Assignment #1: Relazione

PROGRAMMAZIONE DI RETI

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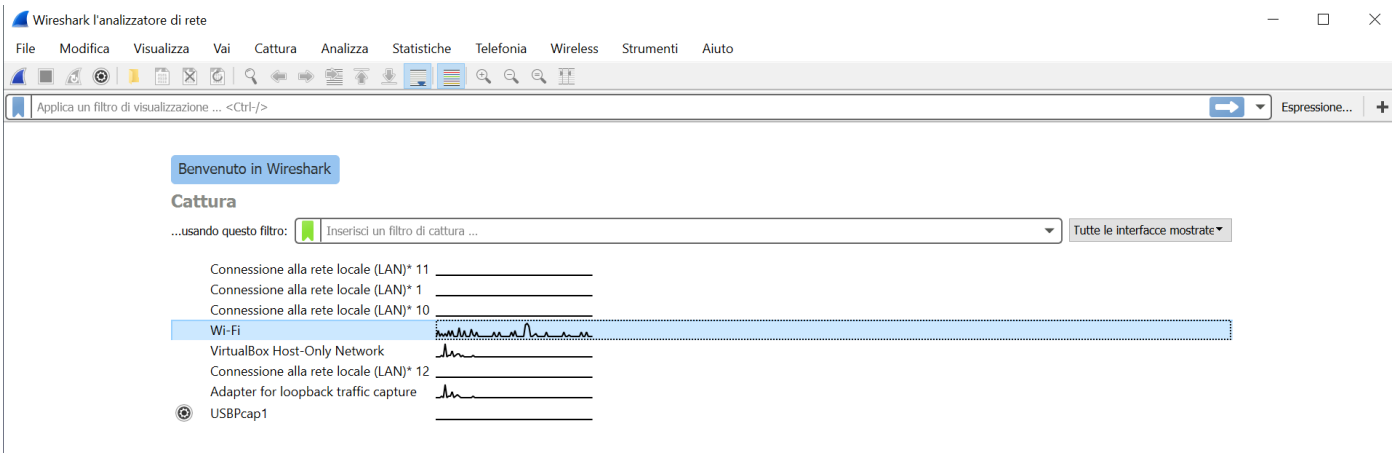
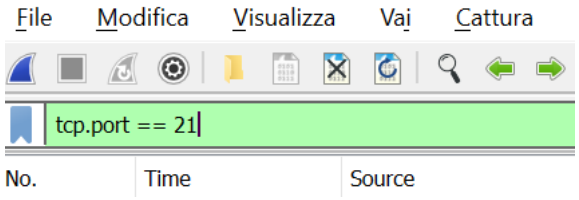
TASK 1

Phase-0

Dopo aver aperto Wireshark per analizzare il traffico dei pacchetti in rete, è stata selezionata l'interfaccia Wi-Fi.



Successivamente è stato applicato il filtro "*tcp.port == 21*" per analizzare i pacchetti appartenenti alla sessione ftp.



Phase-1

È stata inizializzata una sessione FTP presso il server ftp.ubuntu.com, sono stati inseriti username *anonymous* e password nulla.

```
C:\Users\marti>ftp ftp.ubuntu.com
Connesso a ftp.ubuntu.com.
220 FTP server (vsftpd)
200 Always in UTF8 mode.
Utente (ftp.ubuntu.com:(none)): anonymous
331 Please specify the password.
Password:
230 Login successful.
```

55	7.844208	192.168.1.11	91.189.88.24	TCP	66 49994 → 21 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=1 SACK_PERM=1
56	7.891590	91.189.88.24	192.168.1.11	TCP	66 21 → 49994 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1452 SACK_PERM=1 WS=128
57	7.891716	192.168.1.11	91.189.88.24	TCP	54 49994 → 21 [ACK] Seq=1 Ack=1 Win=8192 Len=0
58	7.945264	91.189.88.24	192.168.1.11	FTP	79 Response: 220 FTP server (vsftpd)
59	7.954270	192.168.1.11	91.189.88.24	FTP	68 Request: OPTS UTF8 ON
60	8.001661	91.189.88.24	192.168.1.11	TCP	60 21 → 49994 [ACK] Seq=26 Ack=15 Win=29312 Len=0
61	8.002501	91.189.88.24	192.168.1.11	FTP	80 Response: 200 Always in UTF8 mode.
62	8.042776	192.168.1.11	91.189.88.24	TCP	54 49994 → 21 [ACK] Seq=15 Ack=52 Win=8141 Len=0
76	11.915958	192.168.1.11	91.189.88.24	FTP	70 Request: USER anonymous
77	11.964825	91.189.88.24	192.168.1.11	FTP	88 Response: 331 Please specify the password.
78	12.004219	192.168.1.11	91.189.88.24	TCP	54 49994 → 21 [ACK] Seq=31 Ack=86 Win=8107 Len=0
79	12.704605	192.168.1.11	91.189.88.24	FTP	61 Request: PASS
80	12.752874	91.189.88.24	192.168.1.11	FTP	77 Response: 230 Login successful.
81	12.793098	192.168.1.11	91.189.88.24	TCP	54 49994 → 21 [ACK] Seq=38 Ack=109 Win=8084 Len=0

Phase-2

Sono stati inseriti una serie di comandi ftp sul terminale:

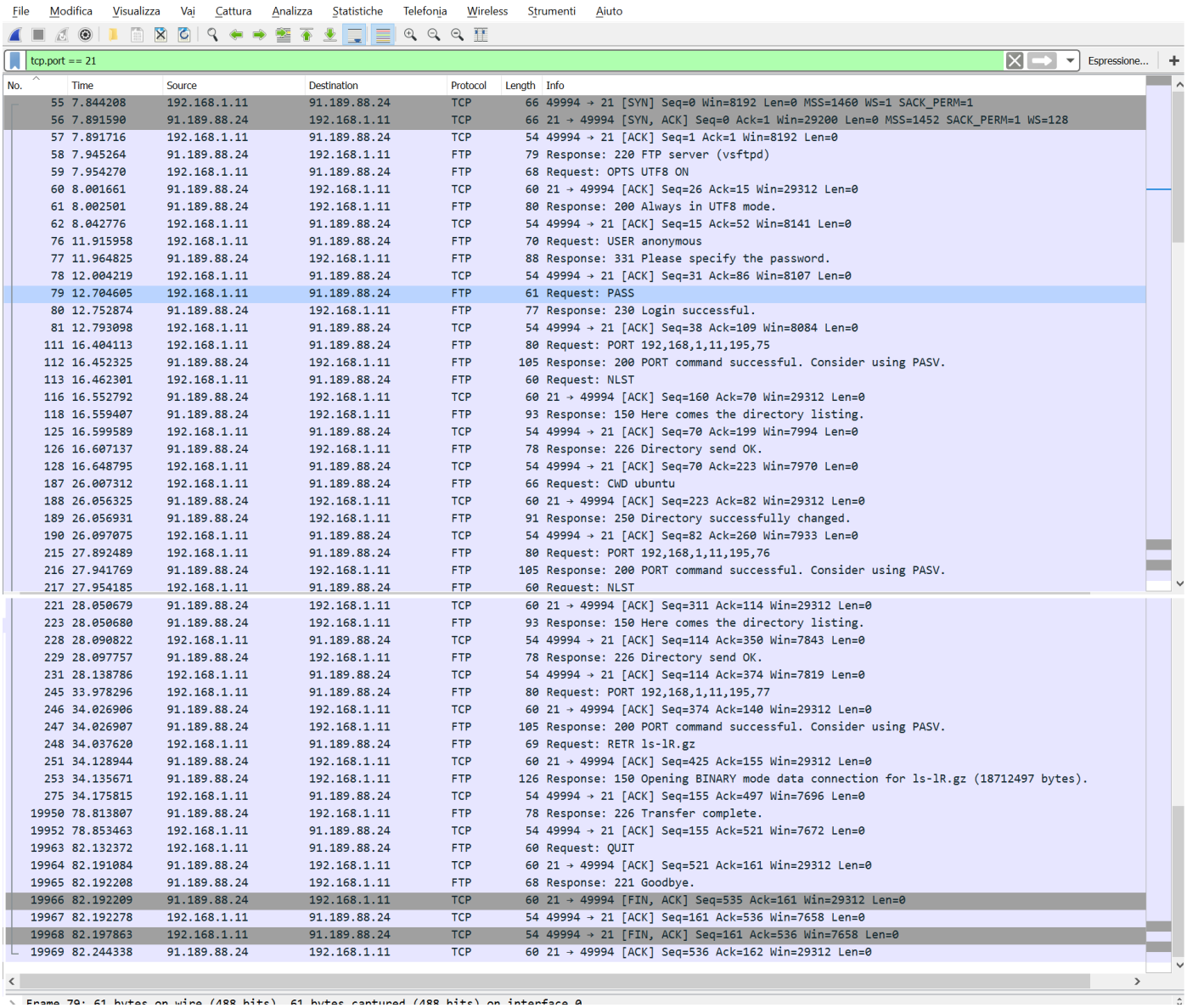
1. ?: per visualizzare l'elenco dei comandi FTP disponibili
2. ls: per visualizzare il contenuto della directory corrente
3. cd ubuntu: per modificare la directory corrente in ubuntu

4. ls: per visualizzare il contenuto della cartella ubuntu
5. get ls-lR.gz: per scaricare il file *ls-lR.gz*
6. exit: per terminare la sessione FTP

```
ftp> ?
I comandi possono essere abbreviati. I comandi sono:

!               delete          literal         prompt          send
?               debug           ls              put             status
append          dir             mdelete         pwd             trace
ascii           disconnect      mdir            quit            type
bell            get             mget            quote           user
binary          glob            mkdir           recv            verbose
bye             hash            mls             remotehelp
cd              help            mput            rename
close           lcd             open            rmdir
ftp> ls
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
ubuntu
226 Directory send OK.
ftp: 11 bytes received in 0.00secondi 5.50Kbyte/sec)
ftp> cd ubuntu
250 Directory successfully changed.
ftp> ls
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
dists
indices
ls-lR.gz
pool
project
ubuntu
226 Directory send OK.
ftp: 52 bytes received in 0.01secondi 8.67Kbyte/sec)
ftp> get ls-lR.gz
200 PORT command successful. Consider using PASV.
150 Opening BINARY mode data connection for ls-lR.gz (18712497 bytes).
226 Transfer complete.
ftp: 18712497 bytes received in 49.34secondi 379.29Kbyte/sec)
ftp> bye
221 Goodbye.
```

Una volta eseguiti tutti i comandi è stato analizzato il traffico generato attraverso Wireshark.

