

PES2UG22CS556 - Lab # 3

Siri N Shetty

Semester-4 Section-J

Understanding Persistent and Non-persistent HTTP Connections

To understand persistent and non-persistent HTTP connections and corresponding performance impact.

Create a web page with N (e.g. 10) embedded images. Each image should be of minimum 2 MB size. Configure your browser (Firefox) with following settings (each setting requires repeat of experiment)

- Non persistent connection
- 2 persistent connections
- 4 persistent connections
- 6 persistent connections
- 10 persistent connections.

Observation: Note down the time taken to display the entire page in each of the settings. Ensure that (cache is cleared before starting the web request). Explain the response time differences. What is the optimal number of persistent connections for best performance? Explain your answer.

Introduction

The Apache HTTP server is the most widely-used web server in the world. It provides many powerful features including dynamically loadable modules, robust media support, and extensive integration with other popular software.

Objective: Understand persistent and non-persistent HTTP connections and corresponding performance impact.

Experiment: Create a web page with N (e.g. 10) embedded images. Each image should be of minimum 2 MB size. Configure your browser (Firefox) with following settings (each setting requires repeat of experiment)

- a) Non-persistent connection
- b) 2 persistent connections
- c) 4 persistent connections
- d) 6 persistent connections
- e) 10 persistent connections

Note down the time taken to display the entire page in each of the settings. **Ensure that cache is cleared before starting the web request.** Explain the response time differences. What is the optimal number of persistent connections for best performance? Explain your answer.

Note: To install Apache server, use the following command,

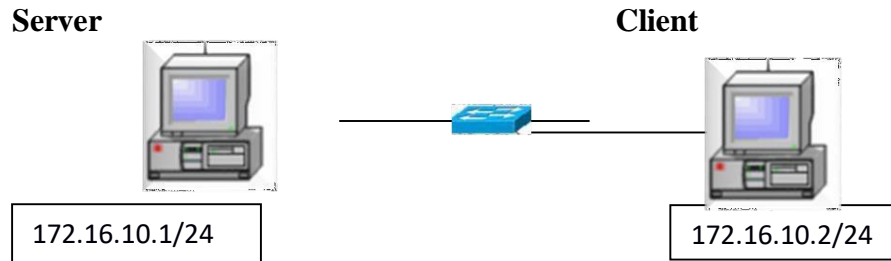
```
sudo apt-get install apache2
```

If there is any error during installation, update the package manager by issuing the command,

```
sudo apt-get update
```

EXECUTION STEPS

Step 1: Connect 2 desktops using switch and cables as shown below. (Use 2 VMs on Virtualbox or VMware instead of physical connections.)



Server Side:

Step 2: Check your Web Server

At the end of the installation process, Ubuntu 16.04 starts Apache. The web server should already be up and running. We can check with the `systemctl` command to make sure the service is running by typing:

`sudo systemctl status apache2`

or

`sudo service apache2 status`

As you can see above, the service appears to have started successfully. However, the best way to test this is to actually request a page from Apache. You can access the default Apache landing page to confirm that the software is running properly. You can access this through your server's domain name or IP address.

```
(kali@DESKTOP-F9UMPJU)-[~]
$ sudo service apache2 start
Starting Apache httpd web server: apache2.

(kali@DESKTOP-F9UMPJU)-[~]
$ sudo service apache2 status
apache2 is running.
```

Step 3: Server IP address can be set by the following command

`$sudo ip addr add 172.16.10.1/24 dev enps0`
`$sudo ip addr`

Note: If IP address fluctuates, kindly setup the IP address manually using 'Edit connections'.

```
(kali@DESKTOP-F9UMPJU)-[~]
$ sudo ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default 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 mq state UP group default qlen 1000
    link/ether 00:15:5d:8b:e0:06 brd ff:ff:ff:ff:ff:ff
    inet 172.27.97.244/20 brd 172.27.111.255 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::215:5dff:fe8b:e006/64 scope link
        valid_lft forever preferred_lft forever
```

Step 4: The **apache2.conf** file present in the **/etc/apache2** directory is modified as:

- a) The **keep-alive** option was set (i.e. value was made **ON**)
- b) The **MaximumKeepAliveRequests** were set to **2**

\$sudo nano /etc/apache2/apache2.conf

```
GNU nano 7.2                                apache2.conf *
#
# Timeout: The number of seconds before receives and sends time out.
#
Timeout 300
#
# KeepAlive: Whether or not to allow persistent connections (more than
# one request per connection). Set to "Off" to deactivate.
#
KeepAlive On
#
# MaxKeepAliveRequests: The maximum number of requests to allow
# during a persistent connection. Set to 0 to allow an unlimited amount.
# We recommend you leave this number high, for maximum performance.
#
MaxKeepAliveRequests 2
#
# KeepAliveTimeout: Number of seconds to wait for the next request from the
# same client on the same connection.
#
KeepAliveTimeout 5

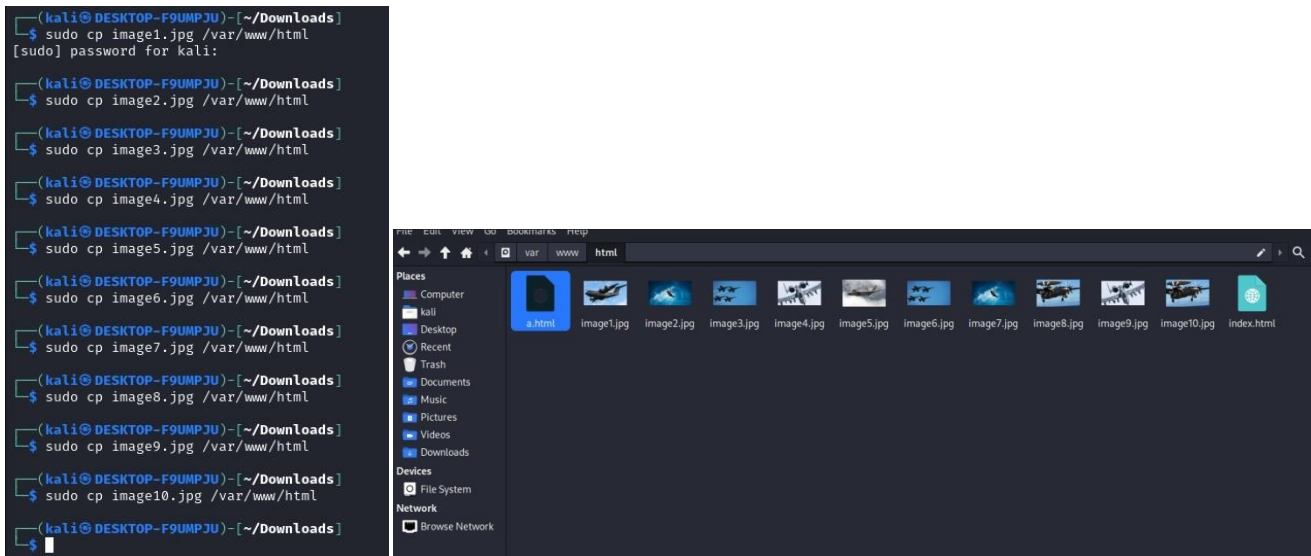
# These need to be set in /etc/apache2/envvars
User ${APACHE_RUN_USER}
Group ${APACHE_RUN_GROUP}
```

