

WEEK-2 SUBMISSION

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Week #2

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
```

```
Activities Terminal en1 suhan@suhan: ~
suhan@suhan:~$ sudo apt-get install apache2
[sudo] password for suhan:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  apache2-bin apache2-data apache2-utils libapr1 libaprutil1 libaprutil1-dbd-sqlite3 libaprutil1-ldap
Suggested packages:
  apache2-doc apache2-suexec-pristine | apache2-suexec-custom
The following NEW packages will be installed:
  apache2 apache2-bin apache2-data apache2-utils libapr1 libaprutil1 libaprutil1-dbd-sqlite3 libaprutil1-ldap
0 upgraded, 8 newly installed, 0 to remove and 321 not upgraded.
Need to get 1,713 kB of archives.
After this operation, 7,494 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libapr1 amd64 1.6.5-1ubuntu1 [91.4 kB]
Get:2 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libaprutil1 amd64 1.6.1-4ubuntu2 [84.7 kB]
Get:3 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libaprutil1-dbd-sqlite3 amd64 1.6.1-4ubuntu2 [10.5 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libaprutil1-ldap amd64 1.6.1-4ubuntu2 [8,736 B]
Get:5 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 apache2-bin amd64 2.4.41-4ubuntu3.1 [1,180 kB]
Get:6 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 apache2-data all 2.4.41-4ubuntu3.1 [158 kB]
Get:7 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 apache2-utils amd64 2.4.41-4ubuntu3.1 [83.8 kB]
Get:8 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 apache2 amd64 2.4.41-4ubuntu3.1 [95.5 kB]
Fetched 1,713 kB in 1s (1,177 kB/s)
Selecting previously unselected package libapr1:amd64.
(Reading database ... 182521 files and directories currently installed.)
Preparing to unpack .../0-libapr1_1.6.5-1ubuntu1_amd64.deb ...
Unpacking libapr1:amd64 (1.6.5-1ubuntu1) ...
Selecting previously unselected package libaprutil1:amd64.