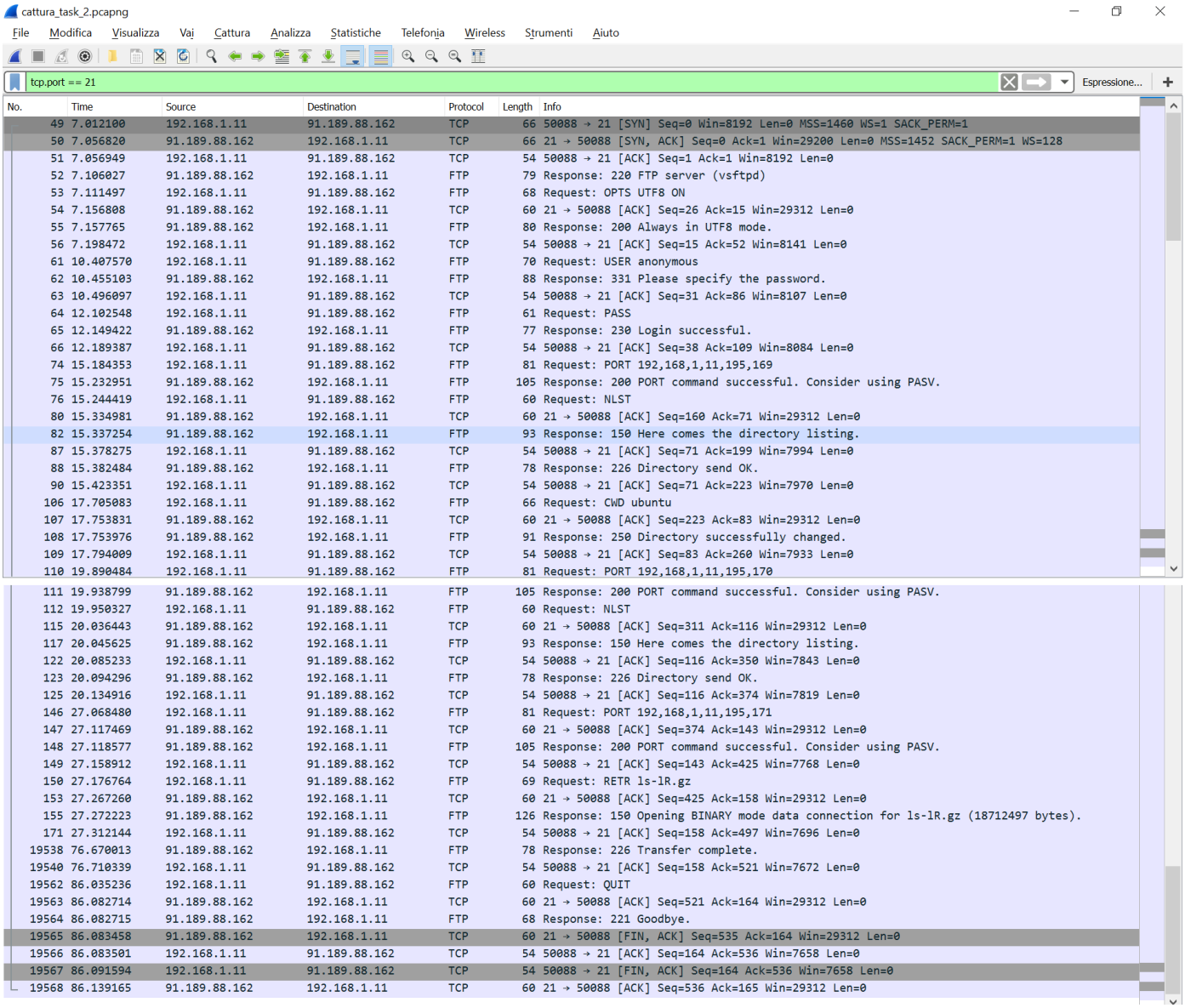

File Modifica Visualizza Vai Cattura Analizza Statistiche Telefonia Wireless Strumenti Aiuto
tcp.port == 21
Espressione...
No. Time Source Destination Protocol Length Info
55 7.844208 192.168.1.11 91.189.88.24 TCP 66 49994 → 21 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=1 SACK_PERM=1
56 7.891590 91.189.88.24 192.168.1.11 TCP 66 21 → 49994 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1452 SACK_PERM=1 WS=128
57 7.891716 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=1 Ack=1 Win=8192 Len=0
58 7.945264 91.189.88.24 192.168.1.11 FTP 79 Response: 220 FTP server (vsftpd)
59 7.954270 192.168.1.11 91.189.88.24 FTP 68 Request: OPTS UTF8 ON
60 8.001661 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=26 Ack=15 Win=29312 Len=0
61 8.002501 91.189.88.24 192.168.1.11 FTP 80 Response: 200 Always in UTF8 mode.
62 8.042776 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=15 Ack=52 Win=8141 Len=0
76 11.915958 192.168.1.11 91.189.88.24 FTP 70 Request: USER anonymous
77 11.964825 91.189.88.24 192.168.1.11 FTP 88 Response: 331 Please specify the password.
78 12.004219 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=31 Ack=86 Win=8107 Len=0
79 12.704605 192.168.1.11 91.189.88.24 FTP 61 Request: PASS
80 12.752874 91.189.88.24 192.168.1.11 FTP 77 Response: 230 Login successful.
81 12.793098 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=38 Ack=109 Win=8084 Len=0
111 16.404113 192.168.1.11 91.189.88.24 FTP 80 Request: PORT 192,168,1,11,195,75
112 16.452325 91.189.88.24 192.168.1.11 FTP 105 Response: 200 PORT command successful. Consider using PASV.
113 16.462301 192.168.1.11 91.189.88.24 FTP 60 Request: NLST
116 16.552792 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=160 Ack=70 Win=29312 Len=0
118 16.559407 91.189.88.24 192.168.1.11 FTP 93 Response: 150 Here comes the directory listing.
125 16.599589 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=70 Ack=199 Win=7994 Len=0
126 16.607137 91.189.88.24 192.168.1.11 FTP 78 Response: 226 Directory send OK.
128 16.648795 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=70 Ack=223 Win=7970 Len=0
187 26.007312 192.168.1.11 91.189.88.24 FTP 66 Request: CWD ubuntu
188 26.056325 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=223 Ack=82 Win=29312 Len=0
189 26.056931 91.189.88.24 192.168.1.11 FTP 91 Response: 250 Directory successfully changed.
190 26.097075 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=82 Ack=260 Win=7933 Len=0
215 27.892489 192.168.1.11 91.189.88.24 FTP 80 Request: PORT 192,168,1,11,195,76
216 27.941769 91.189.88.24 192.168.1.11 FTP 105 Response: 200 PORT command successful. Consider using PASV.
217 27.954185 192.168.1.11 91.189.88.24 FTP 60 Request: NLST
221 28.050679 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=311 Ack=114 Win=29312 Len=0
223 28.050680 91.189.88.24 192.168.1.11 FTP 93 Response: 150 Here comes the directory listing.
228 28.090822 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=114 Ack=350 Win=7843 Len=0
229 28.097757 91.189.88.24 192.168.1.11 FTP 78 Response: 226 Directory send OK.
231 28.138786 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=114 Ack=374 Win=7819 Len=0
245 33.978296 192.168.1.11 91.189.88.24 FTP 80 Request: PORT 192,168,1,11,195,77
246 34.026906 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=374 Ack=140 Win=29312 Len=0
247 34.026907 91.189.88.24 192.168.1.11 FTP 105 Response: 200 PORT command successful. Consider using PASV.
248 34.037620 192.168.1.11 91.189.88.24 FTP 69 Request: RETR ls-lR.gz
251 34.128944 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=425 Ack=155 Win=29312 Len=0
253 34.135671 91.189.88.24 192.168.1.11 FTP 126 Response: 150 Opening BINARY mode data connection for ls-lR.gz (18712497 bytes).
275 34.175815 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=155 Ack=497 Win=7696 Len=0
19950 78.813807 91.189.88.24 192.168.1.11 FTP 78 Response: 226 Transfer complete.
19952 78.853463 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=155 Ack=521 Win=7672 Len=0
19963 82.132372 192.168.1.11 91.189.88.24 FTP 60 Request: QUIT
19964 82.191084 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=521 Ack=161 Win=29312 Len=0
19965 82.192208 91.189.88.24 192.168.1.11 FTP 68 Response: 221 Goodbye.
19966 82.192209 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [FIN, ACK] Seq=535 Ack=161 Win=29312 Len=0
19967 82.192278 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [ACK] Seq=161 Ack=536 Win=7658 Len=0
19968 82.197863 192.168.1.11 91.189.88.24 TCP 54 49994 → 21 [FIN, ACK] Seq=161 Ack=536 Win=7658 Len=0
19969 82.244338 91.189.88.24 192.168.1.11 TCP 60 21 → 49994 [ACK] Seq=536 Ack=162 Win=29312 Len=0

TASK 2

Questions about Phase-0

1. Which is the most appropriate filter that allows you to display only traffic belonging to the FTP session? To answer this question, consider that there are multiple filters that you can adopt to achieve such goal, but one of those filters is the most suitable one.

Il filtro più appropriato per evidenziare un traffico FTP quando non si è a conoscenza dell'indirizzo ip del server è *tcp.port == 21*, in quanto permette di visualizzare i pacchetti scambiati con la well-known port del server dove tutte le richieste dei client vengono spedite.