[Cancelled]

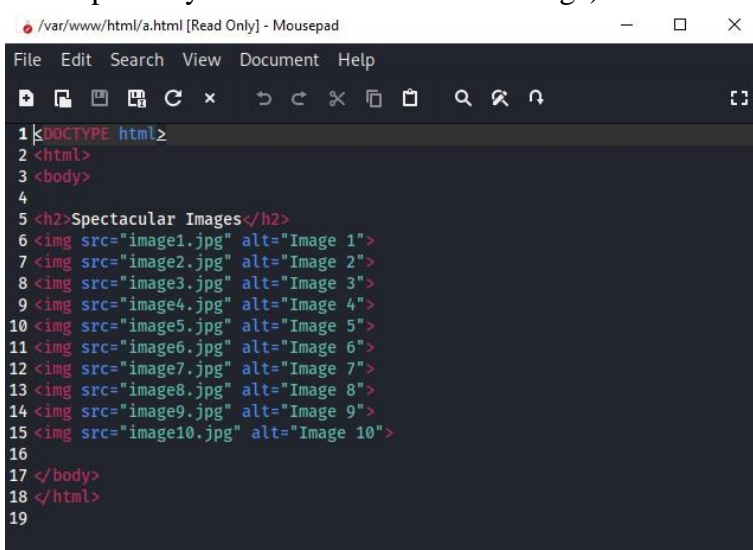
⌘ Help ⌘ Write Out ⌘ Where Is ⌘ Cut ⌘ Execute ⌘ Location ⌘ Undo ⌘ Set Mark ⌘ To Bracket ⌘ Previous
⌘ Exit ⌘ Read File ⌘ Replace ⌘ Paste ⌘ Justify ⌘ Go To Line ⌘ Redo ⌘ Copy ⌘ Where Was ⌘ Next

Step 5: Store images in the server path. A html page consisting of 10 images having size > 2MB were placed and accessed by the client. This html page is stored in the location - **/var/www/html/file_name.html**.

Note: Use the images provided by faculty incharges.



Step 6: Prepare a web page as shown below. The html file needs to add 10 images. (Kindly skip the style attribute in the below image)



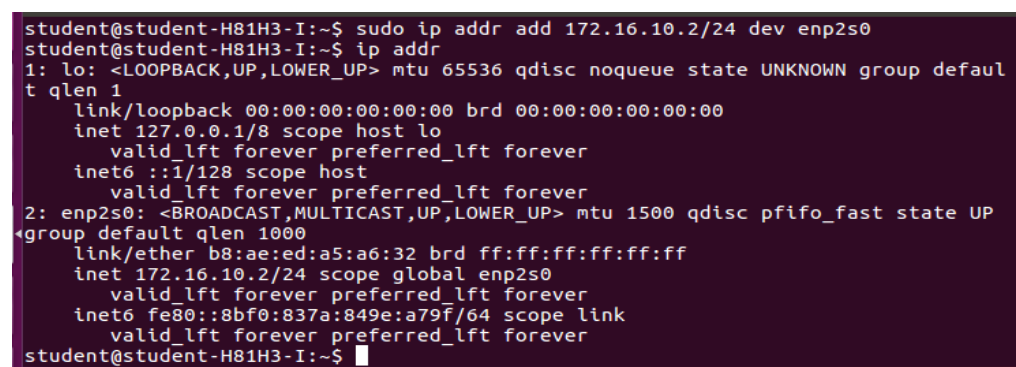
Client side:

Client IP address can be set by the following command.

\$sudo ip addr add 172.16.10.2/24 dev enps0

\$sudo ip addr

Note: If IP address fluctuates, kindly setup the IP address manually using 'Edit connections'.



There are broadly two parts of execution:

1. Dealing with non-persistent connections
2. Dealing with persistent connections

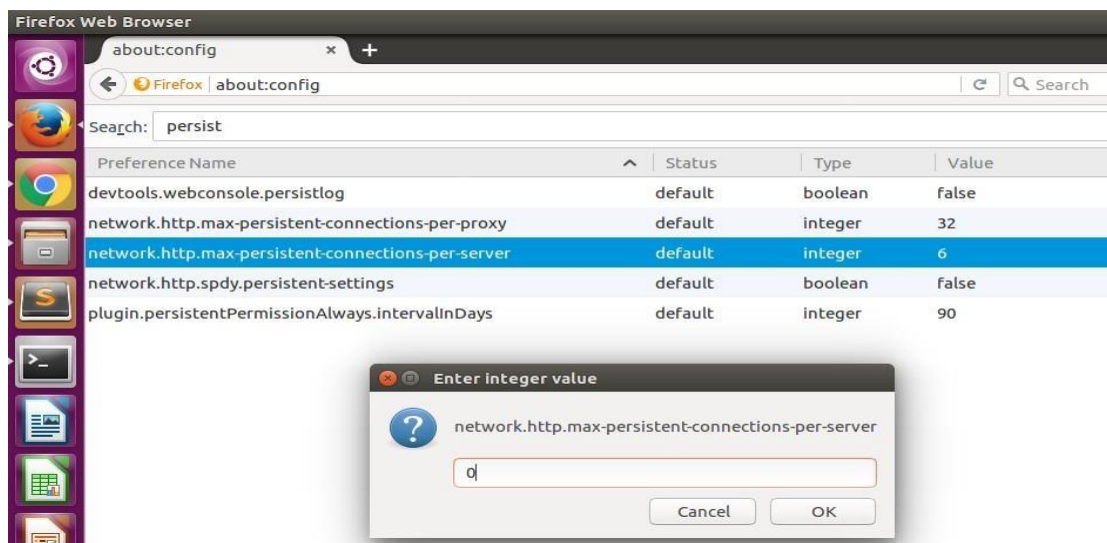
Open Firefox browser to configure for persistent option. Go to browser and type

about:config and search for the term '**persistent**'

- While using non-persistent connection experiment, the **max-persistent-connections-per-server** has the value set to **0** and **persistent-settings** value set to false.
- While using persistent connection experiment, the **max-persistent-connections-per-server** should have value greater than 0 (depending on the number of persistent connections needed) and **persistent-settings** value set to true.

PART 1: NON-PERSISTENT CONNECTION

Step 1: This is done by setting the value of max-persistent-connection-per-server to 0 in the client computer.



Step 2: Access web page on client-side browser (Firefox)

The client could access the file as:

/file_name.html where--> **172.16.10.1** is Server's IP

Here the file name is **a.html** present in server. So, by typing **172.16.10.1/a.html** in client browser, we will be able to open the requested web page.

Note 1: The wireshark should capture the packets between the client and the server while the file is accessed.

Note 2: The images in the HTML page should have all the permissions specified through the server for the proper access.