Preparing to unpack .../1-libaprutil1_1.6.1-4ubuntu2_amd64.deb ...
Unpacking libaprutil1:amd64 (1.6.1-4ubuntu2) ...
Selecting previously unselected package libaprutil1-dbd-sqlite3:amd64.
```

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

```
sudo apt-get update
```

EXECUTION STEPS

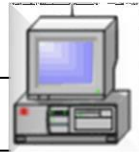
Step 1: Connect 2 desktops using switch and cables as shown below. (Use 2 VMs on Virtualbox or VMware instead of physical connections.)

Server



172.16.10.1/24

Client



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`

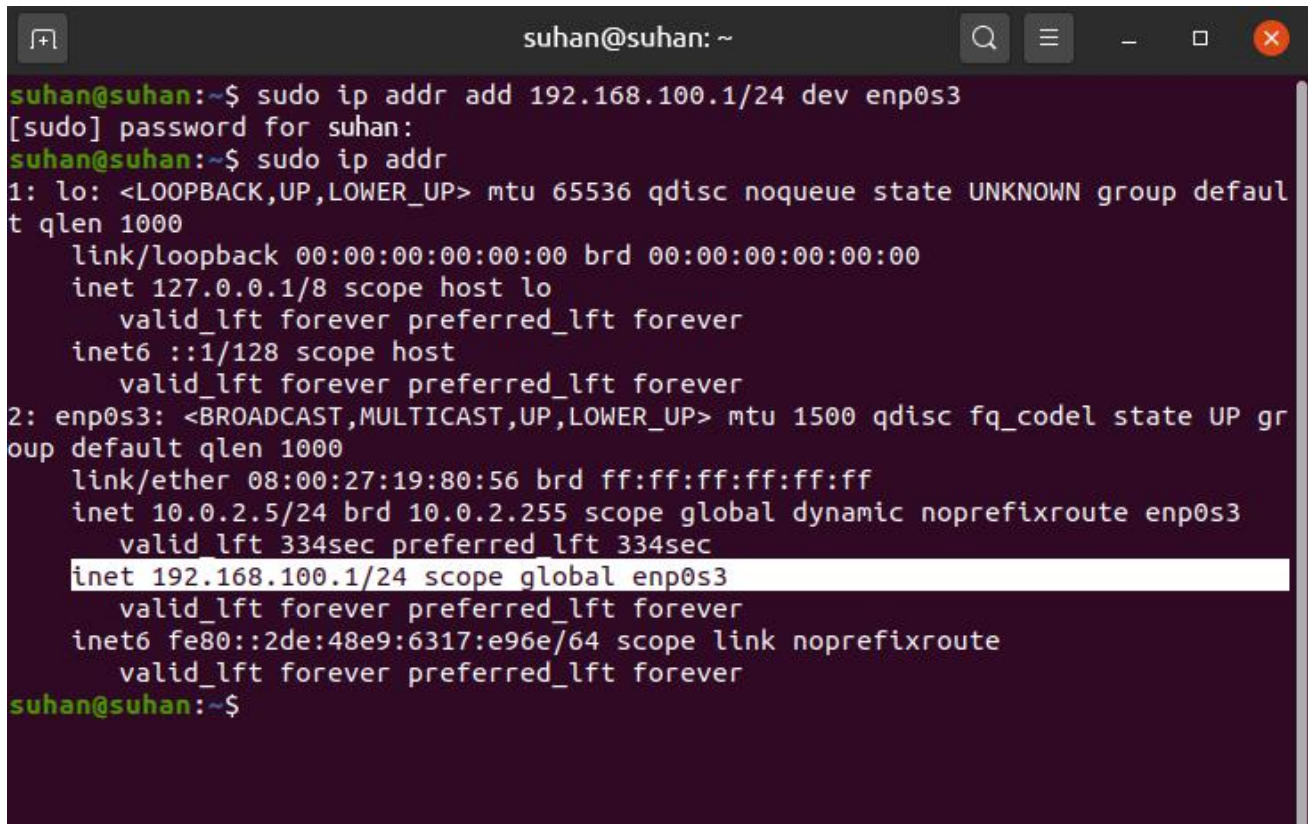
```
0 upgraded, 0 newly installed, 0 to remove and 321 not upgraded.
suh@suhan:~$ sudo systemctl status apache2
● apache2.service - The Apache HTTP Server
   Loaded: loaded (/lib/systemd/system/apache2.service; enabled; vendor preset: enabled)
   Active: active (running) since Sat 2021-02-06 15:23:30 IST; 16min ago
     Docs: https://httpd.apache.org/docs/2.4/
   Main PID: 3457 (apache2)
    Tasks: 55 (limit: 1109)
   Memory: 4.8M
   CGroup: /system.slice/apache2.service
           └─3457 /usr/sbin/apache2 -k start
             └─3458 /usr/sbin/apache2 -k start
               └─3460 /usr/sbin/apache2 -k start

Feb 08 16:45:24 suhansystemd[1]: Starting The Apache HTTP Server...
Feb 08 16:45:24 suhanapache2[3456]: AH00558: apache2: Could not reliably determine the
Feb 08 16:45:24 suhansystemd[1]: Started The Apache HTTP Server.
lines 1-15/15 (END)
```

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

\$sudo ip addr add 192.168.100.1/24 dev enp0s3

\$sudo ip addr

A terminal window titled 'suhan@suhan: ~' with standard window controls. The terminal shows the execution of 'sudo ip addr add 192.168.100.1/24 dev enp0s3' followed by a password prompt. Then 'sudo ip addr' is run, displaying details for the loopback interface 'lo' and the ethernet interface 'enp0s3'. The line 'inet 192.168.100.1/24 scope global enp0s3' is highlighted with a white background.

