



Final Project- Simple FTP Client

BUPT/QMUL
2019-5-9



北京邮电大学

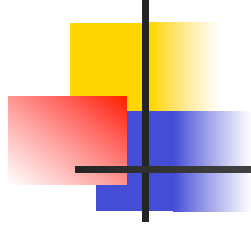
BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

Electronic Engineering 



Content

- Introduction
- Using *nc* command to connect FTP server
 - To learn about passive and active mode, control connection and data connection of FTP
- Using **Wireshark** to get familiar with FTP
 - To learn about the communication procedure, commands and replies of FTP



Introduction



About the Project

- A simple FTP client
 - Implement all the content of **Project Requirements**
 - Use C language in Linux operation system
 - Use gcc compiler and gdb debug tool
 - Use CLI (Command Line Interface) as input & output
- Important date
 - Program check: before the end of lab time in week 16
 - Source code and the report are required to be submitted
 - FTP: 10.3.255.85
 - User name/password: gjxy-project/student
 - Deadline: before 22:00, 2019-06-16 (UTC+8)



Documents to read

- *ftp client project-requirements-20190509*
 - Basic requirements – should be implemented
 - Extension requirements – if possible
- 实验指导书-20190509
 - Some helpful information for reference
- ftp client project report-20190509
 - Sample report for reference
- main.c
 - Program infrastructure for reference
 - Note: This is just a reference. You can definitely follow your own design rule.



Using nc to connect FTP server (I)

- To learn about **passive mode**, control connection and data connection of FTP



nc command

- nc (netcat)
- Function: open TCP connections, send UDP packets, listen on arbitrary TCP and UDP ports, do port scanning, and deal with both IPv4 and IPv6
- Parameters
 - -4: for IPv4
 - -l: listen for an incoming connection
 - -v: give more verbose output



Objective

- Use nc to login FTP server
- Learn how to open control connection and data connection (**Passive mode**)
- Understand the functionality of control connection and data connection
- Learn the communication procedure, commands and replies of FTP