No.	Time	Source	Destination	Protocol	Length	Info
49	7.012100	192.168.1.11	91.189.88.162	TCP	66	50088 → 21 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=1 SACK_PERM=1
50	7.056820	91.189.88.162	192.168.1.11	TCP	66	21 → 50088 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1452 SACK_PERM=1 WS=128
51	7.056949	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=1 Ack=1 Win=8192 Len=0
52	7.106027	91.189.88.162	192.168.1.11	FTP	79	Response: 220 FTP server (vsftpd)
53	7.111497	192.168.1.11	91.189.88.162	FTP	68	Request: OPTS UTF8 ON
54	7.156808	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=26 Ack=15 Win=29312 Len=0
55	7.157765	91.189.88.162	192.168.1.11	FTP	80	Response: 200 Always in UTF8 mode.
56	7.198472	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=15 Ack=52 Win=8141 Len=0
61	10.407570	192.168.1.11	91.189.88.162	FTP	70	Request: USER anonymous
62	10.455103	91.189.88.162	192.168.1.11	FTP	88	Response: 331 Please specify the password.
63	10.496097	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=31 Ack=86 Win=8107 Len=0
64	12.102548	192.168.1.11	91.189.88.162	FTP	61	Request: PASS
65	12.149422	91.189.88.162	192.168.1.11	FTP	77	Response: 230 Login successful.
66	12.189387	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=38 Ack=109 Win=8084 Len=0
74	15.184353	192.168.1.11	91.189.88.162	FTP	81	Request: PORT 192,168,1,11,195,169
75	15.232951	91.189.88.162	192.168.1.11	FTP	105	Response: 200 PORT command successful. Consider using PASV.
76	15.244419	192.168.1.11	91.189.88.162	FTP	60	Request: NLST
80	15.334981	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=160 Ack=71 Win=29312 Len=0
82	15.337254	91.189.88.162	192.168.1.11	FTP	93	Response: 150 Here comes the directory listing.
87	15.378275	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=71 Ack=199 Win=7994 Len=0
88	15.382484	91.189.88.162	192.168.1.11	FTP	78	Response: 226 Directory send OK.
90	15.423351	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=71 Ack=223 Win=7970 Len=0
106	17.705083	192.168.1.11	91.189.88.162	FTP	66	Request: CWD ubuntu
107	17.753831	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=223 Ack=83 Win=29312 Len=0
108	17.753976	91.189.88.162	192.168.1.11	FTP	91	Response: 250 Directory successfully changed.
109	17.794009	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=83 Ack=260 Win=7933 Len=0
110	19.890484	192.168.1.11	91.189.88.162	FTP	81	Request: PORT 192,168,1,11,195,170
111	19.938799	91.189.88.162	192.168.1.11	FTP	105	Response: 200 PORT command successful. Consider using PASV.
112	19.950327	192.168.1.11	91.189.88.162	FTP	60	Request: NLST
115	20.036443	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=311 Ack=116 Win=29312 Len=0
117	20.045625	91.189.88.162	192.168.1.11	FTP	93	Response: 150 Here comes the directory listing.
122	20.085233	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=116 Ack=350 Win=7843 Len=0
123	20.094296	91.189.88.162	192.168.1.11	FTP	78	Response: 226 Directory send OK.
125	20.134916	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=116 Ack=374 Win=7819 Len=0
146	27.068480	192.168.1.11	91.189.88.162	FTP	81	Request: PORT 192,168,1,11,195,171
147	27.117469	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=374 Ack=143 Win=29312 Len=0
148	27.118577	91.189.88.162	192.168.1.11	FTP	105	Response: 200 PORT command successful. Consider using PASV.
149	27.158912	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=143 Ack=425 Win=7768 Len=0
150	27.176764	192.168.1.11	91.189.88.162	FTP	69	Request: RETR ls-lR.gz
153	27.267260	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=425 Ack=158 Win=29312 Len=0
155	27.272223	91.189.88.162	192.168.1.11	FTP	126	Response: 150 Opening BINARY mode data connection for ls-lR.gz (18712497 bytes).
171	27.312144	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=158 Ack=497 Win=7696 Len=0
19538	76.670013	91.189.88.162	192.168.1.11	FTP	78	Response: 226 Transfer complete.
19540	76.710339	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=158 Ack=521 Win=7672 Len=0
19562	86.035236	192.168.1.11	91.189.88.162	FTP	60	Request: QUIT
19563	86.082714	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=521 Ack=164 Win=29312 Len=0
19564	86.082715	91.189.88.162	192.168.1.11	FTP	68	Response: 221 Goodbye.
19565	86.083458	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [FIN, ACK] Seq=535 Ack=164 Win=29312 Len=0
19566	86.083501	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [ACK] Seq=164 Ack=536 Win=7658 Len=0
19567	86.091594	192.168.1.11	91.189.88.162	TCP	54	50088 → 21 [FIN, ACK] Seq=164 Ack=536 Win=7658 Len=0
19568	86.139165	91.189.88.162	192.168.1.11	TCP	60	21 → 50088 [ACK] Seq=536 Ack=165 Win=29312 Len=0

Questions about Phase-1

1. Which is the IP address of the Ubuntu FTP server?

L'indirizzo del server ftp Ubuntu che ha risposto alla richiesta di connessione è 91.189.88.162.

2. Which is the TCP port adopted by your FTP client in order to start the TCP three-way-handshake to the Ubuntu FTP server?

La porta utilizzata dal client per iniziare la connessione con il server ftp Ubuntu è la 50088.

3. Which are the messages, Request and Response, exchanged during this Phase? Describe who sends this message to who (i.e., from client to server, or vice-versa).
Also, indicate:
i) if those messages belongs to the command or to the data connection;

ii) which TCP ports are used during this exchange.

Dopo la three-way handshake avviata dal client verso il server, i messaggi di request e response sono i seguenti:

52	7.106027	91.189.88.162	192.168.1.11	FTP	79 Response: 220 FTP server (vsftpd)
53	7.111497	192.168.1.11	91.189.88.162	FTP	68 Request: OPTS UTF8 ON
55	7.157765	91.189.88.162	192.168.1.11	FTP	80 Response: 200 Always in UTF8 mode.
61	10.407570	192.168.1.11	91.189.88.162	FTP	70 Request: USER anonymous
62	10.455103	91.189.88.162	192.168.1.11	FTP	88 Response: 331 Please specify the password.
64	12.102548	192.168.1.11	91.189.88.162	FTP	61 Request: PASS
65	12.149422	91.189.88.162	192.168.1.11	FTP	77 Response: 230 Login successful.

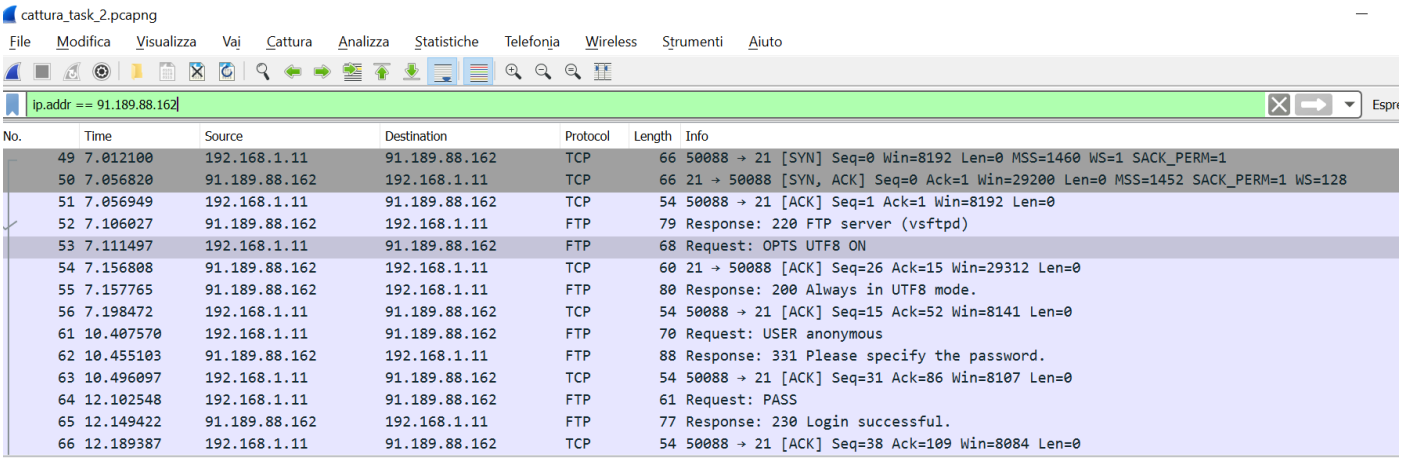
Packet No. :

