Lab #3

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   **Client**

172.16.10.1/24   172.16.10.2/24
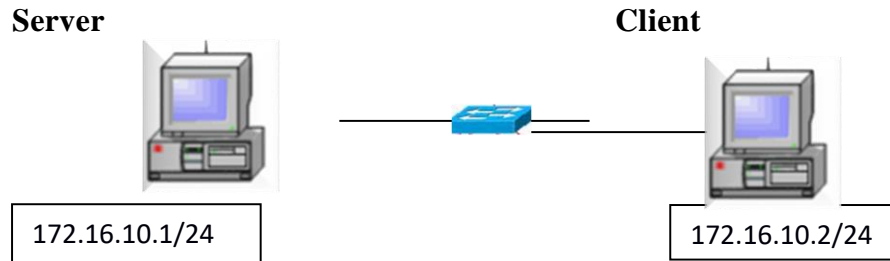
Server Side:

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.

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

> **$sudo ip addr add 172.16.10.1/24 dev enps0**
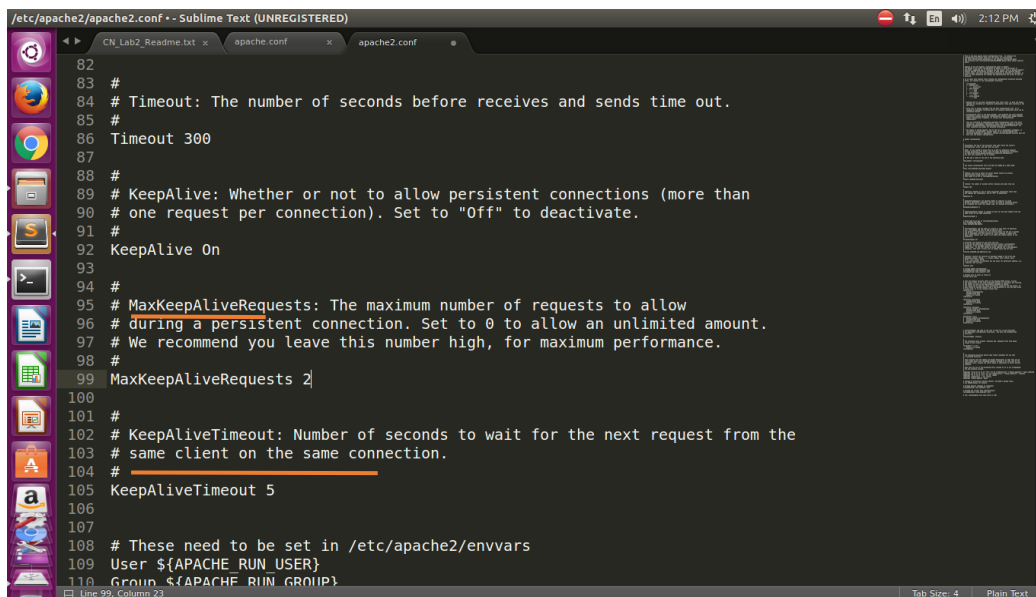> **$sudo ip addr**

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

```
student@student-H81H3-I:~$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1
    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: enp2s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether b8:ae:ed:a5:a5:a9 brd ff:ff:ff:ff:ff:ff
    inet 172.16.10.1/24 brd 172.16.10.255 scope global enp2s0
       valid_lft forever preferred_lft forever
    inet6 fe80::c901:c994:4cf5:f837/64 scope link
       valid_lft forever preferred_lft forever
student@student-H81H3-I:~$
```

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**

```
/etc/apache2/apache2.conf • - Sublime Text (UNREGISTERED)
CN_Lab2_Readme.txt    apache.conf    apache2.conf
82
83  #
84  # Timeout: The number of seconds before receives and sends time out.
85  #
86  Timeout 300
87
88  #
89  # KeepAlive: Whether or not to allow persistent connections (more than
90  # one request per connection). Set to "Off" to deactivate.
91  #
92  KeepAlive On
93
94  #
95  # MaxKeepAliveRequests: The maximum number of requests to allow
96  # during a persistent connection. Set to 0 to allow an unlimited amount.
97  # We recommend you leave this number high, for maximum performance.
98  #
99  MaxKeepAliveRequests 2
100
101 #
102 # KeepAliveTimeout: Number of seconds to wait for the next request from the
103 # same client on the same connection.
104 #
105 KeepAliveTimeout 5
106
107
108 # These need to be set in /etc/apache2/envvars
109 User ${APACHE_RUN_USER}
110 Group ${APACHE_RUN_GROUP}
Line 99, Column 23                              Tab Size: 4    Plain Text
```