```
suhan@suhan:~$ sudo ip addr add 192.168.100.1/24 dev enp0s3
[sudo] password for suhan:
suhan@suhan:~$ 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: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:19:80:56 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.5/24 brd 10.0.2.255 scope global dynamic noprefixroute enp0s3
        valid_lft 334sec preferred_lft 334sec
    inet 192.168.100.1/24 scope global enp0s3
        valid_lft forever preferred_lft forever
    inet6 fe80::2de:48e9:6317:e96e/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
suhan@suhan:~$
```

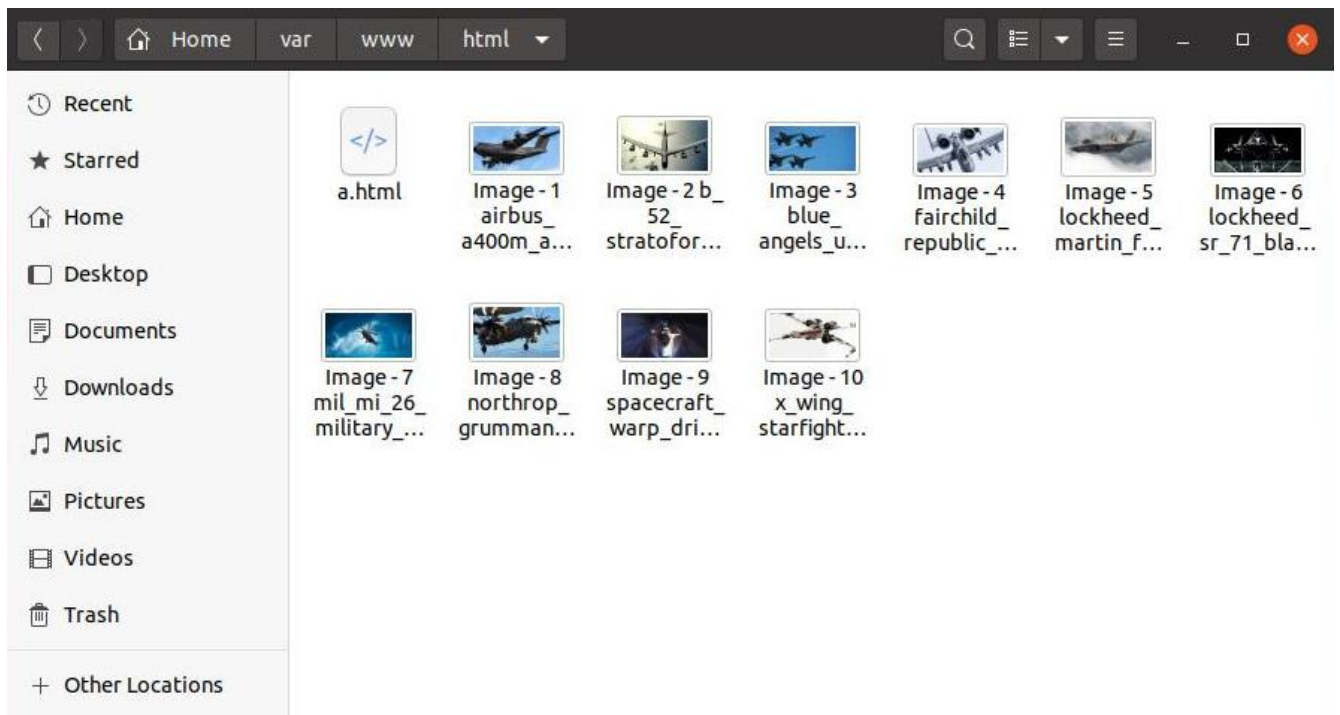
Step 4: The **apache2.conf** file present in the **etc/apache2** directory is modified as:

- 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


```
suhan@suhan: ~  
GNU nano 4.8 /etc/apache2/apache2.conf  
#  
DefaultRuntimeDir ${APACHE_RUN_DIR}  
#  
# PidFile: The file in which the server should record its process  
# identification number when it starts.  
# This needs to be set in /etc/apache2/envvars  
#  
PidFile ${APACHE_PID_FILE}  
#  
# 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  
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos M-U Undo  
^X Exit ^R Read File ^\ Replace ^U Paste Text ^T To Spell ^_ Go To Line M-E Redo
```

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`.



Step 6: Prepare a web page as shown below. The html file needs to add 10 images.

```

Text Editor
a.html
~/var/www/html

1 <!DOCTYPE html>
2 <html>
3 <body>
4 <h2>FIGHTER PLANES</h2>
5 </img>
6 </img>
7 </img>
8 </img>
9 </img>
10 </img>
11 </img>
12 </img>
13 </img>
14 </img>
15 </body>
16 </html>

```

Client side:

Client IP address can be set by the following command.