52. Response (server -> client): il server si identifica al client
53. Request (client -> server): il client chiede di utilizzare la codifica UTF8
55. Response (server -> client): il server dichiara di essere già in codifica UTF8
61. Request (client -> server): il client chiede di effettuare il login con USER anonymous
62. Response (server -> client): il server chiede di specificare la password
64. Request (client -> server): il client invia la PASS vuota
65. Response (server -> client): il server comunica che il login è avvenuto con successo

Tutti questi messaggi appartengono alla "*command connection*", infatti le porte coinvolte sono la 50088 per il client e la 21 per il server.

4. Is there any message exchanged on the data connection? Hint: to answer this question, consider to change your filter in ip.addr == <ubuntu_ftp_server_IP_Addr>

Durante la fase di connessione al server non viene scambiato nessun messaggio sulla "data connection", infatti non viene mai aperta.



Questions about Phase-2

Step 1: ?, the question mark allows to display which command can be performed on the FTP server.

```
ftp> ?
I comandi possono essere abbreviati. I comandi sono:

!               delete          literal         prompt          send
?               debug           ls              put             status
append          dir             mdelete         pwd             trace
ascii           disconnect      mdir            quit            type
bell            get             mget            quote           user
binary          glob            mkdir           recv            verbose
bye             hash            mls             remotehelp
cd              help            mput            rename
close           lcd             open            rmdir
```

1. Which messages, if any, are exchanged between client and server?

Per questo comando non vengono inviati messaggi al server. Le informazioni relative ai comandi utilizzabili sul server FTP sono contenute nell'applicazione dell'utente, che quindi può direttamente rispondere senza dover fare richieste al server.

Step 2: ls, this command allows to display the content of the current folder.

```
ftp> ls
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
ubuntu
226 Directory send OK.
ftp: 11 bytes received in 0.00secondi 5.50Kbyte/sec)
```

1. Which messages, if any, are exchanged between client and server?

I messaggi scambiati tra client e server per eseguire il comando sono:

74	15.184353	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,169
75	15.232951	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
76	15.244419	192.168.1.11	91.189.88.162	FTP	60 Request: NLST
77	15.290019	91.189.88.162	192.168.1.11	TCP	74 42385 → 50089 [SYN] Seq=0 Win=29200 Len=0 MSS=1452 SACK_PERM=1 TSval=210651545 TSecr=0…
78	15.290156	192.168.1.11	91.189.88.162	TCP	66 50089 → 42385 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM=1
80	15.334981	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=160 Ack=71 Win=29312 Len=0
81	15.335770	91.189.88.162	192.168.1.11	TCP	60 42385 → 50089 [ACK] Seq=1 Ack=1 Win=29312 Len=0
82	15.337254	91.189.88.162	192.168.1.11	FTP	93 Response: 150 Here comes the directory listing.
83	15.337255	91.189.88.162	192.168.1.11	TCP	62 42385 → 50089 [PSH, ACK] Seq=1 Ack=1 Win=29312 Len=8
84	15.337256	91.189.88.162	192.168.1.11	TCP	60 42385 → 50089 [FIN, ACK] Seq=9 Ack=1 Win=29312 Len=0
85	15.337324	192.168.1.11	91.189.88.162	TCP	54 50089 → 42385 [ACK] Seq=1 Ack=10 Win=132096 Len=0
86	15.348206	192.168.1.11	91.189.88.162	TCP	54 50089 → 42385 [FIN, ACK] Seq=1 Ack=10 Win=132096 Len=0
87	15.378275	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=71 Ack=199 Win=7994 Len=0
88	15.382484	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Directory send OK.
89	15.392699	91.189.88.162	192.168.1.11	TCP	60 42385 → 50089 [ACK] Seq=10 Ack=2 Win=29312 Len=0
90	15.423351	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=71 Ack=223 Win=7970 Len=0

I messaggi Request e Response scambiati tra client e server sono quindi questi:

74	15.184353	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,169
75	15.232951	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
76	15.244419	192.168.1.11	91.189.88.162	FTP	60 Request: NLST
82	15.337254	91.189.88.162	192.168.1.11	FTP	93 Response: 150 Here comes the directory listing.
88	15.382484	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Directory send OK.

2. On which connection, command or data, are those message exchanged?

I messaggi contenenti le Request e le Response sono inviati sulla connessione di controllo, mentre le informazioni richieste dal comando NLST sono inviate sulla connessione dati.

3. In case messages are exchanged on data connection:

a. Is data connection opened in ACTIVE or PASSIVE mode? Please, motivate your answer by telling your consideration
b. Whether connection is ACTIVE or PASSIVE, which TCP port is used to establish the connection?

La connessione dati è aperta in modo attivo, perchè il server effettua la prima richiesta di connessione verso la porta designata dal client nel comando PORT (cioè la 50089). La porta utilizzata per stabilire la connessione è la 42385 del server.

4. For each connection, command and data, list all messages (request and response) being exchanged, describing the meaning of each message.

Sul collegamento di controllo sono scambiati i seguenti pacchetti.

74	15.184353	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,169
75	15.232951	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
76	15.244419	192.168.1.11	91.189.88.162	FTP	60 Request: NLST
80	15.334981	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=160 Ack=71 Win=29312 Len=0
82	15.337254	91.189.88.162	192.168.1.11	FTP	93 Response: 150 Here comes the directory listing.
87	15.378275	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=71 Ack=199 Win=7994 Len=0
88	15.382484	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Directory send OK.
90	15.423351	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=71 Ack=223 Win=7970 Len=0

I pacchetti di Request e Response sono i seguenti.

Packet No. :

74. Il client effettua una Request di connessione attiva al server tramite il comando PORT all'interno del quale comunica la porta sulla quale il server deve effettuare la richiesta.
75. Il server risponde che ha accettato la richiesta di connessione attiva alla porta specificata.

76. Il client effettua una Request al server del comando NLST
82. Il server comunica al client che sta trasmettendo sulla connessione dati le informazioni richieste.
88. il server informa il client che le informazioni sono state inviate con successo.