Step 3: Use wireshark. Open wireshark in the server computer while client is trying to access the server's local host webpage. Apply 'http' filter and note the time to capture all the 10 images.

http						
No.	Time	Source	Destination	Protocol	Length	Info
25	0.211530105	172.16.10.1	172.16.10.2	HTTP	568	HTTP/1.1 404 Not Found (text/html)
27	2.070581279	172.16.10.2	172.16.10.1	HTTP	421	GET /a.html HTTP/1.1
28	2.070866155	172.16.10.1	172.16.10.2	HTTP	641	HTTP/1.1 200 OK (text/html)
30	2.117160769	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(1).jpg HTTP/1.1
35	2.117571913	172.16.10.1	172.16.10.2	HTTP	1200	HTTP/1.1 200 OK (JPEG JFIF image)
36	2.117753115	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(2).jpg HTTP/1.1
45	2.117944288	172.16.10.1	172.16.10.2	HTTP	463	HTTP/1.1 200 OK (JPEG JFIF image)
51	2.118574057	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(4).jpg HTTP/1.1
63	2.119058490	172.16.10.1	172.16.10.2	HTTP	242	HTTP/1.1 200 OK (JPEG JFIF image)
65	2.119487932	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(3).jpg HTTP/1.1
77	2.119784374	172.16.10.1	172.16.10.2	HTTP	565	HTTP/1.1 200 OK (JPEG JFIF image)
79	2.120323770	172.16.10.2	172.16.10.1	HTTP	359	GET /lion-wild-africa-african.jpg HTTP/1.1
94	2.121263792	172.16.10.2	172.16.10.1	HTTP	341	GET /images.jpg HTTP/1.1
110	2.122045168	172.16.10.1	172.16.10.2	HTTP	1226	HTTP/1.1 200 OK (JPEG JFIF image)
117	2.122719543	172.16.10.2	172.16.10.1	HTTP	343	GET /download.jpg HTTP/1.1
138	2.123847115	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(1).jpg HTTP/1.1
160	2.124700199	172.16.10.2	172.16.10.1	HTTP	362	GET /soap-bubble-1958650_960_720.jpg HTTP/1.1
164	2.124733805	172.16.10.1	172.16.10.2	HTTP	1017	HTTP/1.1 200 OK (JPEG JFIF image)
171	2.125125151	172.16.10.1	172.16.10.2	HTTP	711	HTTP/1.1 200 OK (JPEG JFIF image)
184	2.126599573	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(2).jpg HTTP/1.1
252	2.131056667	172.16.10.1	172.16.10.2	HTTP	114	HTTP/1.1 200 OK (JPEG JFIF image)
529	2.151487483	172.16.10.1	172.16.10.2	HTTP	73	HTTP/1.1 200 OK (JPEG JFIF image)
3834	2.429637133	172.16.10.1	172.16.10.2	HTTP	1124	HTTP/1.1 200 OK (JPEG JFIF image)

Here it is $2.429637133 - 2.070581279 = 0.359055854$

PART 2: PERSISTENT CONNECTIONS

Step 1: For 2 persistent connections, set the value of **max-persistent-connection-per-server** to **2** in the client computer.

Step 2: Repeat the **steps 1-3** in the previous section.

http						
No.	Time	Source	Destination	Protocol	Length	Info
28	0.158495832	172.16.10.1	172.16.10.2	HTTP	568	HTTP/1.1 404 Not Found (text/html)
30	2.685888334	172.16.10.2	172.16.10.1	HTTP	421	GET /a.html HTTP/1.1
31	2.686488793	172.16.10.1	172.16.10.2	HTTP	641	HTTP/1.1 200 OK (text/html)
33	2.734091058	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(1).jpg HTTP/1.1
38	2.734592637	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(2).jpg HTTP/1.1
39	2.734696958	172.16.10.1	172.16.10.2	HTTP	1200	HTTP/1.1 200 OK (JPEG JFIF image)
48	2.735025557	172.16.10.1	172.16.10.2	HTTP	463	HTTP/1.1 200 OK (JPEG JFIF image)
49	2.735180365	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(4).jpg HTTP/1.1
66	2.736079156	172.16.10.1	172.16.10.2	HTTP	243	HTTP/1.1 200 OK (JPEG JFIF image)
68	2.736374643	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(3).jpg HTTP/1.1
82	2.736755733	172.16.10.1	172.16.10.2	HTTP	565	HTTP/1.1 200 OK (JPEG JFIF image)
85	2.737381832	172.16.10.2	172.16.10.1	HTTP	359	GET /lion-wild-africa-african.jpg HTTP/1.1
92	2.737840608	172.16.10.2	172.16.10.1	HTTP	341	GET /images.jpg HTTP/1.1
101	2.738335480	172.16.10.2	172.16.10.1	HTTP	343	GET /download.jpg HTTP/1.1
119	2.738809142	172.16.10.1	172.16.10.2	HTTP	1226	HTTP/1.1 200 OK (JPEG JFIF image)
121	2.739075438	172.16.10.1	172.16.10.2	HTTP	1016	HTTP/1.1 200 OK (JPEG JFIF image)
139	2.740900738	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(1).jpg HTTP/1.1
143	2.741014891	172.16.10.2	172.16.10.1	HTTP	362	GET /soap-bubble-1958650_960_720.jpg HTTP/1.1
148	2.741205777	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(2).jpg HTTP/1.1
179	2.742807473	172.16.10.1	172.16.10.2	HTTP	113	HTTP/1.1 200 OK (JPEG JFIF image)
190	2.743723330	172.16.10.1	172.16.10.2	HTTP	712	HTTP/1.1 200 OK (JPEG JFIF image)
402	2.764054977	172.16.10.1	172.16.10.2	HTTP	72	HTTP/1.1 200 OK (JPEG JFIF image)
3774	3.042252027	172.16.10.1	172.16.10.2	HTTP	1124	HTTP/1.1 200 OK (JPEG JFIF image)

Here it is $3.042252027 - 2.685888334 = 0.356363$

Step 3: For 4 persistent connections, Set the value of **max-persistent-connection-per-server** to **4** in the client computer.

Step 4: Repeat the **steps 1-3** in the previous section.

http						
No.	Time	Source	Destination	Protocol	Length	Info
28	0.152642908	172.16.10.1	172.16.10.2	HTTP	568	HTTP/1.1 404 Not Found (text/html)
30	1.667969551	172.16.10.2	172.16.10.1	HTTP	421	GET /a.html HTTP/1.1
31	1.668311781	172.16.10.1	172.16.10.2	HTTP	641	HTTP/1.1 200 OK (text/html)
33	1.699473631	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(1).jpg HTTP/1.1
35	1.699692009	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(2).jpg HTTP/1.1
45	1.699900042	172.16.10.1	172.16.10.2	HTTP	463	HTTP/1.1 200 OK (JPEG JFIF image)
46	1.699913003	172.16.10.1	172.16.10.2	HTTP	1200	HTTP/1.1 200 OK (JPEG JFIF image)
47	1.700012712	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(4).jpg HTTP/1.1
63	1.700901747	172.16.10.1	172.16.10.2	HTTP	242	HTTP/1.1 200 OK (JPEG JFIF image)
69	1.701341018	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(3).jpg HTTP/1.1
70	1.701432635	172.16.10.2	172.16.10.1	HTTP	359	GET /lion-wild-africa-african.jpg HTTP/1.1
86	1.701888908	172.16.10.1	172.16.10.2	HTTP	565	HTTP/1.1 200 OK (JPEG JFIF image)
93	1.702192885	172.16.10.2	172.16.10.1	HTTP	341	GET /images.jpg HTTP/1.1
95	1.702219175	172.16.10.2	172.16.10.1	HTTP	343	GET /download.jpg HTTP/1.1
97	1.702228220	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(1).jpg HTTP/1.1
98	1.702233130	172.16.10.2	172.16.10.1	HTTP	362	GET /soap-bubble-1958650_960_720.jpg HTTP/1.1
122	1.703328136	172.16.10.1	172.16.10.2	HTTP	711	HTTP/1.1 200 OK (JPEG JFIF image)
126	1.703773424	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(2).jpg HTTP/1.1
157	1.705498971	172.16.10.1	172.16.10.2	HTTP	1227	HTTP/1.1 200 OK (JPEG JFIF image)
159	1.705614894	172.16.10.1	172.16.10.2	HTTP	113	HTTP/1.1 200 OK (JPEG JFIF image)
167	1.706637782	172.16.10.1	172.16.10.2	HTTP	1017	HTTP/1.1 200 OK (JPEG JFIF image)
414	1.724541388	172.16.10.1	172.16.10.2	HTTP	73	HTTP/1.1 200 OK (JPEG JFIF image)
3825	2.005934395	172.16.10.1	172.16.10.2	HTTP	1124	HTTP/1.1 200 OK (JPEG JFIF image)