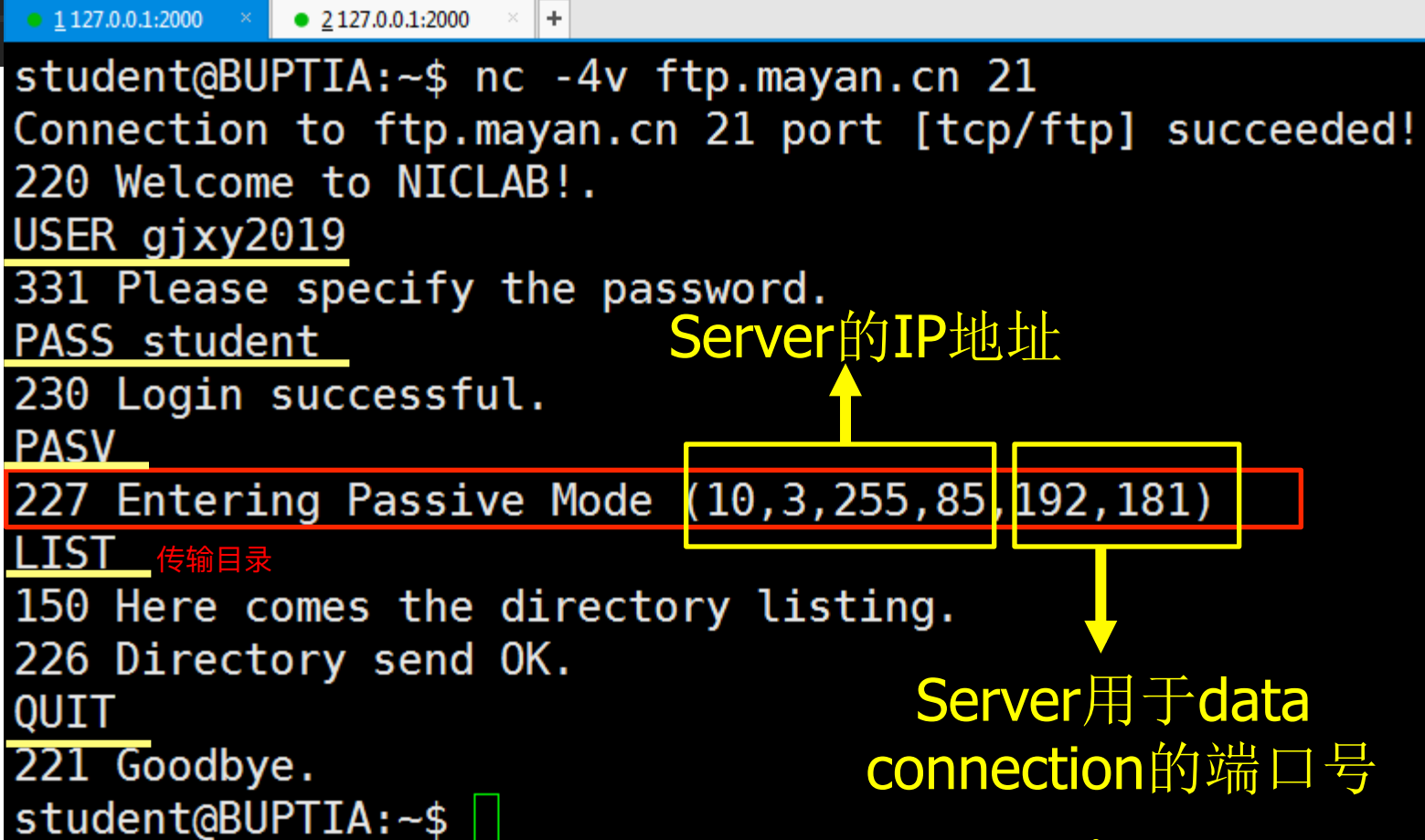


Steps

Note: After connecting to FTP server using *nc*, you should use control commands in the following steps.

- 1. Using nc to connect to given FTP server
 - `$ nc -4v ftp.mayan.cn 21`
- 2. login using username "gjxy2019" and password "student"
- 3. Input command "PASV", calculate port number for data connections: *port* = $p1 \times 256 + p2$, *p1* and *p2* are taken from the server's reply
被动模式, sever被动
- 4. Using another terminal to set up data connection
 - `$ nc -4v ftp.mayan.cn port`
- 5. Input command "LIST"

Example of FTP control connection



```
student@BUPTIA:~$ nc -4v ftp.mayan.cn 21
Connection to ftp.mayan.cn 21 port [tcp/ftp] succeeded!
220 Welcome to NICLAB!.
USER gjxy2019
331 Please specify the password.
PASS student
230 Login successful.
PASV
227 Entering Passive Mode (10,3,255,85,192,181)
LIST
150 Here comes the directory listing.
226 Directory send OK.
QUIT
221 Goodbye.
student@BUPTIA:~$
```

Server的IP地址



(10,3,255,85,

192,181)



Server用于data
connection的端口号

:

$192 * 256 + 181 = 49333$

Example of FTP data connection

- After inputting command "LIST" in terminal of command connection, it displays in terminal of data connection: 再开一个窗口 用nc重新建立连接

```
student@BUPTIA:~$ nc -4v ftp.mayan.cn 49333 端口号 计算出的port
Connection to ftp.mayan.cn 49333 port [tcp/*] succeeded!
-rwxr-xr-x 1 0 0 603493 Feb 24 14:34 0-Outline-20190225.pdf
-rwxr-xr-x 1 0 0 2002003 Feb 24 14:43 1-Introduction.pdf
-rwxr-xr-x 1 0 0 1582878 Mar 03 20:13 2-Network Definition & Layered Architecture-20190304.pdf
-rwxr-xr-x 1 0 0 983258 Mar 10 17:05 3-Network Programming-20190311.pdf
-rwxr-xr-x 1 0 0 500577 Mar 17 10:26 4-NetworkProgramming-2-20190318.pdf
-rwxr-xr-x 1 0 0 991421 Mar 24 18:25 5-NetworkProgramming-3-20190325.pdf
-rwxr-xr-x 1 0 0 2002510 Mar 31 18:04 6-DHCP-20190401.pdf
-rwxr-xr-x 1 0 0 33105 Mar 31 18:04 6-How DHCP Relay works-20190401.pdf
-rwxr-xr-x 1 0 0 1197536 Apr 07 22:15 7-DNS-20190408.pdf
-rwxr-xr-x 1 0 0 2340797 Apr 15 07:52 8-TELNET-20190415.pdf
-rwxr-xr-x 1 0 0 1524716 Apr 21 22:01 9-FTP-20190422.pdf
-rwxr-xr-x 1 0 0 2185131 Mar 03 20:14 Lab01-Setup-20190228.pdf
-rwxr-xr-x 1 0 0 249634 Mar 06 16:54 Lab02-Assignment.pdf
-rwxr-xr-x 1 0 0 985652 Mar 06 16:54 Lab02-IntroductionLinux(Part_I).pdf
-rwxr-xr-x 1 0 0 510838 Mar 10 17:05 Lab03-Assignment.pdf
-rwxr-xr-x 1 0 0 1437223 Mar 10 17:05 Lab03-IntroductionLinux(Part_II).pdf
-rwxr-xr-x 1 0 0 128570 Mar 17 10:26 Lab04-Assignment.pdf
-rwxr-xr-x 1 0 0 697961 Mar 24 18:25 Lab05~06-UDP.pdf
-rwxr-xr-x 1 0 0 723047 Apr 02 17:53 Lab06~07-Hostentry.pdf
-rwxr-xr-x 1 0 0 653 Mar 31 18:45 Lab06~07-hostentry.c
-rwxr-xr-x 1 0 0 252866 Apr 07 22:18 Lab07~08-TCP.pdf
```



Using nc to connect FTP server (II)

- To learn about **active mode**, control connection and data connection of FTP

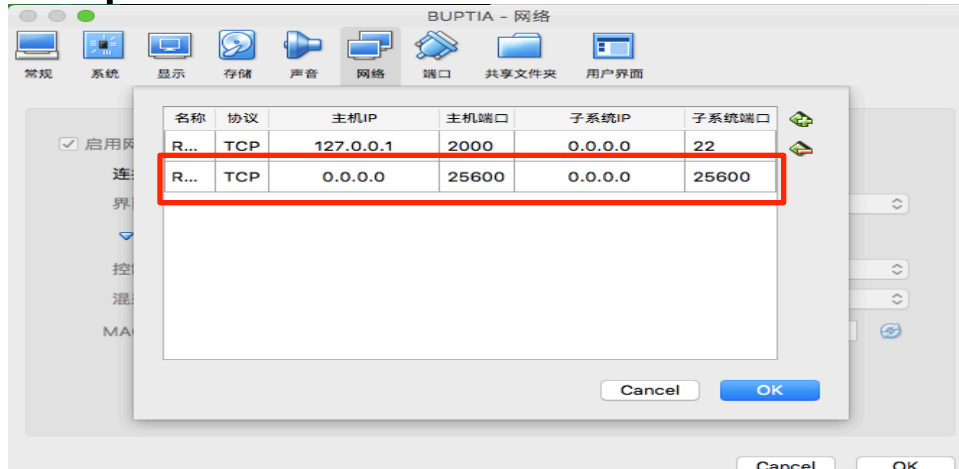


Objective

- Use nc to login FTP server
- Learn how to open control connection and data connection (**Active mode**)
- Fully understand the functionality of control connection and data connection
- Learn the communication procedure, commands and replies of FTP

Steps

- 1. Figure out ip address *ip1.ip2.ip3.ip4* of your physical machine
 - E.g. 10.3.255.115, *ip1*=10 *ip2*=3 *ip3*=255 *ip4*=115
- 2. Choose the last five digits of your student ID as a port number
 - E.g. 2016225600, *port*=25600
- 3. Set port forward rule in virtualbox