Sul collegamento dati, invece, sono scambiati i seguenti pacchetti.

```
77 15.290019    91.189.88.162    192.168.1.11     TCP    74 42385 → 50089 [SYN] Seq=0 Win=29200 Len=0 MSS=1452 SACK_PERM=1 TSval=210651545 TSecr=0 WS=128
78 15.290156    192.168.1.11     91.189.88.162    TCP    66 50089 → 42385 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM=1
81 15.335770    91.189.88.162    192.168.1.11     TCP    60 42385 → 50089 [ACK] Seq=1 Ack=1 Win=29312 Len=0
83 15.337255    91.189.88.162    192.168.1.11     TCP    62 42385 → 50089 [PSH, ACK] Seq=1 Ack=1 Win=29312 Len=8
84 15.337256    91.189.88.162    192.168.1.11     TCP    60 42385 → 50089 [FIN, ACK] Seq=9 Ack=1 Win=29312 Len=0
85 15.337324    192.168.1.11     91.189.88.162    TCP    54 50089 → 42385 [ACK] Seq=1 Ack=10 Win=132096 Len=0
86 15.348206    192.168.1.11     91.189.88.162    TCP    54 50089 → 42385 [FIN, ACK] Seq=1 Ack=10 Win=132096 Len=0
89 15.392699    91.189.88.162    192.168.1.11     TCP    60 42385 → 50089 [ACK] Seq=10 Ack=2 Win=29312 Len=0
```

In questa connessione non vengono scambiati pacchetti Request e Response, ma semplicemente le informazioni relative al contenuto della directory, richieste con NLST. Il collegamento poi chiuso appena viene terminato il trasferimento.

Step 3: cd <folder>, adopt this command to enter the folder displayed at step 2.

```
ftp> cd ubuntu
250 Directory successfully changed.
```

1. Which messages, if any, are exchanged between client and server?

I messaggi scambiati tra client e server per eseguire il comando sono:

```
106 17.705083    192.168.1.11     91.189.88.162    FTP    66 Request: CWD ubuntu
107 17.753831    91.189.88.162    192.168.1.11     TCP    60 21 → 50088 [ACK] Seq=223 Ack=83 Win=29312 Len=0
108 17.753976    91.189.88.162    192.168.1.11     FTP    91 Response: 250 Directory successfully changed.
109 17.794009    192.168.1.11     91.189.88.162    TCP    54 50088 → 21 [ACK] Seq=83 Ack=260 Win=7933 Len=0
```

I messaggi Request e Response scambiati tra client e server sono quindi questi:

```
106 17.705083    192.168.1.11     91.189.88.162    FTP    66 Request: CWD ubuntu
108 17.753976    91.189.88.162    192.168.1.11     FTP    91 Response: 250 Directory successfully changed.
```

2. On which connection, command or data, are those message exchanged?

I messaggi per questo comando sono trasferiti tutti sulla connessione di controllo tra server e client. La connessione dati non viene mai aperta.

4. For each connection, command and data, list all messages (request and response) being exchanged, describing the meaning of each message.

Sul collegamento di controllo sono scambiati i seguenti pacchetti.

```
106 17.705083    192.168.1.11     91.189.88.162    FTP    66 Request: CWD ubuntu
107 17.753831    91.189.88.162    192.168.1.11     TCP    60 21 → 50088 [ACK] Seq=223 Ack=83 Win=29312 Len=0
108 17.753976    91.189.88.162    192.168.1.11     FTP    91 Response: 250 Directory successfully changed.
109 17.794009    192.168.1.11     91.189.88.162    TCP    54 50088 → 21 [ACK] Seq=83 Ack=260 Win=7933 Len=0
```

Packet No. :

106. Il client effettua una Request al server di cambiare la directory corrente con ./ubuntu tramite il comando CWD
108. Il server comunica al client che la directory è stata cambiata con successo con quella desiderata

Sulla connessione dati, invece, non sono scambiati pacchetti.

Step 4: ls, enter again this command.

```
ftp> ls
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
dists
indices
ls-lR.gz
pool
project
ubuntu
226 Directory send OK.
ftp: 52 bytes received in 0.01secondi 10.40Kbyte/sec)
```

1. Which messages, if any, are exchanged between client and server?

I messaggi scambiati tra client e server per eseguire il comando sono:

110	19.890484	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,170
111	19.938799	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
112	19.950327	192.168.1.11	91.189.88.162	FTP	60 Request: NLST
113	19.995206	91.189.88.162	192.168.1.11	TCP	74 34305 → 50090 [SYN] Seq=0 Win=29200 Len=0 MSS=1452 SACK_PERM=1 TSval=210656250 TSecr=0…
114	19.995339	192.168.1.11	91.189.88.162	TCP	66 50090 → 34305 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM=1
115	20.036443	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=311 Ack=116 Win=29312 Len=0
116	20.041708	91.189.88.162	192.168.1.11	TCP	60 34305 → 50090 [ACK] Seq=1 Ack=1 Win=29312 Len=0
117	20.045625	91.189.88.162	192.168.1.11	FTP	93 Response: 150 Here comes the directory listing.
118	20.046669	91.189.88.162	192.168.1.11	TCP	103 34305 → 50090 [PSH, ACK] Seq=1 Ack=1 Win=29312 Len=49
119	20.047566	91.189.88.162	192.168.1.11	TCP	60 34305 → 50090 [FIN, ACK] Seq=50 Ack=1 Win=29312 Len=0
120	20.047605	192.168.1.11	91.189.88.162	TCP	54 50090 → 34305 [ACK] Seq=1 Ack=51 Win=131840 Len=0
121	20.063258	192.168.1.11	91.189.88.162	TCP	54 50090 → 34305 [FIN, ACK] Seq=1 Ack=51 Win=131840 Len=0
122	20.085233	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=116 Ack=350 Win=7843 Len=0
123	20.094296	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Directory send OK.
124	20.109820	91.189.88.162	192.168.1.11	TCP	60 34305 → 50090 [ACK] Seq=51 Ack=2 Win=29312 Len=0
125	20.134916	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=116 Ack=374 Win=7819 Len=0

I messaggi Request e Response scambiati tra client e server sono quindi questi:

110	19.890484	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,170
111	19.938799	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
112	19.950327	192.168.1.11	91.189.88.162	FTP	60 Request: NLST
117	20.045625	91.189.88.162	192.168.1.11	FTP	93 Response: 150 Here comes the directory listing.
123	20.094296	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Directory send OK.

2. On which connection, command or data, are those message exchanged?

I messaggi contenenti le Request e le Response sono inviati sulla connessione di controllo, mentre le informazioni richieste dal comando NLST sono inviate sulla connessione dati.

3. In case messages are exchanged on data connection:

c. Is data connection opened in ACTIVE or PASSIVE mode? Please, motivate your answer by telling your consideration
d. Whether connection is ACTIVE or PASSIVE, which TCP port is used to establish the connection?

La connessione dati è aperta in modo attivo, perchè il server effettua la prima richiesta di connessione verso la porta designata dal client nel comando PORT (cioè la 50090). La porta utilizzata per stabilire la connessione è la 34305 del server.

4. For each connection, command and data, list all messages (request and response) being exchanged, describing the meaning of each message.

Sul collegamento di controllo sono scambiati i seguenti pacchetti.