\$sudo ip addr add 192.168.100.1/24 dev eth0

\$sudo ip addr


```
root@kali:~# sudo ip addr add 192.168.100.1/24 dev eth0
root@kali:~# 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 pfifo_fast state UP grou
p default qlen 1000
    link/ether 08:00:27:14:1e:36 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 468sec preferred_lft 468sec
    inet 192.168.100.1/24 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe14:1e36/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
root@kali:~#
```

There are broadly two parts of execution:

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

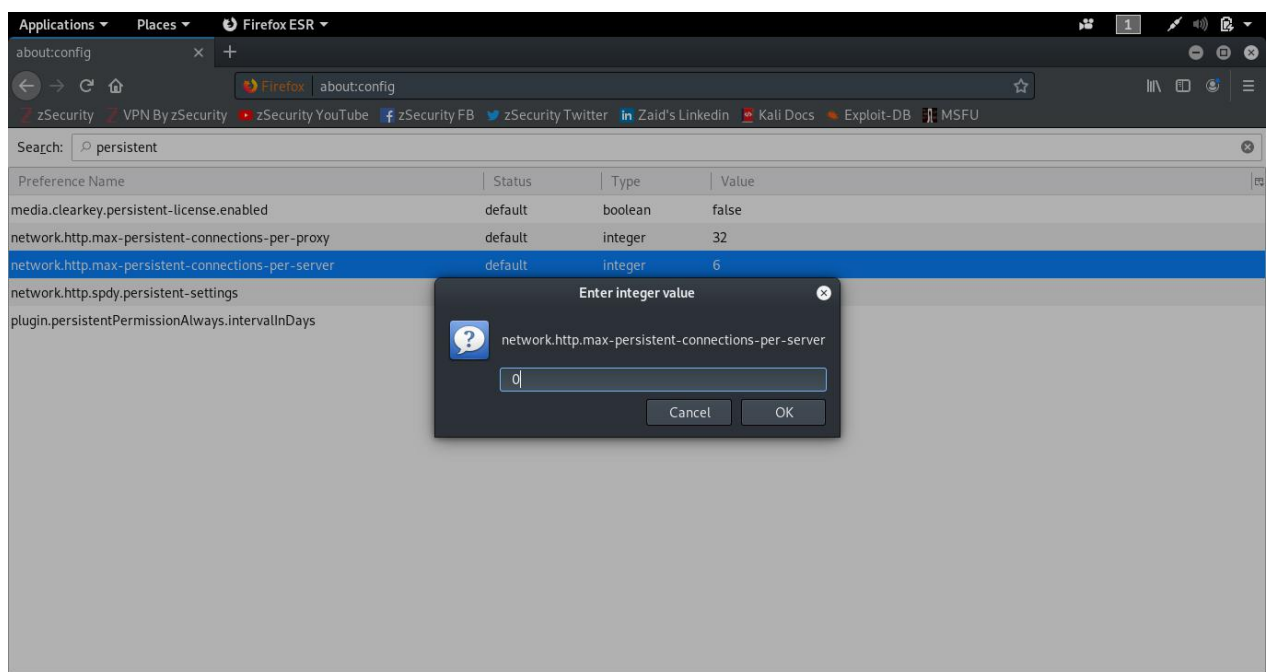
Open Firefox browser to configure for persistent option. Go to browser and type

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)

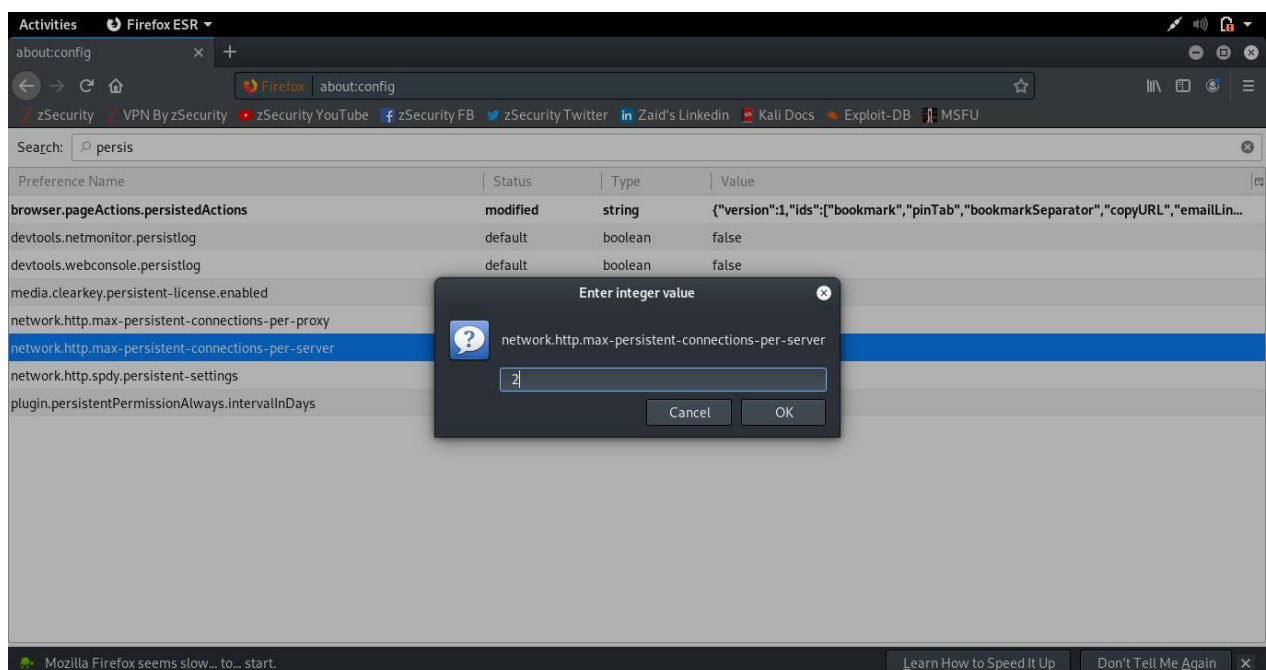
Step 3: Use wireshark. Open wireshark in the server computer while client is trying to access the server's local host webpage. Apply 'http' filter and note the time to capture all the 10 images.

No.	Time	Source	Destination	Protocol	Length	Info
4	0.000269684	192.168.100.4	192.168.100.5	HTTP	398	GET /a.html HTTP/1.1
6	0.000690299	192.168.100.5	192.168.100.4	HTTP	789	HTTP/1.1 200 OK (text/html)
8	0.203847527	192.168.100.4	192.168.100.5	HTTP	416	GET /Image%20-%201%20airbus_a400m_atlas_military_transport_aircraft-5120x2880.jpg HTTP/1.1
