection for file list
```

The server sends the following on a separate connection
to 128.32.48.169, port 189*256 + 39 = 48423

```
< bro-0.9-current.tar.gz.OLD
< bro-0.9a7.tar.gz
< … etc ….
< bro-pub-0.9a4a.tar.gz
```

Here the server closes the separate connection.

The server sends this using the control connection again:

```
< 226 Transfer complete.
remote: bro*
283 bytes received in 0.0013 seconds (218.37 Kbytes/s)
ftp>
```

```
ftp> get bro-0.9a9.tar.gz.TYPO
> TYPE I
< 200 TYPE set to I
> PORT 128,32,48,169,189,41
< 200 PORT command successful
> RETR bro-0.9a9.tar.gz.TYPO
< 550 bro-0.9a9.tar.gz.TYPO: No such file or directory
ftp> get bro-0.9a9.tar.gz
> PORT 128,32,48,169,189,42
< 200 PORT command successful
> RETR bro-0.9a9.tar.gz
< 150 Opening BINARY mode data connection for bro-0.9a9.tar.gz (34406
```

The server now transfers the 3MB+ file using a separate connection
To 128.32.48.169, port 189*256+42 = 48426.

When done, it closes the separate connection and continues on the control channel:

```
< 226 Transfer complete.
local: bro-0.9a9.tar.gz remote: bro-0.9a9.tar.gz
3440652 bytes received in 0.81 seconds (4161.86 Kbytes/s)
ftp>
ftp> cd ..
> CWD ..
< 250 CWD command successful
ftp> pwd
> PWD
< 257 "/" is current directory.
ftp> cd secret-files
> CWD secret-files
< 550 secret-files: No such file or directory
ftp> quit
> QUIT
< 221 Goodbye.
```