110	19.890484	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,170
111	19.938799	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
112	19.950327	192.168.1.11	91.189.88.162	FTP	60 Request: NLST
115	20.036443	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=311 Ack=116 Win=29312 Len=0
117	20.045625	91.189.88.162	192.168.1.11	FTP	93 Response: 150 Here comes the directory listing.
122	20.085233	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=116 Ack=350 Win=7843 Len=0
123	20.094296	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Directory send OK.
125	20.134916	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=116 Ack=374 Win=7819 Len=0

I pacchetti di Request e Response sono i seguenti.

Packet No. :

110. Il client effettua una Request di connessione attiva al server tramite il comando PORT all'interno del quale comunica la porta sulla quale il server deve effettuare la richiesta.
111. Il server risponde che ha accettato la richiesta di connessione attiva alla porta specificata.
112. Il client effettua una Request al server del comando NLST
117. Il server comunica al client che sta trasmettendo sulla connessione dati le informazioni richieste.
123. Il server informa il client che le informazioni sono state inviate con successo.

Sul collegamento dati, invece, sono scambiati i seguenti pacchetti.

113	19.995206	91.189.88.162	192.168.1.11	TCP	74 34305 → 50090 [SYN] Seq=0 Win=29200 Len=0 MSS=1452 SACK_PERM=1 TSval=210656250 TSecr=0 WS=128
114	19.995339	192.168.1.11	91.189.88.162	TCP	66 50090 → 34305 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM=1
116	20.041708	91.189.88.162	192.168.1.11	TCP	60 34305 → 50090 [ACK] Seq=1 Ack=1 Win=29312 Len=0
118	20.046669	91.189.88.162	192.168.1.11	TCP	103 34305 → 50090 [PSH, ACK] Seq=1 Ack=1 Win=29312 Len=49
119	20.047566	91.189.88.162	192.168.1.11	TCP	60 34305 → 50090 [FIN, ACK] Seq=50 Ack=1 Win=29312 Len=0
120	20.047605	192.168.1.11	91.189.88.162	TCP	54 50090 → 34305 [ACK] Seq=1 Ack=51 Win=131840 Len=0
121	20.063258	192.168.1.11	91.189.88.162	TCP	54 50090 → 34305 [FIN, ACK] Seq=1 Ack=51 Win=131840 Len=0
124	20.109820	91.189.88.162	192.168.1.11	TCP	60 34305 → 50090 [ACK] Seq=51 Ack=2 Win=29312 Len=0

In questa connessione non vengono scambiati pacchetti Request e Response, ma semplicemente le informazioni relative al contenuto della directory, richieste con NLST. Il collegamento poi chiuso appena viene terminato il trasferimento.

Step 5: get ls-lR.gz, this command allows the download of ls-lR.gz.

```
ftp> get ls-lR.gz
200 PORT command successful. Consider using PASV.
150 Opening BINARY mode data connection for ls-lR.gz (18712497 bytes).
226 Transfer complete.
ftp: 18712497 bytes received in 49.34secondi 379.29Kbyte/sec)
```

1. Which messages, if any, are exchanged between client and server?

I messaggi scambiati tra client e server per eseguire il comando sono:

146	27.068480	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,171
147	27.117469	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=374 Ack=143 Win=29312 Len=0
148	27.118577	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
149	27.158912	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=143 Ack=425 Win=7768 Len=0
150	27.176764	192.168.1.11	91.189.88.162	FTP	69 Request: RETR ls-lR.gz
151	27.225710	91.189.88.162	192.168.1.11	TCP	74 41639 → 50091 [SYN] Seq=0 Win=29200 Len=0 MSS=1452 SACK_PERM=1 TSval=210663480 TSecr=0…
152	27.225864	192.168.1.11	91.189.88.162	TCP	66 50091 → 41639 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM=1
153	27.267260	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=425 Ack=158 Win=29312 Len=0
154	27.270701	91.189.88.162	192.168.1.11	TCP	60 41639 → 50091 [ACK] Seq=1 Ack=1 Win=29312 Len=0
155	27.272223	91.189.88.162	192.168.1.11	FTP	126 Response: 150 Opening BINARY mode data connection for ls-lR.gz (18712497 bytes).
156	27.278151	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=1 Ack=1 Win=29312 Len=1452
157	27.278152	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=1453 Ack=1 Win=29312 Len=1452
158	27.278208	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=2905 Win=132096 Len=0
159	27.284428	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=2905 Ack=1 Win=29312 Len=1452
160	27.284429	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=4357 Ack=1 Win=29312 Len=1452
161	27.284450	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=5809 Win=132096 Len=0
162	27.295792	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=5809 Ack=1 Win=29312 Len=1452
19526	76.605489	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18703213 Ack=1 Win=29312 Len=1452
19527	76.608994	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18704665 Ack=1 Win=29312 Len=1452
19528	76.609061	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=18706117 Win=132096 Len=0
19529	76.612330	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18706117 Ack=1 Win=29312 Len=1452
19530	76.615500	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18707569 Ack=1 Win=29312 Len=1452
19531	76.615568	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=18709021 Win=132096 Len=0
19532	76.619286	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18709021 Ack=1 Win=29312 Len=1452
19533	76.622576	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18710473 Ack=1 Win=29312 Len=1452
19534	76.622646	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=18711925 Win=132096 Len=0
19535	76.624832	91.189.88.162	192.168.1.11	TCP	627 41639 → 50091 [FIN, PSH, ACK] Seq=18711925 Ack=1 Win=29312 Len=573
19536	76.624928	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=18712499 Win=131328 Len=0
19537	76.639693	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [FIN, ACK] Seq=1 Ack=18712499 Win=131328 Len=0
19538	76.670013	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Transfer complete.
19539	76.685610	91.189.88.162	192.168.1.11	TCP	60 41639 → 50091 [ACK] Seq=18712499 Ack=2 Win=29312 Len=0
19540	76.710339	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=158 Ack=521 Win=7672 Len=0
19562	86.035236	192.168.1.11	91.189.88.162	FTP	60 Request: QUIT
19563	86.082714	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=521 Ack=164 Win=29312 Len=0
19564	86.082715	91.189.88.162	192.168.1.11	FTP	68 Response: 221 Goodbye.
19565	86.083458	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [FIN, ACK] Seq=535 Ack=164 Win=29312 Len=0
19566	86.083501	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=164 Ack=536 Win=7658 Len=0

I messaggi Request e Response scambiati tra client e server sono quindi questi:

146	27.068480	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,171
148	27.118577	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
150	27.176764	192.168.1.11	91.189.88.162	FTP	69 Request: RETR ls-lR.gz
155	27.272223	91.189.88.162	192.168.1.11	FTP	126 Response: 150 Opening BINARY mode data connection for ls-lR.gz (18712497 bytes).
19538	76.670013	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Transfer complete.

2. On which connection, command or data, are those message exchanged?

I messaggi contenenti le Request e le Response sono inviati sulla connessione di controllo, mentre il file richiesto dal comando RETR è inviato sulla connessione dati.

