COMPUTER NETWORKS LAB – WEEK 2

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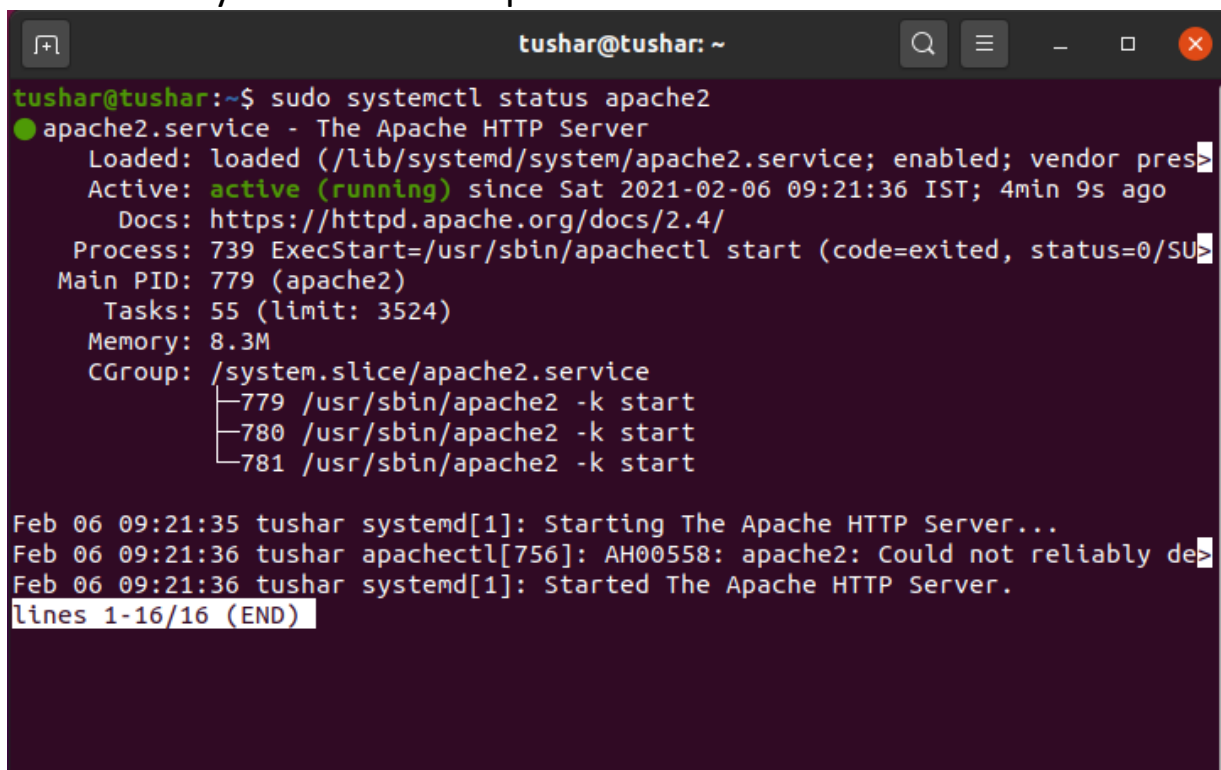
1. CONFIGURATION OF SERVER AND CLIENT:

1.1. Server side(ubuntu) configuration

- The Apache server is installed in server machine using the following command:

        sudo apt-get install apache2

- To make sure that the web server is running , we use the following command in the server machine:

        sudo systemctl status apache2

 The above image says that the server is active and running successfully.

- The server IP address is set manually using "Edit Connections".

It is set to :10.0.9.12.

```
tushar@tushar:~$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group defaul
t qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP gr
oup default qlen 1000
    link/ether 08:00:27:95:92:47 brd ff:ff:ff:ff:ff:ff
    inet 10.0.9.12/24 brd 10.0.9.255 scope global noprefixroute enp0s3
       valid_lft forever preferred_lft forever
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute enp0s3
       valid_lft 476sec preferred_lft 476sec
    inet6 fe80::f865:8faf:24cf:4fd4/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
tushar@tushar:~$
```
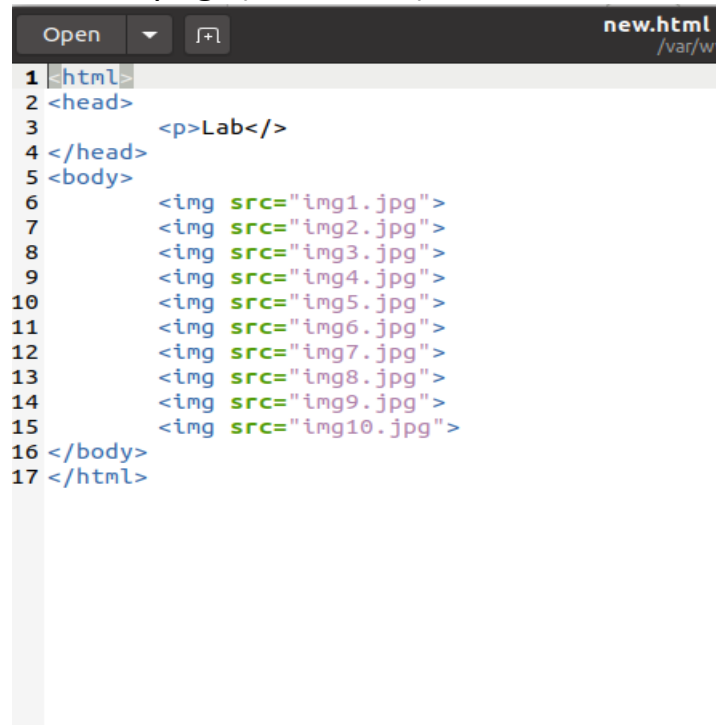
- The apache.config file in etc/apache2 directory is modified as:
    -'keep alive' option is set to on.
    -'MaximumKeepAliveRequests' is set to 2.

```
98 KeepAlive On
99
00 #
01 # MaxKeepAliveRequests: The maximum number of requests to allow
02 # during a persistent connection. Set to 0 to allow an unlimited amount.
03 # We recommend you leave this number high, for maximum performance.
04 #
05 MaxKeepAliveRequests 2
06
```