Here is it $2.005934395 - 1.667969557 = 0.337964838$

Step 5: For 6 persistent connections, set the value of **max-persistent-connection-per-server** to **6** in the server computer.

Step 6: Repeat the **steps 1-3** in the previous section.

http						
No.	Time	Source	Destination	Protocol	Length	Info
21	0.100232302	172.16.10.2	172.16.10.1	HTTP	306	GET /favicon.ico HTTP/1.1
22	0.100476138	172.16.10.1	172.16.10.2	HTTP	568	HTTP/1.1 404 Not Found (text/html)
24	0.184514911	172.16.10.2	172.16.10.1	HTTP	366	GET /favicon.ico HTTP/1.1
25	0.184789474	172.16.10.1	172.16.10.2	HTTP	568	HTTP/1.1 404 Not Found (text/html)
27	3.915242469	172.16.10.2	172.16.10.1	HTTP	421	GET /a.html HTTP/1.1
28	3.915930950	172.16.10.1	172.16.10.2	HTTP	641	HTTP/1.1 200 OK (text/html)
30	3.934519286	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(1).jpg HTTP/1.1
31	3.934703623	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(2).jpg HTTP/1.1
44	3.935084209	172.16.10.1	172.16.10.2	HTTP	1200	HTTP/1.1 200 OK (JPEG JFIF image)
45	3.935091751	172.16.10.1	172.16.10.2	HTTP	463	HTTP/1.1 200 OK (JPEG JFIF image)
50	3.935485109	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(4).jpg HTTP/1.1
68	3.936344013	172.16.10.1	172.16.10.2	HTTP	243	HTTP/1.1 200 OK (JPEG JFIF image)
74	3.936634551	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(3).jpg HTTP/1.1
75	3.936649737	172.16.10.2	172.16.10.1	HTTP	359	GET /lion-wild-africa-african.jpg HTTP/1.1
76	3.936654620	172.16.10.2	172.16.10.1	HTTP	341	GET /images.jpg HTTP/1.1
78	3.936684823	172.16.10.2	172.16.10.1	HTTP	343	GET /download.jpg HTTP/1.1
80	3.936696984	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(1).jpg HTTP/1.1
122	3.937371850	172.16.10.2	172.16.10.1	HTTP	362	GET /soap-bubble-1958650_960_720.jpg HTTP/1.1
123	3.937539442	172.16.10.1	172.16.10.2	HTTP	1227	HTTP/1.1 200 OK (JPEG JFIF image)
160	3.939256627	172.16.10.1	172.16.10.2	HTTP	1017	HTTP/1.1 200 OK (JPEG JFIF image)
167	3.940125154	172.16.10.1	172.16.10.2	HTTP	712	HTTP/1.1 200 OK (JPEG JFIF image)
183	3.941778538	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(2).jpg HTTP/1.1
229	3.946434434	172.16.10.1	172.16.10.2	HTTP	565	HTTP/1.1 200 OK (JPEG JFIF image)
233	3.946891865	172.16.10.1	172.16.10.2	HTTP	113	HTTP/1.1 200 OK (JPEG JFIF image)
441	3.964535410	172.16.10.1	172.16.10.2	HTTP	72	HTTP/1.1 200 OK (JPEG JFIF image)
3771	4.241013689	172.16.10.1	172.16.10.2	HTTP	1124	HTTP/1.1 200 OK (JPEG JFIF image)

Here it is $4.241013689 - 3.915242469 = 0.325771229$

Step 7: For 10 persistent connections, set the value of **max-persistent-connection-per-server** to **10** in the client computer.

Step 8: Repeat the **steps 1-3** in the previous section.

http						
No.	Time	Source	Destination	Protocol	Length	Info
27	0.192665375	172.16.10.1	172.16.10.2	HTTP	568	HTTP/1.1 404 Not Found (text/html)
29	1.556964626	172.16.10.2	172.16.10.1	HTTP	421	GET /a.html HTTP/1.1
30	1.557214715	172.16.10.1	172.16.10.2	HTTP	641	HTTP/1.1 200 OK (text/html)
32	1.575716934	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(1).jpg HTTP/1.1
33	1.575953704	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(2).jpg HTTP/1.1
46	1.576334520	172.16.10.1	172.16.10.2	HTTP	1200	HTTP/1.1 200 OK (JPEG JFIF image)
47	1.576343533	172.16.10.1	172.16.10.2	HTTP	463	HTTP/1.1 200 OK (JPEG JFIF image)
52	1.576760416	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(4).jpg HTTP/1.1
70	1.577515601	172.16.10.1	172.16.10.2	HTTP	243	HTTP/1.1 200 OK (JPEG JFIF image)
76	1.577834686	172.16.10.2	172.16.10.1	HTTP	347	GET /images%20(3).jpg HTTP/1.1
77	1.577847379	172.16.10.2	172.16.10.1	HTTP	359	GET /lion-wild-africa-african.jpg HTTP/1.1
78	1.577855269	172.16.10.2	172.16.10.1	HTTP	341	GET /images.jpg HTTP/1.1
80	1.577886802	172.16.10.2	172.16.10.1	HTTP	343	GET /download.jpg HTTP/1.1
82	1.577905312	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(1).jpg HTTP/1.1
118	1.578606528	172.16.10.2	172.16.10.1	HTTP	362	GET /soap-bubble-1958650_960_720.jpg HTTP/1.1
119	1.578639337	172.16.10.1	172.16.10.2	HTTP	1227	HTTP/1.1 200 OK (JPEG JFIF image)
146	1.580341669	172.16.10.1	172.16.10.2	HTTP	712	HTTP/1.1 200 OK (JPEG JFIF image)
169	1.582240704	172.16.10.2	172.16.10.1	HTTP	349	GET /download%20(2).jpg HTTP/1.1
187	1.583749770	172.16.10.1	172.16.10.2	HTTP	1017	HTTP/1.1 200 OK (JPEG JFIF image)
219	1.586862673	172.16.10.1	172.16.10.2	HTTP	113	HTTP/1.1 200 OK (JPEG JFIF image)
222	1.587108849	172.16.10.1	172.16.10.2	HTTP	565	HTTP/1.1 200 OK (JPEG JFIF image)
455	1.606226568	172.16.10.1	172.16.10.2	HTTP	72	HTTP/1.1 200 OK (JPEG JFIF image)
3814	1.882459413	172.16.10.1	172.16.10.2	HTTP	1124	HTTP/1.1 200 OK (JPEG JFIF image)