110	0.216918447	192.168.100.5	192.168.100.4	HTTP	10593	HTTP/1.1 200 OK (JPEG JFIF image)
112	0.229403533	192.168.100.4	192.168.100.5	HTTP	386	GET /Image%20-%202%20b_52_stratofortress_bomber.jpg HTTP/1.1
141	0.234075095	192.168.100.5	192.168.100.4	HTTP	12609	HTTP/1.1 200 OK (JPEG JFIF image)
148	0.238154789	192.168.100.4	192.168.100.5	HTTP	392	GET /Image%20-%203%20blue_angels_us_navy_4k-3840x2160.jpg HTTP/1.1
266	0.245371293	192.168.100.5	192.168.100.4	HTTP	24427	HTTP/1.1 200 OK (JPEG JFIF image)
270	0.254634774	192.168.100.4	192.168.100.5	HTTP	411	GET /Image%20-%204%20fairchild_republic_a_10_thunderbolt_ii_4k-3840x2160.jpg HTTP/1.1
337	0.266269413	192.168.100.5	192.168.100.4	HTTP	43505	HTTP/1.1 200 OK (JPEG JFIF image)
339	0.273078495	192.168.100.4	192.168.100.5	HTTP	409	GET /Image%20-%205%20lockheed_martin_f_35_lightning_ii_stealth_fighter.jpg HTTP/1.1
373	0.277213977	192.168.100.5	192.168.100.4	HTTP	45800	HTTP/1.1 200 OK (JPEG JFIF image)
380	0.286203587	192.168.100.4	192.168.100.5	HTTP	397	GET /Image%20-%206%20lockheed_sr_71_blackbird_4k-5120x2880.jpg HTTP/1.1
511	0.299449289	192.168.100.5	192.168.100.4	HTTP	54004	HTTP/1.1 200 OK (JPEG JFIF image)
514	0.303269145	192.168.100.4	192.168.100.5	HTTP	402	GET /Image%20-%207%20mil_m1_26_military_helicopter_4k-3840x2160.jpg HTTP/1.1
552	0.307247697	192.168.100.5	192.168.100.4	HTTP	19991	HTTP/1.1 200 OK (JPEG JFIF image)