- A html page consisting of 10 images (img1.jpg-img10.jpg) is
stored(along with the images) in the path:
    /var/www/html/new.html
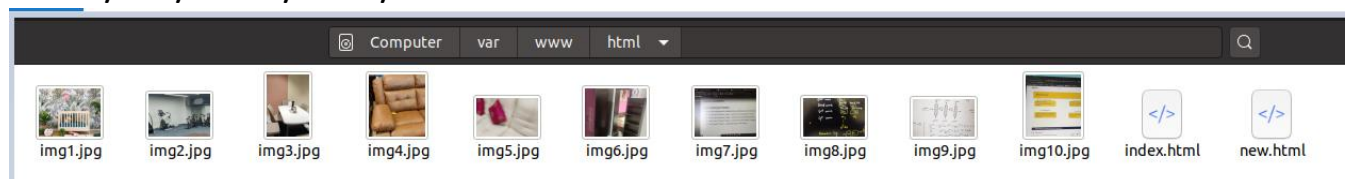
- A web page(new.html) is created as shown:

```
Open   ▼   ⊞                                    new.html
                                                /var/wv
1 <html>
2 <head>
3          <p>Lab</>
4 </head>
5 <body>
6          <img src="img1.jpg">
7          <img src="img2.jpg">
8          <img src="img3.jpg">
9          <img src="img4.jpg">
10         <img src="img5.jpg">
11         <img src="img6.jpg">
12         <img src="img7.jpg">
13         <img src="img8.jpg">
14         <img src="img9.jpg">
15         <img src="img10.jpg">
16 </body>
17 </html>
```

1.2. Client side (parrot)configuration
- The server IP address is set manually using "Edit Connections". It is set to :10.0.9.50.

```
●  ●  ●                        Parrot Terminal
File  Edit  View  Search  Terminal  Help
┌─[user@parrot]─[~]
└─ $ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group defaul
t qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP gr
oup default qlen 1000
    link/ether 08:00:27:5e:5e:9f brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.4/24 brd 10.0.2.255 scope global dynamic noprefixroute eth0
       valid_lft 529sec preferred_lft 529sec
    inet 10.0.9.50/24 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::61df:88a8:dd4c:ea1/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
┌─[user@parrot]─[~]
└─ $
```
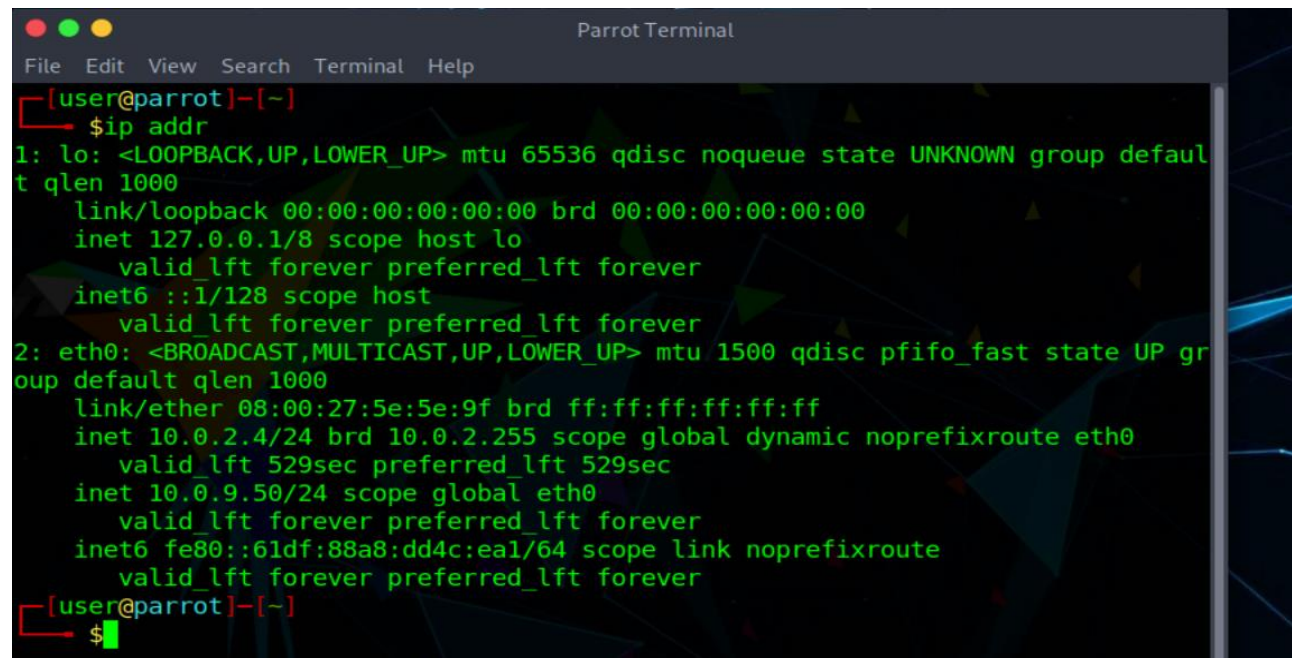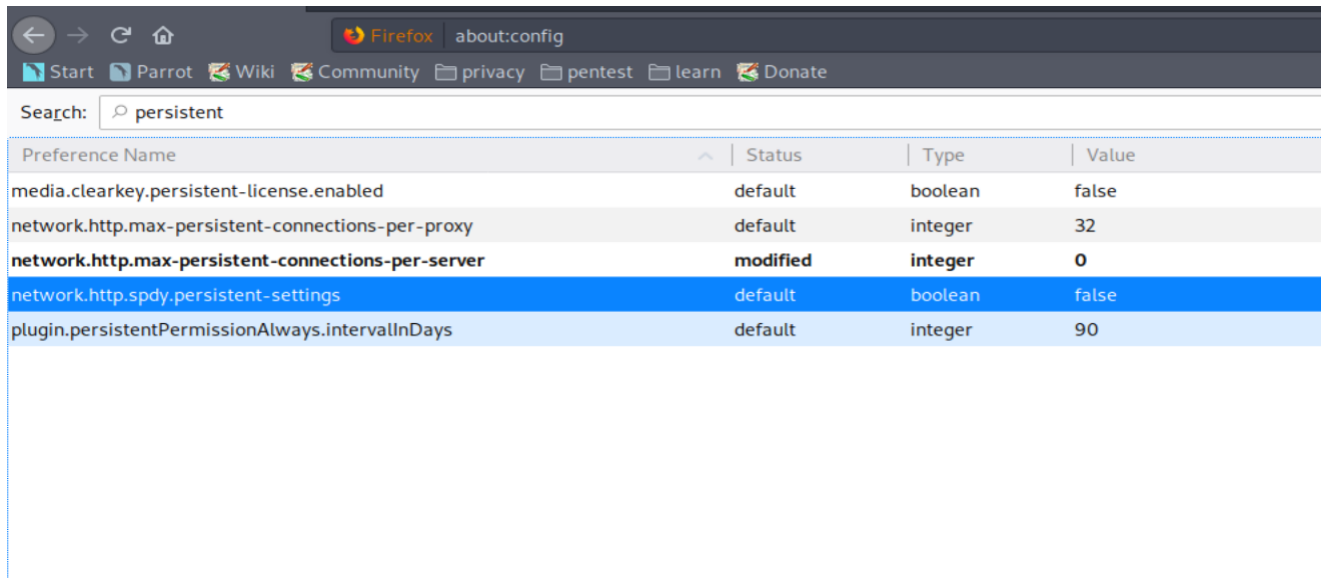
2. NON-PERSISTENT CONNECTION:

- The value of max-persistent-connections-per-server is set to 0 in the client's machine. Also, spdy.persistent-settings is set to 'false' as shown in the screenshot below.
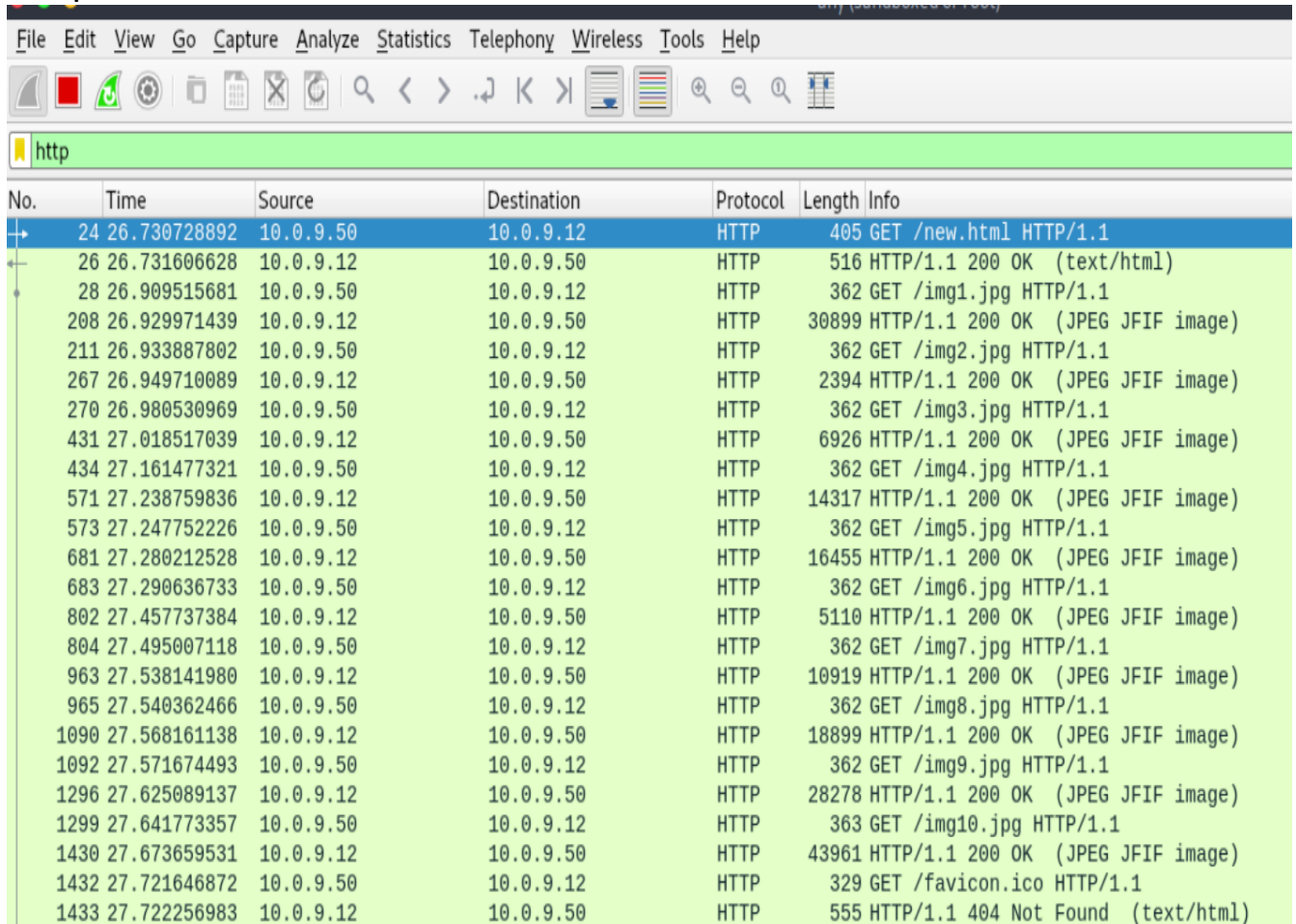
- The web page is accessed on client-side browser by typing in: 10.0.9.12/new.html, where "10.0.9.12" is server's IP address and "new.html" is the file which is in the server side.
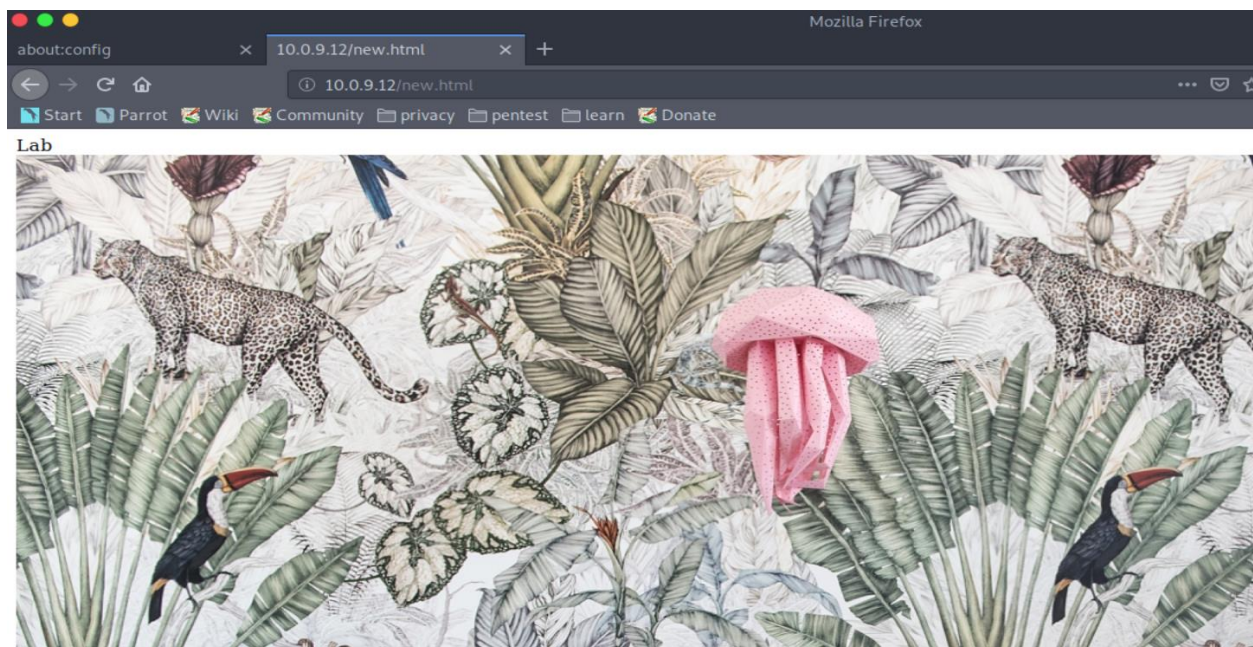
- Wireshark is launched and 'http' filter is applied and we can observe the packets as below.