Here it is $1.882459413 - 1.556964626 = 0.325494787$

OBSERVATIONS REQUIRED:

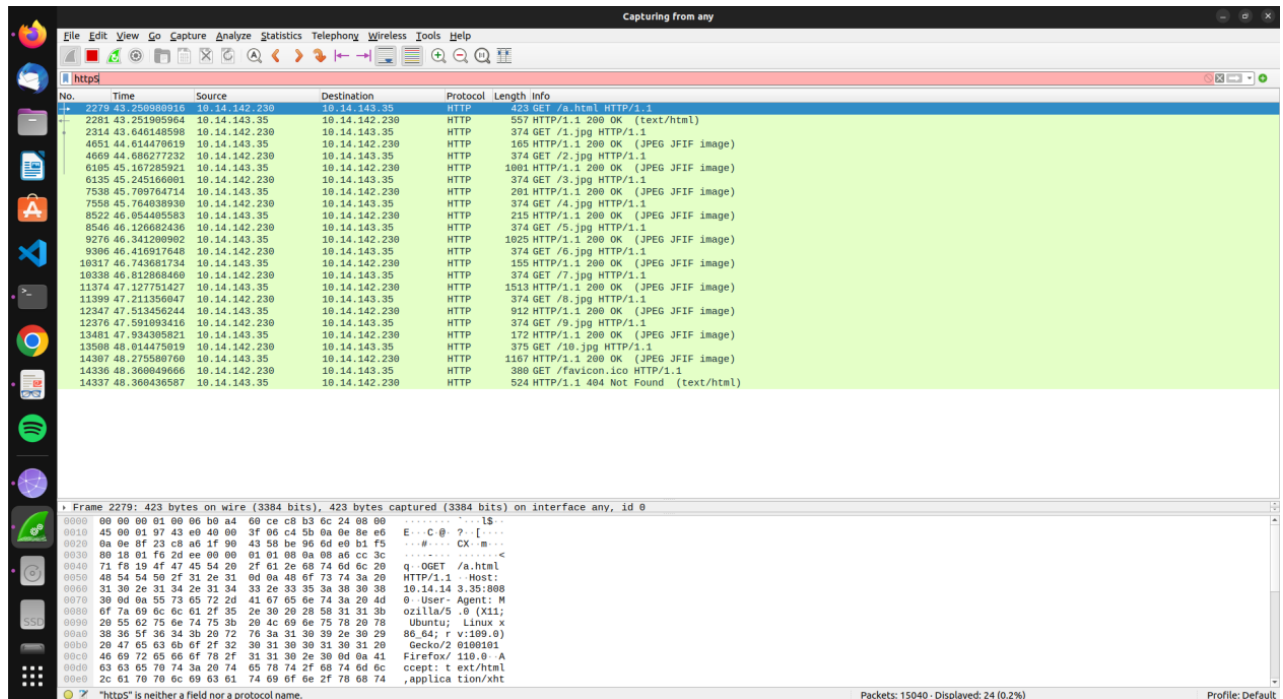
Calculate the time taken to load objects from the server for non-persistent and persistent connections (2, 4, 6, 8 & 10). Find out the optimal number of HTTP persistent connections based on your observations.

SCREENSHOTS REQUIRED FOR SUBMISSION:

- 1) Non-persistent connection wireshark capture (should include all 10 images)
- 2) Persistent connections wireshark capture – 2, 4, 6, 8 & 10 respectively (should include all 10 images).

PART 1: NON-PERSISTENT CONNECTION

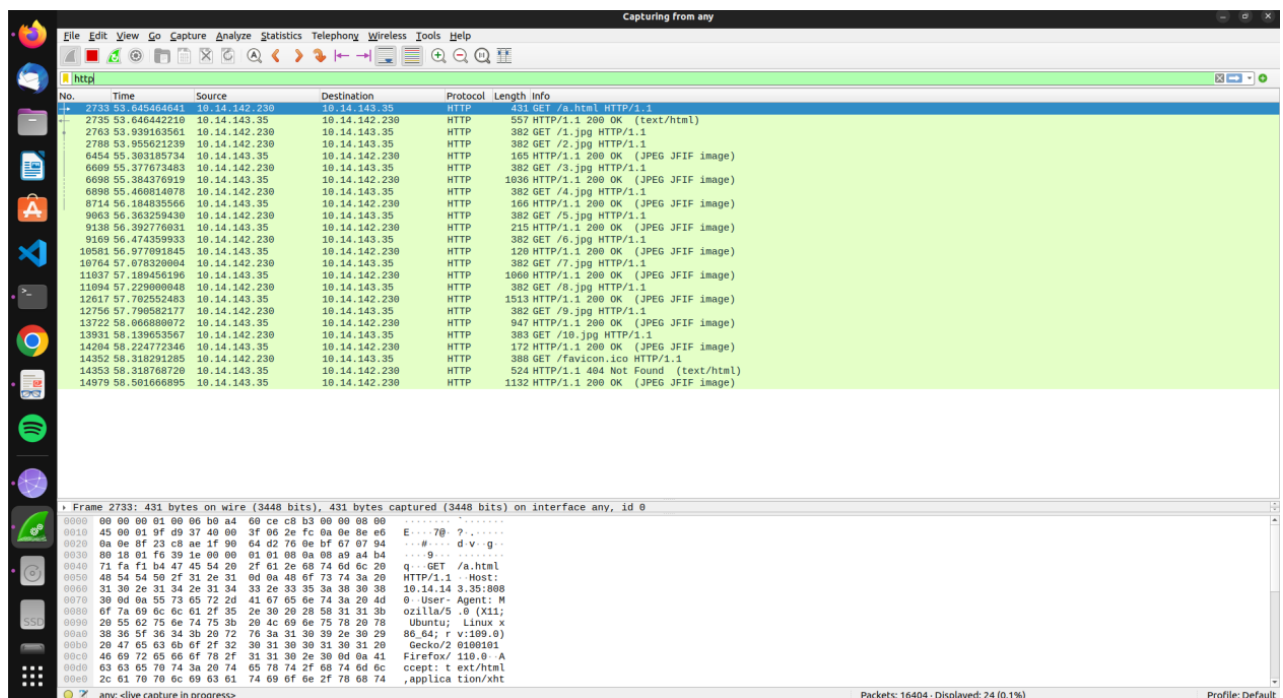
This is done by setting the value of max-persistent-connection-per-server to 0 in the client computer