554	0.316045747	192.168.100.4	192.168.100.5	HTTP	415	GET /Image%20-%208%20northrop_grumman_e_2_hawkeye_amercian_military_aircraft.jpg HTTP/1.1
592	0.326584462	192.168.100.5	192.168.100.4	HTTP	10316	HTTP/1.1 200 OK (JPEG JFIF image)
600	0.329443398	192.168.100.4	192.168.100.5	HTTP	381	GET /Image%20-%209%20spacecraft_warp_drive.jpg HTTP/1.1
756	0.341329028	192.168.100.5	192.168.100.4	HTTP	10892	HTTP/1.1 200 OK (JPEG JFIF image)
758	0.372624784	192.168.100.4	192.168.100.5	HTTP	395	GET /Image%20-%2010%20x_wing_starfighter_4k_8k-7680x4320.jpg HTTP/1.1
869	0.402922481	192.168.100.5	192.168.100.4	HTTP	23333	HTTP/1.1 200 OK (JPEG JFIF image)
872	0.478711925	192.168.100.4	192.168.100.5	HTTP	313	GET /favicon.ico HTTP/1.1
874	0.478963663	192.168.100.5	192.168.100.4	HTTP	523	HTTP/1.1 404 Not Found (text/html)
885	1.429534287	192.168.100.5	35.232.111.17	HTTP	143	GET / HTTP/1.1
887	1.665721497	35.232.111.17	192.168.100.5	HTTP	204	HTTP/1.1 204 No Content
972	301.404280182	192.168.100.5	34.122.121.32	HTTP	143	GET / HTTP/1.1
974	301.626641538	34.122.121.32	192.168.100.5	HTTP	204	HTTP/1.1 204 No Content

Here it is $0.402922481 - 0.00026084 = 0.402661797$

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.

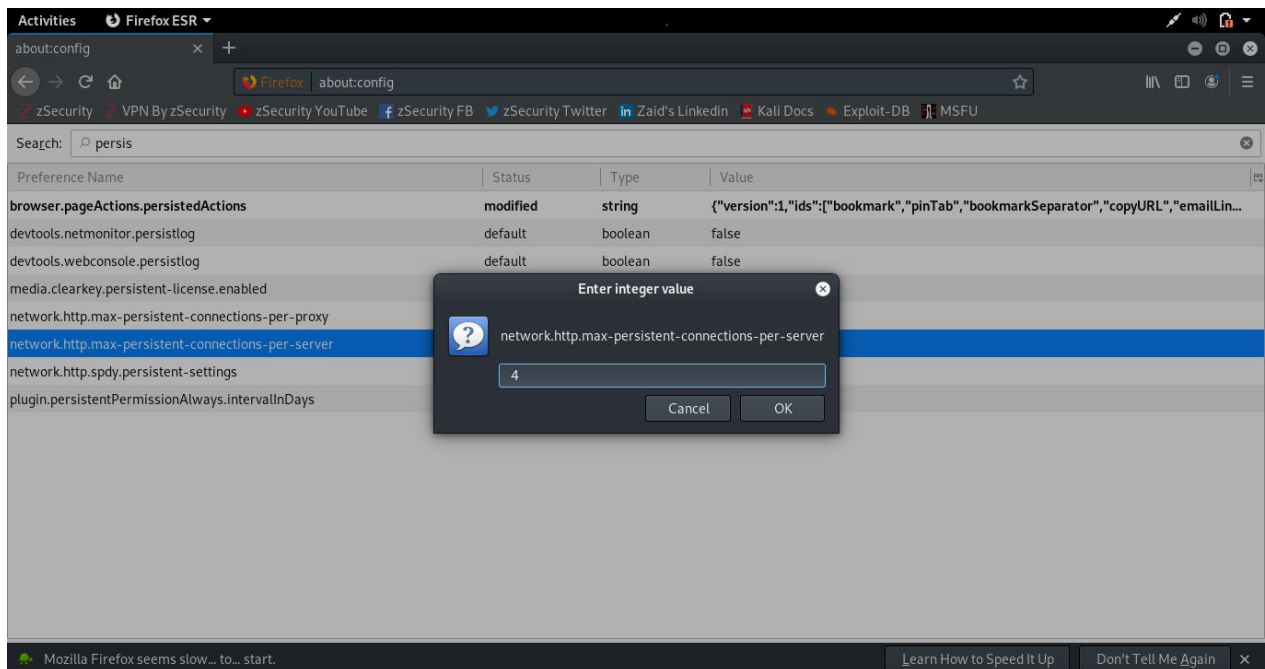


Step 2: Repeat the **steps 1-3** in the previous section.