Time to capture all the 10 images =

Time at last Response-Time at first GET request

= 27.673659531-26.730728892

= 0.942930639

3. PERSISTENT CONNECTIONS:

- The spdy.persistent-settings is set to 'true' in all types of persistent connections in the client browser.

3.1: 2 Persistent Connections:
- The value of max-persistent-connections-per-server is set to 2 in the client's machine.

Preference Name	Status	Type	Value
media.clearkey.persistent-license.enabled	default	boolean	false
network.http.max-persistent-connections-per-proxy	default	integer	32
network.http.max-persistent-connections-per-server	modified	integer	2
network.http.spdy.persistent-settings	modified	boolean	true
plugin.persistentPermissionAlways.intervalInDays	default	integer	90

- Wireshark packet capture:

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

http

No.	Time	Source	Destination	Protocol	Length	Info
74	65.363060237	10.0.9.50	10.0.9.12	HTTP	405	GET /new.html HTTP/1.1
76	65.363720763	10.0.9.12	10.0.9.50	HTTP	516	HTTP/1.1 200 OK (text/html)
78	65.519671049	10.0.9.50	10.0.9.12	HTTP	362	GET /img1.jpg HTTP/1.1
84	65.520240136	10.0.9.50	10.0.9.12	HTTP	362	GET /img2.jpg HTTP/1.1
393	65.569360555	10.0.9.12	10.0.9.50	HTTP	13523	HTTP/1.1 200 OK (JPEG JFIF image)
416	65.578037734	10.0.9.12	10.0.9.50	HTTP	12531	HTTP/1.1 200 OK (JPEG JFIF image)
418	65.582557931	10.0.9.50	10.0.9.12	HTTP	362	GET /img3.jpg HTTP/1.1