Time to capture all 10 images: 48.014 – 43.646 = 4.368

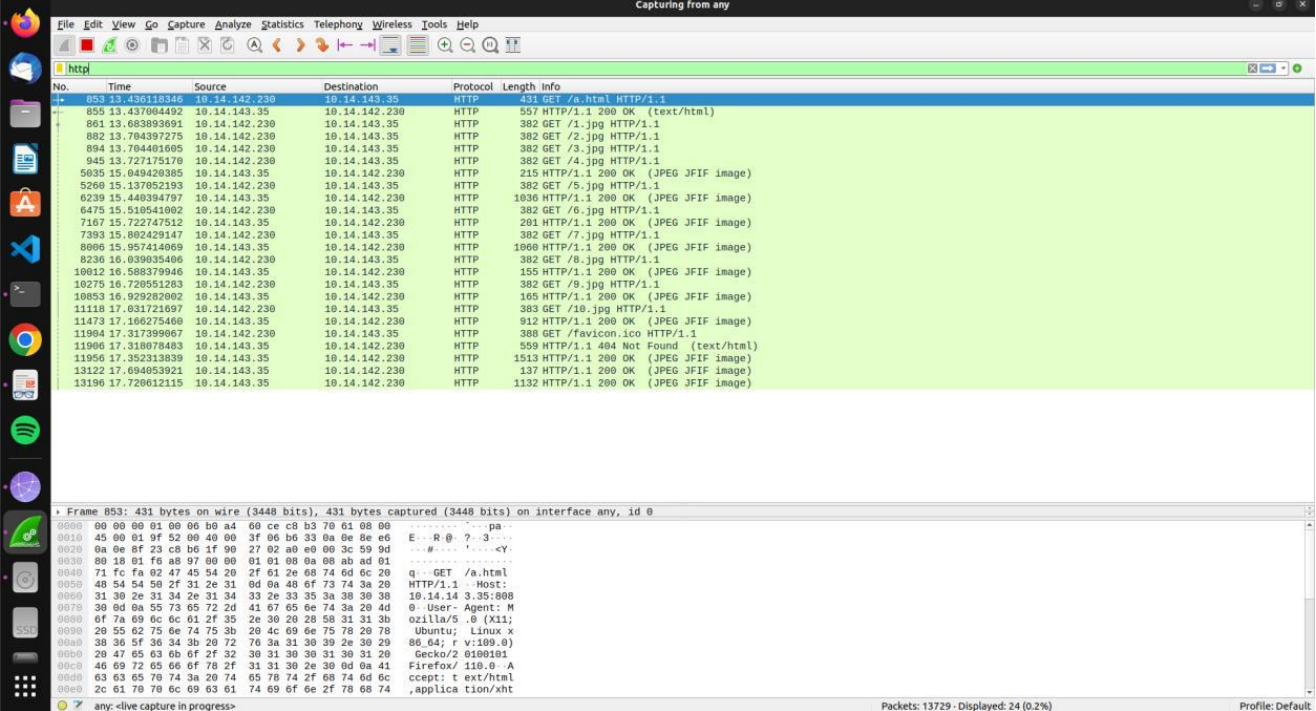
PART 2: PERSISTENT CONNECTIONS

For 2 persistent connections, set the value of max-persistent-connection-per-server to 2 in the client computer



Time to capture all 10 images: $58.139 - 53.939 = 4.2$

Max-Persistent Connection: 4



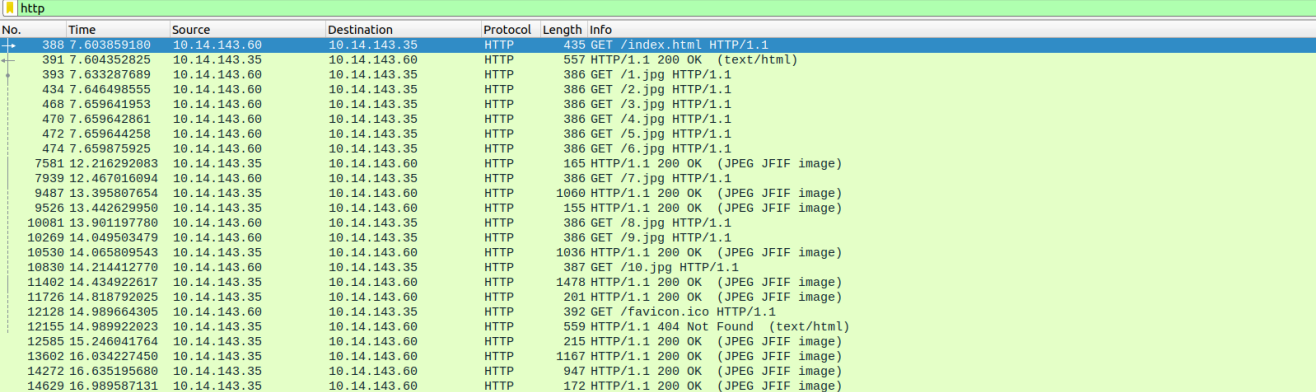
No.	Time	Source	Destination	Protocol	Length	Info
853	13.450119346	10.14.142.230	10.14.143.35	HTTP	431	GET /a.html HTTP/1.1
855	13.437004492	10.14.143.35	10.14.142.230	HTTP	557	HTTP/1.1 200 OK (text/html)
861	13.683893691	10.14.142.230	10.14.143.35	HTTP	382	GET /1.jpg HTTP/1.1
862	13.704397275	10.14.142.230	10.14.143.35	HTTP	382	GET /2.jpg HTTP/1.1
864	13.704401605	10.14.142.230	10.14.143.35	HTTP	382	GET /3.jpg HTTP/1.1
945	13.727175170	10.14.142.230	10.14.143.35	HTTP	382	GET /4.jpg HTTP/1.1
5035	15.049420385	10.14.143.35	10.14.142.230	HTTP	215	HTTP/1.1 200 OK (JPEG JFIF image)
5266	15.137052193	10.14.142.230	10.14.143.35	HTTP	382	GET /5.jpg HTTP/1.1
6239	15.448394797	10.14.143.35	10.14.142.230	HTTP	1036	HTTP/1.1 200 OK (JPEG JFIF image)
6475	15.510541002	10.14.142.230	10.14.143.35	HTTP	382	GET /6.jpg HTTP/1.1
7167	15.722747512	10.14.143.35	10.14.142.230	HTTP	201	HTTP/1.1 200 OK (JPEG JFIF image)
7393	15.802429147	10.14.142.230	10.14.143.35	HTTP	382	GET /7.jpg HTTP/1.1
8066	15.957414069	10.14.143.35	10.14.142.230	HTTP	1060	HTTP/1.1 200 OK (JPEG JFIF image)
8236	16.039035406	10.14.142.230	10.14.143.35	HTTP	382	GET /8.jpg HTTP/1.1
10012	16.588379946	10.14.143.35	10.14.142.230	HTTP	155	HTTP/1.1 200 OK (JPEG JFIF image)
10275	16.720551283	10.14.142.230	10.14.143.35	HTTP	382	GET /9.jpg HTTP/1.1
10853	16.929282092	10.14.143.35	10.14.142.230	HTTP	165	HTTP/1.1 200 OK (JPEG JFIF image)
11118	17.031721697	10.14.142.230	10.14.143.35	HTTP	383	GET /10.jpg HTTP/1.1
11473	17.106025460	10.14.143.35	10.14.142.230	HTTP	812	HTTP/1.1 200 OK (JPEG JFIF image)
11904	17.317399967	10.14.142.230	10.14.143.35	HTTP	388	GET /favicon.ico HTTP/1.1
11906	17.318078483	10.14.143.35	10.14.142.230	HTTP	559	HTTP/1.1 404 Not Found (text/html)
11950	17.352313839	10.14.143.35	10.14.142.230	HTTP	1513	HTTP/1.1 200 OK (JPEG JFIF image)
13122	17.694053921	10.14.143.35	10.14.142.230	HTTP	137	HTTP/1.1 200 OK (JPEG JFIF image)
13190	17.729612115	10.14.143.35	10.14.142.230	HTTP	1132	HTTP/1.1 200 OK (JPEG JFIF image)