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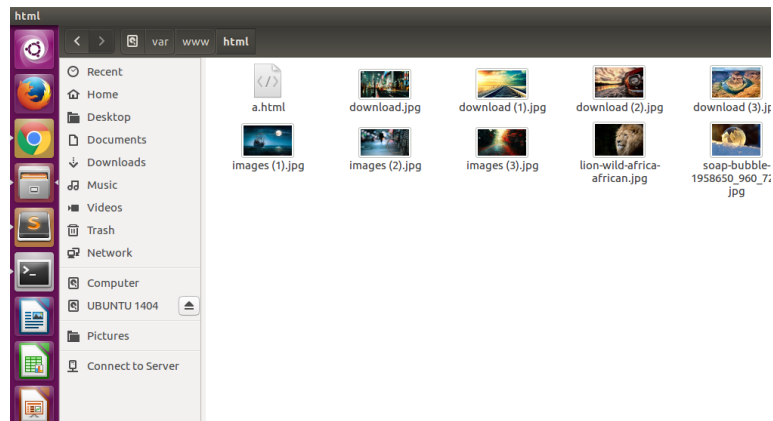
Step 6: Prepare a web page as shown below. The html file needs to add 10 images. (Kindly skip the style attribute in the below image)


```
a.html [Read-Only] (/var/www/html) - gedit

<!DOCTYPE html>
<html>
<body>

<h2>Spectacular Mountain</h2>
<img src="images (1).jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="images (2).jpg" style="width:304px;height:228px;">
<img src="download (4).jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="images (3).jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="lion-wild-africa-african.jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="images.jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="download.jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="download (1).jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="soap-bubble-1958650_960_720.jpg" alt="Mountain View" style="width:304px;height:228px;">
<img src="download (2).jpg" alt="Mountain View" style="width:304px;height:228px;">

</body>
</html>
```

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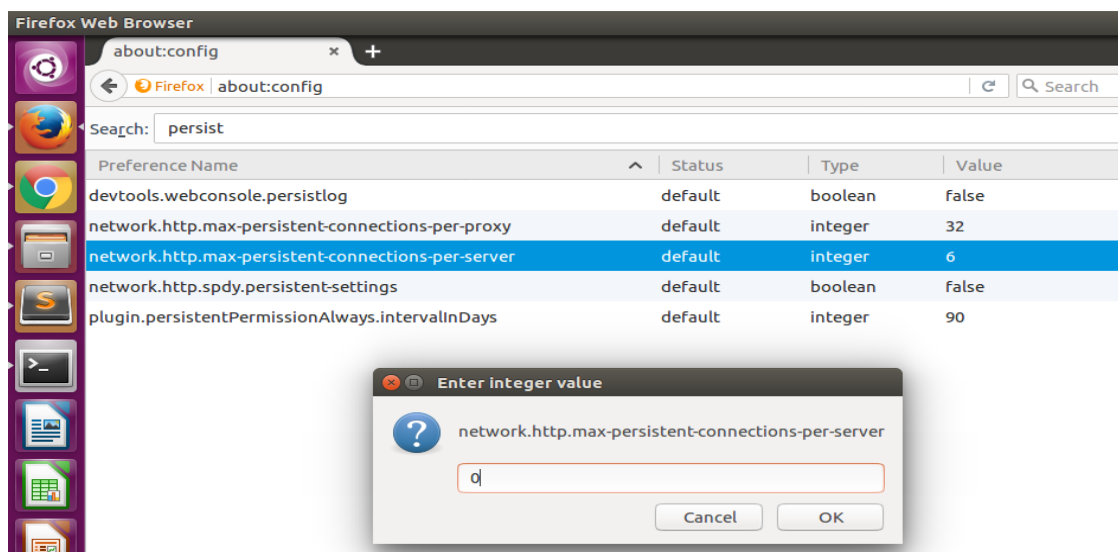
Step 2: Access web page on client-side browser (Firefox)

The client could access the file as:

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

Here the file name is **a.html** present in server. So, by tying **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.

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.

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.

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	1.699908042	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.

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.

Here it is 1.882459413-1.556964626=0.325494787

OBSERVATIONS REQUIRED ON EDMODO:

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 EDMODO:

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).