504	65.602335951	10.0.9.50	10.0.9.12	HTTP	362	GET /img4.jpg HTTP/1.1
769	65.697068869	10.0.9.12	10.0.9.50	HTTP	25750	HTTP/1.1 200 OK (JPEG JFIF image)
801	65.700761814	10.0.9.12	10.0.9.50	HTTP	2733	HTTP/1.1 200 OK (JPEG JFIF image)
803	65.725637784	10.0.9.50	10.0.9.12	HTTP	362	GET /img5.jpg HTTP/1.1
902	65.733712297	10.0.9.12	10.0.9.50	HTTP	15007	HTTP/1.1 200 OK (JPEG JFIF image)
904	65.763515111	10.0.9.50	10.0.9.12	HTTP	362	GET /img6.jpg HTTP/1.1
1007	65.787263228	10.0.9.12	10.0.9.50	HTTP	25382	HTTP/1.1 200 OK (JPEG JFIF image)
1009	65.801514482	10.0.9.50	10.0.9.12	HTTP	362	GET /img7.jpg HTTP/1.1
1010	65.802041073	10.0.9.50	10.0.9.12	HTTP	362	GET /img8.jpg HTTP/1.1
1316	65.936620518	10.0.9.12	10.0.9.50	HTTP	10919	HTTP/1.1 200 OK (JPEG JFIF image)
1319	65.942479195	10.0.9.50	10.0.9.12	HTTP	362	GET /img9.jpg HTTP/1.1
1424	65.988300445	10.0.9.12	10.0.9.50	HTTP	1523	HTTP/1.1 200 OK (JPEG JFIF image)
1432	66.003420683	10.0.9.50	10.0.9.12	HTTP	363	GET /img10.jpg HTTP/1.1
1840	66.102977815	10.0.9.12	10.0.9.50	HTTP	12350	HTTP/1.1 200 OK (JPEG JFIF image)
1843	66.103538005	10.0.9.12	10.0.9.50	HTTP	3417	HTTP/1.1 200 OK (JPEG JFIF image)
1846	66.369058960	10.0.9.50	10.0.9.12	HTTP	329	GET /favicon.ico HTTP/1.1
1847	66.369636177	10.0.9.12	10.0.9.50	HTTP	555	HTTP/1.1 404 Not Found (text/html)

Time to capture all the 10 images =
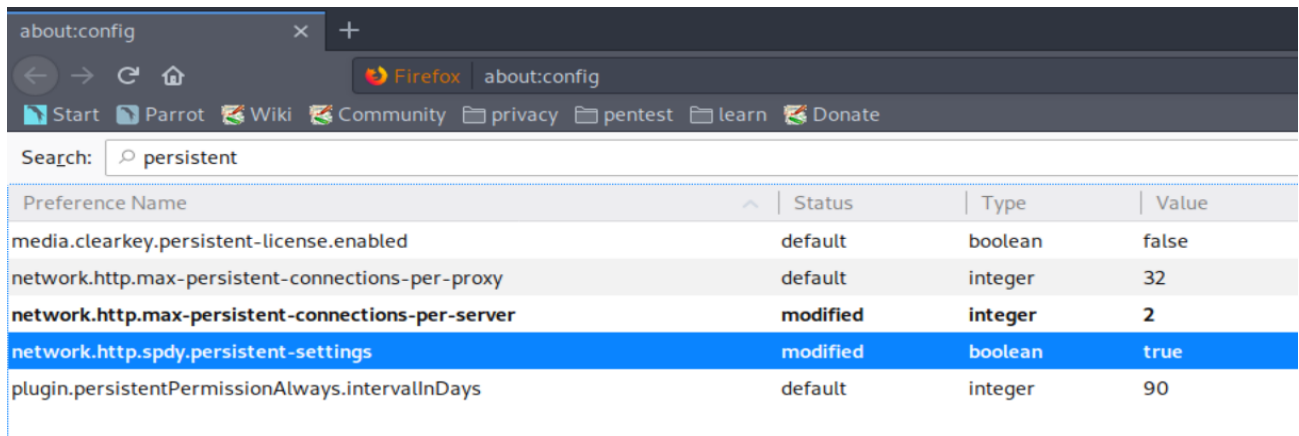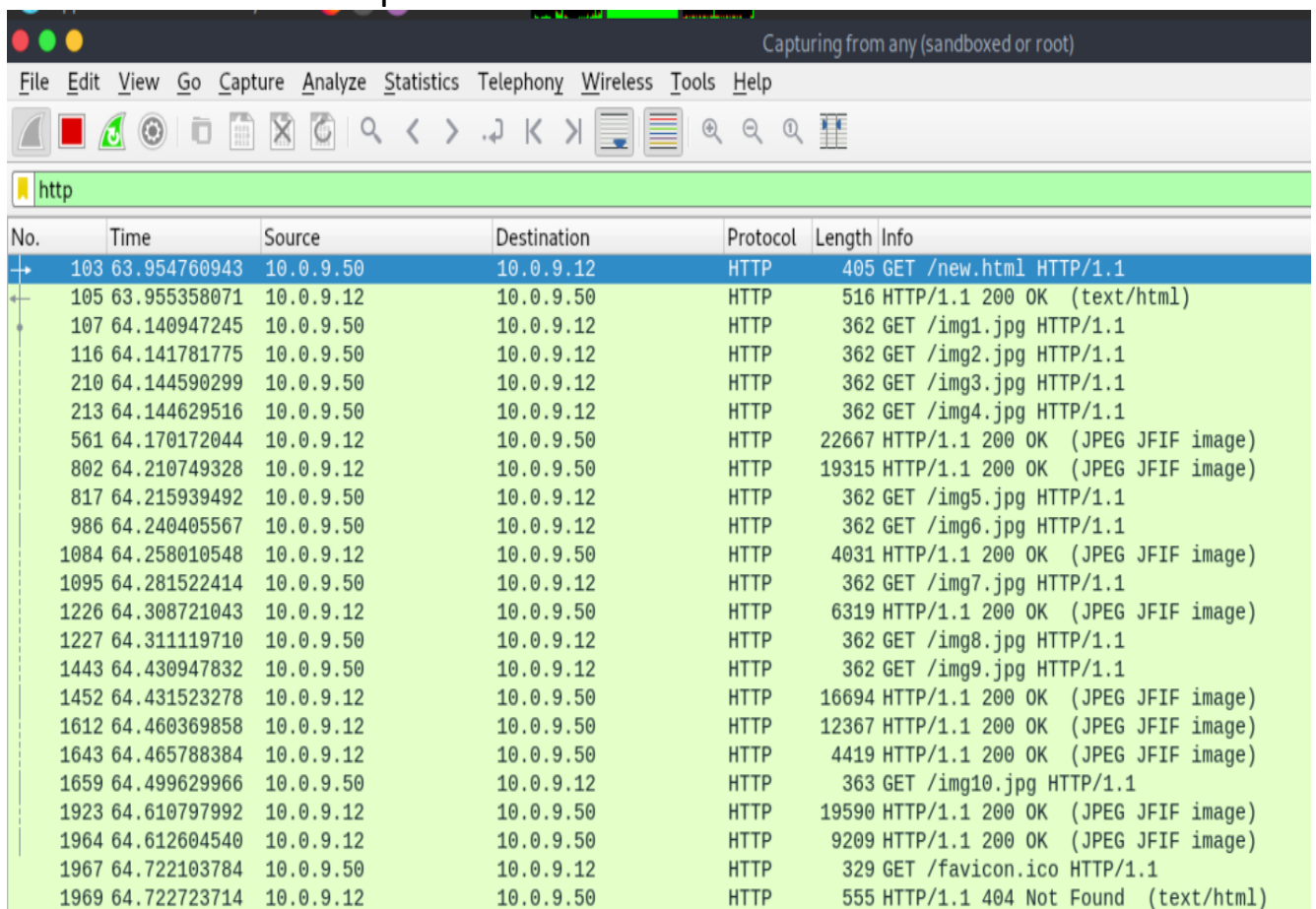
Time at last Response-Time at first GET request