Frame 853: 431 bytes on wire (3448 bits), 431 bytes captured (3448 bits) on interface any, id 0

```
0000  00 00 00 01 00 00 b0 a4 60 ce c8 b3 70 61 08 00  E...R...?..-...
0010  45 00 01 9f 52 00 40 00 3f 06 b6 33 0a 0e 8e e6  E...R...?..-...
0020  0a 0e 8f 23 c8 b6 1f 90 27 02 a0 e0 00 3c 59 9d  E...R...?..-...
0030  00 10 01 f5 a0 97 00 00 01 01 00 0a 08 ab ab 01  E...R...?..-...
0040  71 fc fa 82 47 45 54 20 2f 61 2e 68 74 6d 6c 20  q...GET /a.html
0050  48 54 54 50 2f 31 2e 31 0d 0a 48 6f 73 74 3a 20  HTTP/1.1 Host:
0060  31 30 2e 31 34 2e 31 34 33 2e 33 35 3a 38 30 38  10.14.14 3.35:808
0070  30 0d 0a 55 73 65 72 2d 41 67 65 6e 74 3a 20 4d  0 User-Agent: M
0080  6f 7a 69 6c 6c 61 2f 35 2e 30 20 28 58 31 31 3b  ozilla/5.0 (X11;
0090  20 55 62 75 6e 74 75 3b 20 4c 69 6e 75 78 20 78  Ubuntu; Linux x
00a0  38 36 5f 36 34 30 20 72 76 3a 31 30 39 2e 30 29  66.64; rv:1.9.0)
00b0  20 47 65 63 60 6f 2f 32 30 31 30 30 31 30 31 20  Gecko/2.0.0.0
00c0  46 69 72 65 66 6f 78 2f 31 31 30 2e 30 0d 0a 41  Firefox/11.0.0-A
00d0  63 63 65 70 74 3a 20 74 65 78 74 2f 68 74 6d 6c  ccept: text/html
00e0  2c 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78 68 74  ,applicat ion/xht
```

Time to capture all 10 images : $17.031 - 13.683 = 3.348$

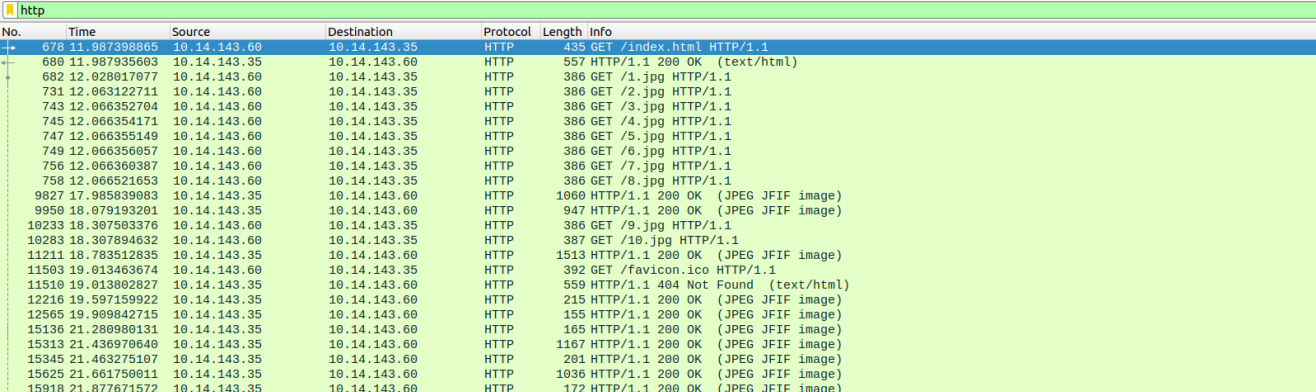
Max-Persistent Connection : 6



No.	Time	Source	Destination	Protocol	Length	Info
388	7.603859180	10.14.143.60	10.14.143.35	HTTP	435	GET /index.html HTTP/1.1
391	7.604352825	10.14.143.35	10.14.143.60	HTTP	557	HTTP/1.1 200 OK (text/html)
393	7.633287609	10.14.143.60	10.14.143.35	HTTP	386	GET /1.jpg HTTP/1.1
434	7.646498555	10.14.143.60	10.14.143.35	HTTP	386	GET /2.jpg HTTP/1.1
468	7.659641953	10.14.143.60	10.14.143.35	HTTP	386	GET /3.jpg HTTP/1.1
470	7.659642861	10.14.143.60	10.14.143.35	HTTP	386	GET /4.jpg HTTP/1.1
472	7.659644258	10.14.143.60	10.14.143.35	HTTP	386	GET /5.jpg HTTP/1.1
474	7.659875925	10.14.143.60	10.14.143.35	HTTP	386	GET /6.jpg HTTP/1.1
7581	12.216292083	10.14.143.35	10.14.143.60	HTTP	165	HTTP/1.1 200 OK (JPEG JFIF image)
7939	12.467016094	10.14.143.60	10.14.143.35	HTTP	386	GET /7.jpg HTTP/1.1
9487	13.395807654	10.14.143.35	10.14.143.60	HTTP	1060	HTTP/1.1 200 OK (JPEG JFIF image)
9526	13.442629950	10.14.143.35	10.14.143.60	HTTP	155	HTTP/1.1 200 OK (JPEG JFIF image)
10081	13.901197780	10.14.143.60	10.14.143.35	HTTP	386	GET /8.jpg HTTP/1.1
10269	14.049503479	10.14.143.60	10.14.143.35	HTTP	386	GET /9.jpg HTTP/1.1
10530	14.065809543	10.14.143.35	10.14.143.60	HTTP	1036	HTTP/1.1 200 OK (JPEG JFIF image)
10830	14.214412770	10.14.143.60	10.14.143.35	HTTP	387	GET /10.jpg HTTP/1.1
11402	14.434922617	10.14.143.35	10.14.143.60	HTTP	1478	HTTP/1.1 200 OK (JPEG JFIF image)
11726	14.818792025	10.14.143.35	10.14.143.60	HTTP	201	HTTP/1.1 200 OK (JPEG JFIF image)
12120	14.98964305	10.14.143.60	10.14.143.35	HTTP	392	GET /favicon.ico HTTP/1.1
12155	14.989922023	10.14.143.35	10.14.143.60	HTTP	559	HTTP/1.1 404 Not Found (text/html)
12585	15.246041764	10.14.143.35	10.14.143.60	HTTP	215	HTTP/1.1 200 OK (JPEG JFIF image)
13602	16.034227450	10.14.143.35	10.14.143.60	HTTP	1167	HTTP/1.1 200 OK (JPEG JFIF image)
14272	16.635195680	10.14.143.35	10.14.143.60	HTTP	947	HTTP/1.1 200 OK (JPEG JFIF image)
14629	16.989587131	10.14.143.35	10.14.143.60	HTTP	172	HTTP/1.1 200 OK (JPEG JFIF image)