http					
No.	Time	Source	Destination	Protocol	Length Info
4	0.000254624	192.168.100.4	192.168.100.5	HTTP	398 GET /a.html HTTP/1.1
6	0.000626298	192.168.100.5	192.168.100.4	HTTP	789 HTTP/1.1 200 OK (text/html)
8	0.210971562	192.168.100.4	192.168.100.5	HTTP	416 GET /Image%20-%201%20airbus_a400m_atlas_military_transport_aircraft-5120x2880.jpg HTTP/1.1
33	0.212097592	192.168.100.4	192.168.100.5	HTTP	386 GET /Image%20-%202%20b_52_stratofortress_bomber.jpg HTTP/1.1
138	0.214233002	192.168.100.4	192.168.100.5	HTTP	392 GET /Image%20-%203%20blue_angels_us_navy_4k-3840x2160.jpg HTTP/1.1
304	0.219688756	192.168.100.4	192.168.100.5	HTTP	411 GET /Image%20-%204%20fairchild_republic_a_10_thunderbolt_ii_4k-3840x2160.jpg HTTP/1.1
374	0.222195526	192.168.100.4	192.168.100.5	HTTP	409 GET /Image%20-%205%20lockheed_martin_f_35_lightning_ii_stealth_fighter.jpg HTTP/1.1
445	0.225435253	192.168.100.4	192.168.100.5	HTTP	397 GET /Image%20-%206%20lockheed_sr_71_blackbird_4k-5120x2880.jpg HTTP/1.1
447	0.225435291	192.168.100.4	192.168.100.5	HTTP	402 GET /Image%20-%207%20m11_mi_26_military_helicopter_4k-3840x2160.jpg HTTP/1.1
449	0.225435329	192.168.100.4	192.168.100.5	HTTP	415 GET /Image%20-%208%20northrop_grumman_e_2_hawkeye_american_military_aircraft.jpg HTTP/1.1
563	0.227355992	192.168.100.5	192.168.100.4	HTTP	13211 HTTP/1.1 200 OK (JPEG JFIF image)
602	0.228128121	192.168.100.4	192.168.100.5	HTTP	381 GET /Image%20-%209%20spacecraft_warp_drive.jpg HTTP/1.1
767	0.232428352	192.168.100.4	192.168.100.5	HTTP	395 GET /Image%20-%2010%20x_wing_starfighter_4k_8k-7680x4320.jpg HTTP/1.1
812	0.234184669	192.168.100.5	192.168.100.4	HTTP	40716 HTTP/1.1 200 OK (JPEG JFIF image)
917	0.236830197	192.168.100.5	192.168.100.4	HTTP	28679 HTTP/1.1 200 OK (JPEG JFIF image)
1279	0.252162407	192.168.100.5	192.168.100.4	HTTP	53641 HTTP/1.1 200 OK (JPEG JFIF image)
1284	0.257446142	192.168.100.5	192.168.100.4	HTTP	13116 HTTP/1.1 200 OK (JPEG JFIF image)
1288	0.261099072	192.168.100.5	192.168.100.4	HTTP	14635 HTTP/1.1 200 OK (JPEG JFIF image)