= 66.103538005-65.363060237

= 0.740477768

3.2: 4 Persistent Connections:

- The value of max-persistent-connections-per-server is set to 4 in the client's machine.

Preference Name		Status	Type	Value
media.clearkey.persistent-license.enabled		default	boolean	false
network.http.max-persistent-connections-per-proxy		default	integer	32
network.http.max-persistent-connections-per-server		modified	integer	4
network.http.spdy.persistent-settings		modified	boolean	true
plugin.persistentPermissionAlways.intervalInDays		default	integer	90

- Wireshark Packet Capture:

No.	Time	Source	Destination	Protocol	Length	Info
103	63.954760943	10.0.9.50	10.0.9.12	HTTP	405	GET /new.html HTTP/1.1
105	63.955358071	10.0.9.12	10.0.9.50	HTTP	516	HTTP/1.1 200 OK (text/html)
107	64.140947245	10.0.9.50	10.0.9.12	HTTP	362	GET /img1.jpg HTTP/1.1
116	64.141781775	10.0.9.50	10.0.9.12	HTTP	362	GET /img2.jpg HTTP/1.1
210	64.144590299	10.0.9.50	10.0.9.12	HTTP	362	GET /img3.jpg HTTP/1.1
213	64.144629516	10.0.9.50	10.0.9.12	HTTP	362	GET /img4.jpg HTTP/1.1
561	64.170172044	10.0.9.12	10.0.9.50	HTTP	22667	HTTP/1.1 200 OK (JPEG JFIF image)
802	64.210749328	10.0.9.12	10.0.9.50	HTTP	19315	HTTP/1.1 200 OK (JPEG JFIF image)
817	64.215939492	10.0.9.50	10.0.9.12	HTTP	362	GET /img5.jpg HTTP/1.1
986	64.240405567	10.0.9.50	10.0.9.12	HTTP	362	GET /img6.jpg HTTP/1.1
1084	64.258010548	10.0.9.12	10.0.9.50	HTTP	4031	HTTP/1.1 200 OK (JPEG JFIF image)
1095	64.281522414	10.0.9.50	10.0.9.12	HTTP	362	GET /img7.jpg HTTP/1.1
1226	64.308721043	10.0.9.12	10.0.9.50	HTTP	6319	HTTP/1.1 200 OK (JPEG JFIF image)
1227	64.311119710	10.0.9.50	10.0.9.12	HTTP	362	GET /img8.jpg HTTP/1.1
1443	64.430947832	10.0.9.50	10.0.9.12	HTTP	362	GET /img9.jpg HTTP/1.1
1452	64.431523278	10.0.9.12	10.0.9.50	HTTP	16694	HTTP/1.1 200 OK (JPEG JFIF image)
1612	64.460369858	10.0.9.12	10.0.9.50	HTTP	12367	HTTP/1.1 200 OK (JPEG JFIF image)
1643	64.465788384	10.0.9.12	10.0.9.50	HTTP	4419	HTTP/1.1 200 OK (JPEG JFIF image)
1659	64.499629966	10.0.9.50	10.0.9.12	HTTP	363	GET /img10.jpg HTTP/1.1
1923	64.610797992	10.0.9.12	10.0.9.50	HTTP	19590	HTTP/1.1 200 OK (JPEG JFIF image)
1964	64.612604540	10.0.9.12	10.0.9.50	HTTP	9209	HTTP/1.1 200 OK (JPEG JFIF image)
1967	64.722103784	10.0.9.50	10.0.9.12	HTTP	329	GET /favicon.ico HTTP/1.1
1969	64.722723714	10.0.9.12	10.0.9.50	HTTP	555	HTTP/1.1 404 Not Found (text/html)

Time to capture all the 10 images = Time at last Response-Time at first GET request
=64.612604540-63.954760943
= 0.657843597

3.3: 6 Persistent Connections:

- The value of max-persistent-connections-per-server is set to 6 in the client's machine.