3. In case messages are exchanged on data connection:

a. *Is data connection opened in ACTIVE or PASSIVE mode? Please, motivate your answer by telling your consideration*
b. *Whether connection is ACTIVE or PASSIVE, which TCP port is used to establish the connection?*

La connessione dati viene aperta in modalità attiva, perché è il server che invia il pacchetto di SYN al client per aprire la connessione. Le porte utilizzate in questa connessione dati sono la 41639 per il server e la 50091 per il client.

4. For each connection, command and data, list all messages (request and response) being exchanged, describing the meaning of each message.

Sul collegamento di controllo sono scambiati i seguenti pacchetti.

146	27.068480	192.168.1.11	91.189.88.162	FTP	81 Request: PORT 192,168,1,11,195,171
147	27.117469	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=374 Ack=143 Win=29312 Len=0
148	27.118577	91.189.88.162	192.168.1.11	FTP	105 Response: 200 PORT command successful. Consider using PASV.
149	27.158912	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=143 Ack=425 Win=7768 Len=0
150	27.176764	192.168.1.11	91.189.88.162	FTP	69 Request: RETR ls-lR.gz
153	27.267260	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=425 Ack=158 Win=29312 Len=0
155	27.272223	91.189.88.162	192.168.1.11	FTP	126 Response: 150 Opening BINARY mode data connection for ls-lR.gz (18712497 bytes).
171	27.312144	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=158 Ack=497 Win=7696 Len=0
19538	76.670013	91.189.88.162	192.168.1.11	FTP	78 Response: 226 Transfer complete.
19540	76.710339	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=158 Ack=521 Win=7672 Len=0

I pacchetti di Request e Response sono i seguenti.

Packet No. :

146. Il client effettua una Request di connessione attiva al server tramite il comando PORT all'interno del quale comunica la porta sulla quale il server deve effettuare la richiesta.
148. Il server risponde che ha accettato la richiesta di connessione attiva alla porta specificata.
150. Il client effettua una Request al server del comando RETR, cioè chiede di scaricare il file ls-lR.gz in locale.
124. Il server comunica al client che sta trasferendo il file sulla connessione dati.
19538. Il server informa il client che le trasferimento è stato effettuato con successo.

Sul collegamento dati, invece, sono scambiati i seguenti pacchetti.

151	27.225710	91.189.88.162	192.168.1.11	TCP	74 41639 → 50091 [SYN] Seq=0 Win=29200 Len=0 MSS=1452 SACK_PERM=1 TSval=210663486
152	27.225864	192.168.1.11	91.189.88.162	TCP	66 50091 → 41639 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM
154	27.270701	91.189.88.162	192.168.1.11	TCP	60 41639 → 50091 [ACK] Seq=1 Ack=1 Win=29312 Len=0
156	27.278151	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=1 Ack=1 Win=29312 Len=1452
157	27.278152	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=1453 Ack=1 Win=29312 Len=1452
158	27.278208	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=2905 Win=132096 Len=0
159	27.284428	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=2905 Ack=1 Win=29312 Len=1452
160	27.284429	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=4357 Ack=1 Win=29312 Len=1452
161	27.284450	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=5809 Win=132096 Len=0
19529	76.612550	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18706117 Ack=1 Win=29312 Len=1452
19530	76.615500	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18707569 Ack=1 Win=29312 Len=1452
19531	76.615568	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=18709021 Win=132096 Len=0
19532	76.619286	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18709021 Ack=1 Win=29312 Len=1452
19533	76.622576	91.189.88.162	192.168.1.11	TCP	1506 41639 → 50091 [ACK] Seq=18710473 Ack=1 Win=29312 Len=1452
19534	76.622646	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=18711925 Win=132096 Len=0
19535	76.624832	91.189.88.162	192.168.1.11	TCP	627 41639 → 50091 [FIN, PSH, ACK] Seq=18711925 Ack=1 Win=29312 Len=573
19536	76.624928	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [ACK] Seq=1 Ack=18712499 Win=131328 Len=0
19537	76.639693	192.168.1.11	91.189.88.162	TCP	54 50091 → 41639 [FIN, ACK] Seq=1 Ack=18712499 Win=131328 Len=0
19539	76.685610	91.189.88.162	192.168.1.11	TCP	60 41639 → 50091 [ACK] Seq=18712499 Ack=2 Win=29312 Len=0

In questa connessione non vengono scambiati pacchetti Request e Response, ma semplicemente viene trasferito il file ls-lR.gz, richiesto con RETR. Il collegamento viene poi chiuso appena terminato il trasferimento.

Step 6: exit (or bye), this command allows terminate FTP session.

```
ftp> bye
221 Goodbye.
```

1. Which messages, if any, are exchanged between client and server?

I messaggi scambiati tra client e server per eseguire il comando sono:

19562	86.035236	192.168.1.11	91.189.88.162	FTP	60 Request: QUIT
19563	86.082714	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=521 Ack=164 Win=29312 Len=0
19564	86.082715	91.189.88.162	192.168.1.11	FTP	68 Response: 221 Goodbye.
19565	86.083458	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [FIN, ACK] Seq=535 Ack=164 Win=29312 Len=0
19566	86.083501	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=164 Ack=536 Win=7658 Len=0
19567	86.091594	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [FIN, ACK] Seq=164 Ack=536 Win=7658 Len=0
19568	86.139165	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=536 Ack=165 Win=29312 Len=0

I messaggi Request e Response scambiati tra client e server sono quindi questi:

19562	86.035236	192.168.1.11	91.189.88.162	FTP	60 Request: QUIT
19564	86.082715	91.189.88.162	192.168.1.11	FTP	68 Response: 221 Goodbye.

2. On which connection, command or data, are those message exchanged?

Tutti i messaggi sono scambiati sulla connessione di controllo. La connessione dati non viene aperta.

4. For each connection, command and data, list all messages (request and response) being exchanged, describing the meaning of each message.

Sul collegamento di controllo sono scambiati i seguenti pacchetti.

19562	86.035236	192.168.1.11	91.189.88.162	FTP	60 Request: QUIT
19563	86.082714	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=521 Ack=164 Win=29312 Len=0
19564	86.082715	91.189.88.162	192.168.1.11	FTP	68 Response: 221 Goodbye.
19565	86.083458	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [FIN, ACK] Seq=535 Ack=164 Win=29312 Len=0
19566	86.083501	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [ACK] Seq=164 Ack=536 Win=7658 Len=0
19567	86.091594	192.168.1.11	91.189.88.162	TCP	54 50088 → 21 [FIN, ACK] Seq=164 Ack=536 Win=7658 Len=0
19568	86.139165	91.189.88.162	192.168.1.11	TCP	60 21 → 50088 [ACK] Seq=536 Ack=165 Win=29312 Len=0

I pacchetti di Request e Response sono i seguenti.

Packet No. :

19562. Il client effettua una Request di chiudere la connessione di controllo con il comando QUIT.
19564. Il server invia il messaggio Goodbye al client, confermando la richiesta di chiusura.

E si procede con la chiusura della connessione di controllo.

La connessione dati non viene aperta.