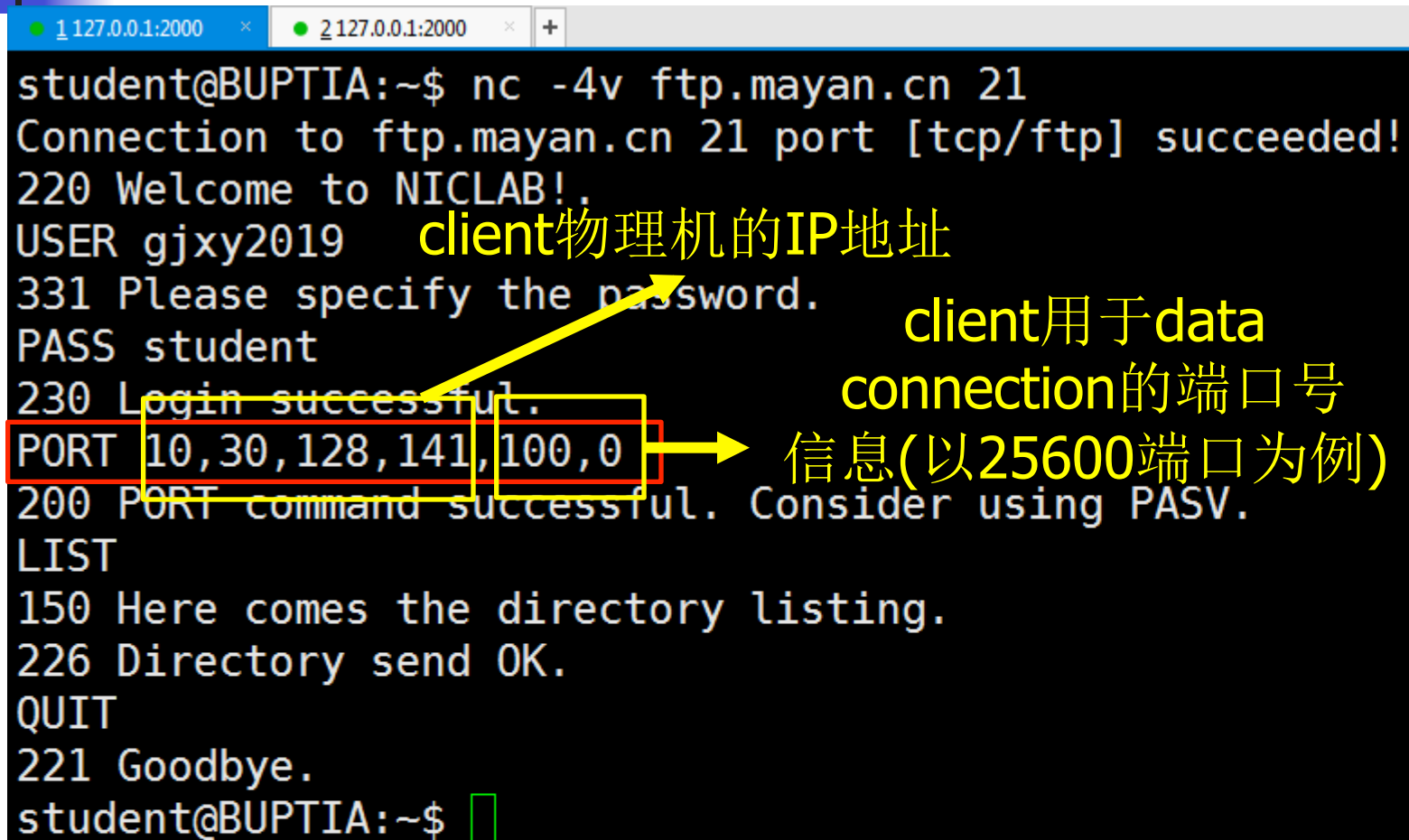




Steps

- 4. Using nc to connect to given FTP server
 - `$ nc -4v ftp.mayan.cn 21`
- 5. login using username "gjxy2019" and password "student"
- 6. Using another terminal to listen to data connection
 - Using IP address of eth0 in virtual machine
 - `$ nc -4lv ip-eth0 port`
- 7. Return to first terminal, calculate port number for data connections: $p1 = [port/256]$, $p2 = port - p1 * 256$, input command "PORT *ip1,ip2,ip3,ip4,p1,p2*"
- 8. Input command "LIST"
- Note: Firewall in physical machine may need to be closed 15