Preference Name	Status	Type	Value
Search: persistent			
media.clearkey.persistent-license.enabled	default	boolean	false
network.http.max-persistent-connections-per-proxy	default	integer	32
network.http.max-persistent-connections-per-server	default	integer	6
network.http.spdy.persistent-settings	modified	boolean	true
plugin.persistentPermissionAlways.intervalInDays	default	integer	90

- Wireshark Packet Capture:

No.	Time	Source	Destination	Protocol	Length	Info
63	9.691070035	10.0.9.50	10.0.9.12	HTTP	405	GET /new.html HTTP/1.1
65	9.691714391	10.0.9.12	10.0.9.50	HTTP	516	HTTP/1.1 200 OK (text/html)
67	9.873094669	10.0.9.50	10.0.9.12	HTTP	362	GET /img1.jpg HTTP/1.1
113	9.876754503	10.0.9.50	10.0.9.12	HTTP	362	GET /img2.jpg HTTP/1.1
145	9.877772340	10.0.9.50	10.0.9.12	HTTP	362	GET /img4.jpg HTTP/1.1
146	9.877831245	10.0.9.50	10.0.9.12	HTTP	362	GET /img3.jpg HTTP/1.1
147	9.877868448	10.0.9.50	10.0.9.12	HTTP	362	GET /img5.jpg HTTP/1.1
148	9.877901825	10.0.9.50	10.0.9.12	HTTP	362	GET /img6.jpg HTTP/1.1
439	9.888420023	10.0.9.12	10.0.9.50	HTTP	13315	HTTP/1.1 200 OK (JPEG JFIF image)
821	9.908875207	10.0.9.12	10.0.9.50	HTTP	4872	HTTP/1.1 200 OK (JPEG JFIF image)
927	9.914368242	10.0.9.12	10.0.9.50	HTTP	2999	HTTP/1.1 200 OK (JPEG JFIF image)
985	9.920038985	10.0.9.12	10.0.9.50	HTTP	4182	HTTP/1.1 200 OK (JPEG JFIF image)
1244	9.952217801	10.0.9.12	10.0.9.50	HTTP	8259	HTTP/1.1 200 OK (JPEG JFIF image)
1247	9.965955438	10.0.9.50	10.0.9.12	HTTP	362	GET /img7.jpg HTTP/1.1
1248	9.966065482	10.0.9.50	10.0.9.12	HTTP	362	GET /img8.jpg HTTP/1.1
1407	9.982526329	10.0.9.12	10.0.9.50	HTTP	22503	HTTP/1.1 200 OK (JPEG JFIF image)
1477	9.996449288	10.0.9.12	10.0.9.50	HTTP	9823	HTTP/1.1 200 OK (JPEG JFIF image)
1479	9.997029855	10.0.9.50	10.0.9.12	HTTP	362	GET /img9.jpg HTTP/1.1
1571	10.027029025	10.0.9.50	10.0.9.12	HTTP	363	GET /img10.jpg HTTP/1.1
1713	10.036793792	10.0.9.12	10.0.9.50	HTTP	42513	HTTP/1.1 200 OK (JPEG JFIF image)
1879	10.236309243	10.0.9.12	10.0.9.50	HTTP	5867	HTTP/1.1 200 OK (JPEG JFIF image)
1985	10.253054272	10.0.9.12	10.0.9.50	HTTP	26830	HTTP/1.1 200 OK (JPEG JFIF image)
1988	10.364052067	10.0.9.50	10.0.9.12	HTTP	329	GET /favicon.ico HTTP/1.1
1990	10.364637141	10.0.9.12	10.0.9.50	HTTP	555	HTTP/1.1 404 Not Found (text/html)