Time to capture all 10 images: $14.214 - 7.633 = 6.581$

Max-Persistent Connection: 8



No.	Time	Source	Destination	Protocol	Length	Info
678	11.987398865	10.14.143.60	10.14.143.35	HTTP	435	GET /index.html HTTP/1.1
680	11.987395603	10.14.143.35	10.14.143.60	HTTP	557	HTTP/1.1 200 OK (text/html)
682	12.028010777	10.14.143.60	10.14.143.35	HTTP	386	GET /1.jpg HTTP/1.1
731	12.063122711	10.14.143.60	10.14.143.35	HTTP	386	GET /2.jpg HTTP/1.1
743	12.066352704	10.14.143.60	10.14.143.35	HTTP	386	GET /3.jpg HTTP/1.1
745	12.066354171	10.14.143.60	10.14.143.35	HTTP	386	GET /4.jpg HTTP/1.1
747	12.066355149	10.14.143.60	10.14.143.35	HTTP	386	GET /5.jpg HTTP/1.1
749	12.066356057	10.14.143.60	10.14.143.35	HTTP	386	GET /6.jpg HTTP/1.1
756	12.066360387	10.14.143.60	10.14.143.35	HTTP	386	GET /7.jpg HTTP/1.1
758	12.066521653	10.14.143.60	10.14.143.35	HTTP	386	GET /8.jpg HTTP/1.1
9827	17.985839983	10.14.143.35	10.14.143.60	HTTP	1060	HTTP/1.1 200 OK (JPEG JFIF image)
9950	18.078193201	10.14.143.35	10.14.143.60	HTTP	947	HTTP/1.1 200 OK (JPEG JFIF image)
10233	18.307593376	10.14.143.60	10.14.143.35	HTTP	386	GET /9.jpg HTTP/1.1
10283	18.307894632	10.14.143.60	10.14.143.35	HTTP	387	GET /10.jpg HTTP/1.1
11211	18.783512835	10.14.143.35	10.14.143.60	HTTP	1513	HTTP/1.1 200 OK (JPEG JFIF image)
11503	19.013463674	10.14.143.60	10.14.143.35	HTTP	392	GET /favicon.ico HTTP/1.1
11510	19.013802827	10.14.143.35	10.14.143.60	HTTP	559	HTTP/1.1 404 Not Found (text/html)
12216	19.597159922	10.14.143.35	10.14.143.60	HTTP	215	HTTP/1.1 200 OK (JPEG JFIF image)
12565	19.909842715	10.14.143.35	10.14.143.60	HTTP	155	HTTP/1.1 200 OK (JPEG JFIF image)
15136	21.280980131	10.14.143.35	10.14.143.60	HTTP	165	HTTP/1.1 200 OK (JPEG JFIF image)
15313	21.436970640	10.14.143.35	10.14.143.60	HTTP	1167	HTTP/1.1 200 OK (JPEG JFIF image)
15345	21.463275107	10.14.143.35	10.14.143.60	HTTP	201	HTTP/1.1 200 OK (JPEG JFIF image)
15625	21.661750811	10.14.143.35	10.14.143.60	HTTP	1036	HTTP/1.1 200 OK (JPEG JFIF image)
15918	21.877671572	10.14.143.35	10.14.143.60	HTTP	172	HTTP/1.1 200 OK (JPEG JFIF image)

Time to capture all 10 images: $18.307 - 12.028 = 6.279$

Max-Persistent Connection: 10

http					
No.	Time	Source	Destination	Protocol	Length Info
476	9.968760000	10.14.143.60	10.14.143.35	HTTP	435 GET /index.html HTTP/1.1
478	9.969152862	10.14.143.35	10.14.143.60	HTTP	557 HTTP/1.1 200 OK (text/html)
482	10.017076151	10.14.143.60	10.14.143.35	HTTP	386 GET /1.jpg HTTP/1.1
542	10.036624430	10.14.143.60	10.14.143.35	HTTP	386 GET /2.jpg HTTP/1.1
544	10.036625408	10.14.143.60	10.14.143.35	HTTP	386 GET /3.jpg HTTP/1.1
546	10.036626316	10.14.143.60	10.14.143.35	HTTP	386 GET /4.jpg HTTP/1.1
548	10.036627294	10.14.143.60	10.14.143.35	HTTP	386 GET /5.jpg HTTP/1.1
550	10.036628272	10.14.143.60	10.14.143.35	HTTP	386 GET /6.jpg HTTP/1.1
552	10.036629250	10.14.143.60	10.14.143.35	HTTP	386 GET /7.jpg HTTP/1.1
554	10.036630158	10.14.143.60	10.14.143.35	HTTP	386 GET /8.jpg HTTP/1.1
556	10.036713200	10.14.143.60	10.14.143.35	HTTP	386 GET /9.jpg HTTP/1.1
558	10.036714100	10.14.143.60	10.14.143.35	HTTP	387 GET /10.jpg HTTP/1.1
8880	14.923004233	10.14.143.35	10.14.143.60	HTTP	1060 HTTP/1.1 200 OK (JPEG JFIF image)
9514	15.467847812	10.14.143.60	10.14.143.35	HTTP	392 GET /favicon.ico HTTP/1.1
9581	15.468144432	10.14.143.35	10.14.143.60	HTTP	559 HTTP/1.1 404 Not Found (text/html)
10056	15.586501647	10.14.143.35	10.14.143.60	HTTP	215 HTTP/1.1 200 OK (JPEG JFIF image)
12165	16.669266113	10.14.143.35	10.14.143.60	HTTP	1167 HTTP/1.1 200 OK (JPEG JFIF image)
12912	17.156886352	10.14.143.35	10.14.143.60	HTTP	165 HTTP/1.1 200 OK (JPEG JFIF image)
13194	17.401570547	10.14.143.35	10.14.143.60	HTTP	155 HTTP/1.1 200 OK (JPEG JFIF image)
13781	17.786570841	10.14.143.35	10.14.143.60	HTTP	1513 HTTP/1.1 200 OK (JPEG JFIF image)
14777	18.272948447	10.14.143.35	10.14.143.60	HTTP	201 HTTP/1.1 200 OK (JPEG JFIF image)
15033	18.513788108	10.14.143.35	10.14.143.60	HTTP	947 HTTP/1.1 200 OK (JPEG JFIF image)
15241	18.622838427	10.14.143.35	10.14.143.60	HTTP	1036 HTTP/1.1 200 OK (JPEG JFIF image)
15282	18.642435736	10.14.143.35	10.14.143.60	HTTP	172 HTTP/1.1 200 OK (JPEG JFIF image)

Time to capture all 10 images: $10.036 - 10.017 = 0.019$

Conclusion:

Therefore, Max-Persistent Connections of 10 takes less time to capture all 10 images.

Time Taken: 0.019