Example of FTP control connection



The image shows a terminal window with two tabs. The first tab is titled '1 127.0.0.1:2000' and the second is '2 127.0.0.1:2000'. The terminal output is as follows:

```
student@BUPTIA:~$ nc -4v ftp.mayan.cn 21
Connection to ftp.mayan.cn 21 port [tcp/ftp] succeeded!
220 Welcome to NICLAB!.
USER gjxy2019
331 Please specify the password.
PASS student
230 Login successful.
PORT 10,30,128,141,100,0
200 PORT command successful. Consider using PASV.
LIST
150 Here comes the directory listing.
226 Directory send OK.
QUIT
221 Goodbye.
student@BUPTIA:~$
```

Annotations on the terminal output:

- A yellow arrow points from the text "client物理机的IP地址" to the IP address "127.0.0.1" in the terminal title bar.
- A yellow arrow points from the text "client用于data connection的端口号" to the port number "21" in the terminal title bar.
- A yellow arrow points from the text "信息(以25600端口为例)" to the IP address "10,30,128,141,100,0" in the terminal output.
- A red box highlights the IP address "10,30,128,141,100,0" in the terminal output.
- A yellow box highlights the port number "100,0" in the terminal output.

Example of FTP data connection

- After inputting command "LIST" in terminal of command connection, it displays in terminal of data connection:

```
student@BUPTIA:~$ nc -4lv 10.0.2.15 25600
Listening on [10.0.2.15] (family 2, port 25600)
Connection from [10.0.2.2] port 25600 [tcp/*] accepted (family 2, sport 20)
-rwxr-xr-x 1 0 0 603493 Feb 24 14:34 0-Outline-20190225.pdf
-rwxr-xr-x 1 0 0 2002003 Feb 24 14:43 1-Introduction.pdf
-rwxr-xr-x 1 0 0 1582878 Mar 03 20:13 2-Network Definition & Layered Architecture-20190304.pdf
-rwxr-xr-x 1 0 0 983258 Mar 10 17:05 3-Network Programming-20190311.pdf
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-rwxr-xr-x 1 0 0 2002510 Mar 31 18:04 6-DHCP-20190401.pdf
-rwxr-xr-x 1 0 0 33105 Mar 31 18:04 6-How DHCP Relay works-20190401.pdf
-rwxr-xr-x 1 0 0 1197536 Apr 07 22:15 7-DNS-20190408.pdf
-rwxr-xr-x 1 0 0 2340797 Apr 15 07:52 8-TELNET-20190415.pdf
-rwxr-xr-x 1 0 0 1524716 Apr 21 22:01 9-FTP-20190422.pdf
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-rwxr-xr-x 1 0 0 985652 Mar 06 16:54 Lab02-IntroductionLinux(Part_I).pdf
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-rwxr-xr-x 1 0 0 697961 Mar 24 18:25 Lab05-06-UDP.pdf
-rwxr-xr-x 1 0 0 723047 Apr 02 17:53 Lab06-07-Hostentry.pdf
-rwxr-xr-x 1 0 0 653 Mar 31 18:45 Lab06-07-hostentry.c
```

Client虚拟机的IP地址



Servers to connect

- Our lesson's ftp server
 - ftp.mayan.cn
- Some public ftp servers that can be used for testing:
 - ftp.sjtu.edu.cn
 - You can use *anonymous* as user name and *guest* or an email address as password. E.g.:
 - anonymous, guest
 - anonymous, abc@123
 - ftp, guest
 - ftp, ftp@



FTP control commands to try

- USER
- PASS
- PWD
- CDUP
- LIST
- STOR
- TYPE
- QUIT
- ...