Time to capture all the 10 images =

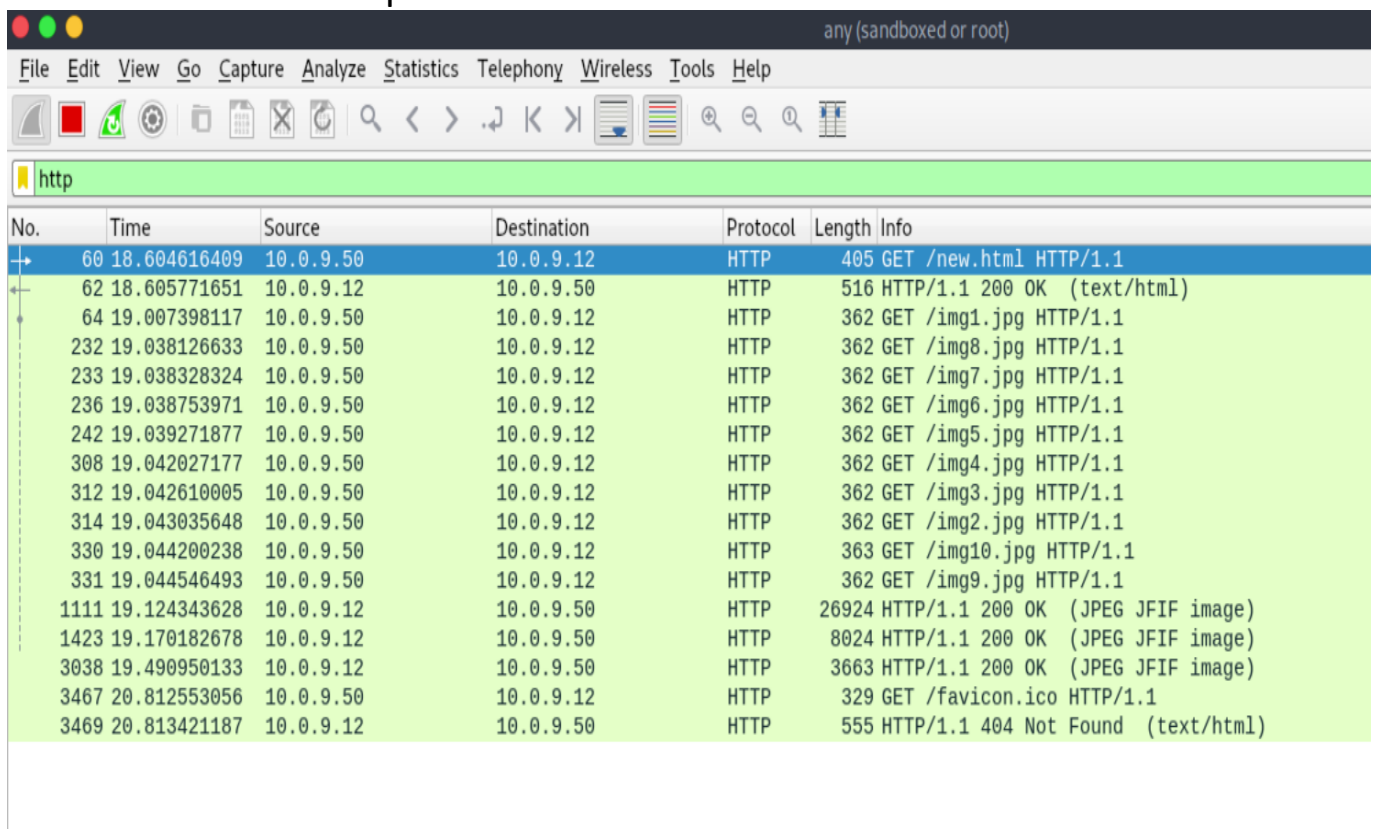Time at last Response-Time at first GET request

= 10.253054272-9.691070035

= 0.561984237

3.4: 10 Persistent Connections:
- The value of max-persistent-connections-per-server is set to 10 in the client's machine.

media.clearkey.persistent-license.enabled	default	boolean	false
network.http.max-persistent-connections-per-proxy	default	integer	32
network.http.max-persistent-connections-per-server	modified	integer	10
network.http.spdy.persistent-settings	modified	boolean	true
plugin.persistentPermissionAlways.intervalInDays	default	integer	90

- Wireshark Packet Capture:

No.	Time	Source	Destination	Protocol	Length	Info
60	18.604616409	10.0.9.50	10.0.9.12	HTTP	405	GET /new.html HTTP/1.1
62	18.605771651	10.0.9.12	10.0.9.50	HTTP	516	HTTP/1.1 200 OK (text/html)
64	19.007398117	10.0.9.50	10.0.9.12	HTTP	362	GET /img1.jpg HTTP/1.1
232	19.038126633	10.0.9.50	10.0.9.12	HTTP	362	GET /img8.jpg HTTP/1.1
233	19.038328324	10.0.9.50	10.0.9.12	HTTP	362	GET /img7.jpg HTTP/1.1
236	19.038753971	10.0.9.50	10.0.9.12	HTTP	362	GET /img6.jpg HTTP/1.1
242	19.039271877	10.0.9.50	10.0.9.12	HTTP	362	GET /img5.jpg HTTP/1.1
308	19.042027177	10.0.9.50	10.0.9.12	HTTP	362	GET /img4.jpg HTTP/1.1
312	19.042610005	10.0.9.50	10.0.9.12	HTTP	362	GET /img3.jpg HTTP/1.1
314	19.043035648	10.0.9.50	10.0.9.12	HTTP	362	GET /img2.jpg HTTP/1.1
330	19.044200238	10.0.9.50	10.0.9.12	HTTP	363	GET /img10.jpg HTTP/1.1
331	19.044546493	10.0.9.50	10.0.9.12	HTTP	362	GET /img9.jpg HTTP/1.1
1111	19.124343628	10.0.9.12	10.0.9.50	HTTP	26924	HTTP/1.1 200 OK (JPEG JFIF image)
1423	19.170182678	10.0.9.12	10.0.9.50	HTTP	8024	HTTP/1.1 200 OK (JPEG JFIF image)
3038	19.490950133	10.0.9.12	10.0.9.50	HTTP	3663	HTTP/1.1 200 OK (JPEG JFIF image)
3467	20.812553056	10.0.9.50	10.0.9.12	HTTP	329	GET /favicon.ico HTTP/1.1
3469	20.813421187	10.0.9.12	10.0.9.50	HTTP	555	HTTP/1.1 404 Not Found (text/html)

Time to capture all the 10 images=

Time at last Response-Time at first GET request
= 19.490950133-18.604616409
= 0.886333724

4. Observations:

- To tabulate the times required for different types of connections.

Number of Persistent connections	Time to capture all the 10 images
0 (non-persistent)	0.942930639
2	0.740477768
4	0.657843597
6	0.561984237
10	0.886333724

- The time required to load initially decreases as the number of persistent connections increases. However as the number of persistent connections further increases, the load time also increases.

- From the above table it is clear that the lowest load time corresponds to 6 persistent connections. Therefore, the optimal number of HTTP persistent connections is 6.