Using Wireshark to get familiar with FTP

- To learn about the communication procedure, commands and replies of FTP



Objective

- Observe the replies from FTP server
- Learn about the function and usage of major FTP commands and reply codes
- Using Wireshark to capture FTP messages and learn about the message flow

Note: You should use user commands in the following steps.

How to connect to the FTP server

- In xShell or Terminal: Login virtual machine and start **wireshark** ;
- In another xShell or Terminal: Type user command as follows:

```
#ftp 10.3.255.85  
(This is the IP address of ftp.mayan.cn.)  
Name: gjxy2019  
Password: student  
ftp> ls  
ftp> pwd  
ftp> get ** (** is the name of the file)  
ftp> put **  
ftp> binary  
ftp> ascii
```
- Try user commands: *ls, pwd, cd, put, get, type, ascii, binary, quit*
- Understand user command and FTP command using wireshark

Note: Only passive mode could be used because of the network configuration in VM. Please use *passive* command in ftp to switch to passive mode.

How to analyze FTP packets

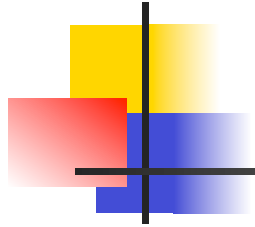
- Set filter as: `tcp.port==20` or `tcp.port==21`

Capturing from eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: `tcp.port==21 or tcp.port==20` Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
214	2.531850000	10.3.255.115	10.3.255.85	TCP	74	40276 > ftp [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=2866802671 TSecr=0
216	2.532298000	10.3.255.85	10.3.255.115	TCP	74	ftp > 40276 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=1332337
217	2.532331000	10.3.255.115	10.3.255.85	TCP	66	40276 > ftp [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2866802671 TSecr=1332337031
221	2.536219000	10.3.255.85	10.3.255.115	FTP	91	Response: 220 Welcome to NICLAB!.
222	2.536274000	10.3.255.115	10.3.255.85	TCP	66	40276 > ftp [ACK] Seq=1 Ack=26 Win=29312 Len=0 TSval=2866802672 TSecr=1332337032
305	6.256434000	10.3.255.115	10.3.255.85	FTP	81	Request: USER gjxy2019
307	6.256968000	10.3.255.85	10.3.255.115	TCP	66	ftp > 40276 [ACK] Seq=26 Ack=16 Win=29056 Len=0 TSval=1332337962 TSecr=2866803602
308	6.257019000	10.3.255.85	10.3.255.115	FTP	100	Response: 331 Please specify the password.
309	6.257045000	10.3.255.115	10.3.255.85	TCP	66	40276 > ftp [ACK] Seq=16 Ack=60 Win=29312 Len=0 TSval=2866803602 TSecr=1332337962
362	9.144521000	10.3.255.115	10.3.255.85	FTP	80	Request: PASS student
364	9.182401000	10.3.255.85	10.3.255.115	TCP	66	ftp > 40276 [ACK] Seq=60 Ack=30 Win=29056 Len=0 TSval=1332338694 TSecr=2866804324
370	9.277973000	10.3.255.85	10.3.255.115	FTP	89	Response: 230 Login successful.
371	9.278025000	10.3.255.115	10.3.255.85	TCP	66	40276 > ftp [ACK] Seq=30 Ack=83 Win=29312 Len=0 TSval=2866804358 TSecr=1332338717
372	9.278114000	10.3.255.115	10.3.255.85	FTP	72	Request: SYST
374	9.278273000	10.3.255.85	10.3.255.115	TCP	66	ftp > 40276 [ACK] Seq=83 Ack=36 Win=29056 Len=0 TSval=1332338718 TSecr=2866804358
375	9.278299000	10.3.255.85	10.3.255.115	FTP	85	Response: 215 UNIX Type: L8
378	9.317469000	10.3.255.115	10.3.255.85	TCP	66	40276 > ftp [ACK] Seq=36 Ack=102 Win=29312 Len=0 TSval=2866804368 TSecr=1332338718
413	10.944248000	10.3.255.115	10.3.255.85	FTP	93	Request: PORT 10,3,255,115,209,140



End