1341	0.270333315	192.168.100.5	192.168.100.4	HTTP	9145 HTTP/1.1 200 OK (JPEG JFIF image)
1456	0.391489890	192.168.100.5	192.168.100.4	HTTP	12005 HTTP/1.1 200 OK (JPEG JFIF image)
1559	0.454116818	192.168.100.5	192.168.100.4	HTTP	7455 HTTP/1.1 200 OK (JPEG JFIF image)
1699	0.473695061	192.168.100.5	192.168.100.4	HTTP	5636 HTTP/1.1 200 OK (JPEG JFIF image)
1701	0.867594907	192.168.100.4	192.168.100.5	HTTP	313 GET /favicon.ico HTTP/1.1
1703	0.867883920	192.168.100.5	192.168.100.4	HTTP	558 HTTP/1.1 404 Not Found (text/html)

Here it is 0.473695061-0.210971562=0.262723499

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

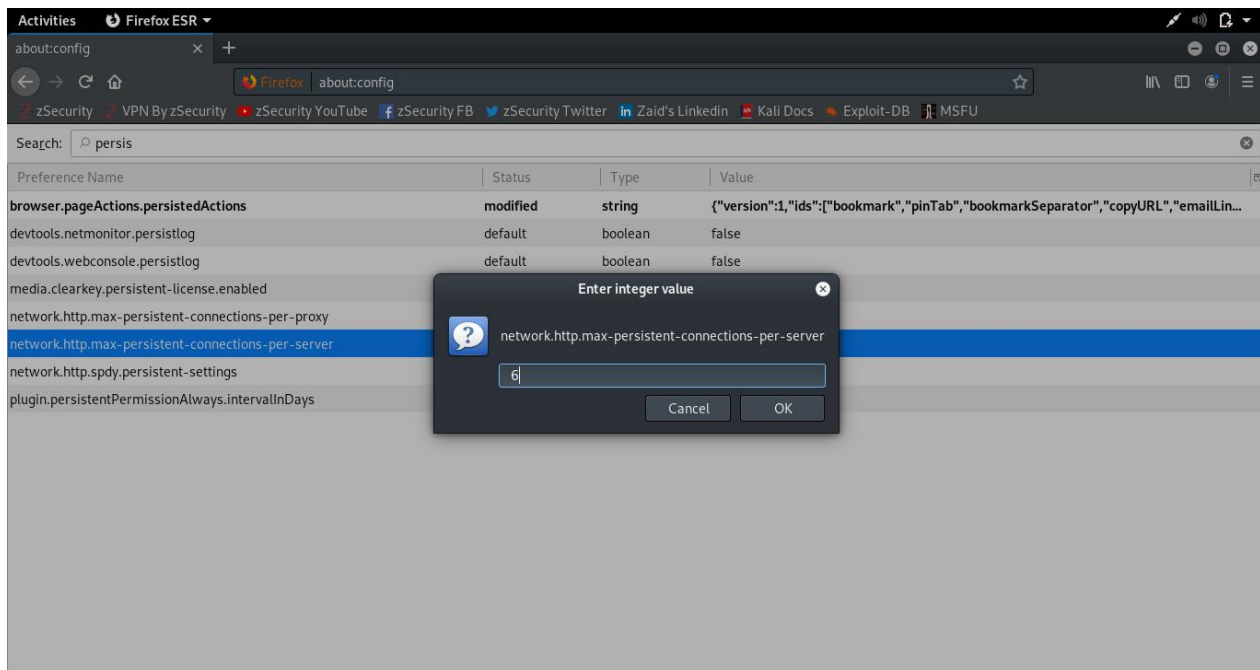


Step 4: Repeat the steps 1-3 in the previous section.

http						
No.	Time	Source	Destination	Protocol	Length	Info
4	0.000326356	192.168.100.4	192.168.100.5	HTTP	398	GET /a.html HTTP/1.1
6	0.000691774	192.168.100.5	192.168.100.4	HTTP	789	HTTP/1.1 200 OK (text/html)
8	0.026264595	192.168.100.4	192.168.100.5	HTTP	416	GET /Image%20-%201%20airbus_a400m_atlas_military_transport_aircraft-5120x2880.jpg HTTP/1.1
145	0.031105530	192.168.100.5	192.168.100.4	HTTP	33505	HTTP/1.1 200 OK (JPEG JFIF image)
147	0.031876579	192.168.100.4	192.168.100.5	HTTP	386	GET /Image%20-%202%20b_52_stratofortress_bomber.jpg HTTP/1.1
235	0.034433287	192.168.100.5	192.168.100.4	HTTP	58980	HTTP/1.1 200 OK (JPEG JFIF image)
238	0.047899597	192.168.100.4	192.168.100.5	HTTP	392	GET /Image%20-%203%20blue_angels_us_navy_4k-3840x2160.jpg HTTP/1.1
309	0.051517102	192.168.100.5	192.168.100.4	HTTP	3051	HTTP/1.1 200 OK (JPEG JFIF image)
317	0.100103379	192.168.100.4	192.168.100.5	HTTP	411	GET /Image%20-%204%20fairchild_republic_a_10_thunderbolt_ii_4k-3840x2160.jpg HTTP/1.1
363	0.111623714	192.168.100.4	192.168.100.5	HTTP	409	GET /Image%20-%205%20lockheed_martin_f_35_lightning_ii_stealth_fighter.jpg HTTP/1.1
429	0.115547906	192.168.100.5	192.168.100.4	HTTP	40008	HTTP/1.1 200 OK (JPEG JFIF image)
424	0.116813536	192.168.100.5	192.168.100.4	HTTP	59398	HTTP/1.1 200 OK (JPEG JFIF image)
432	0.120154634	192.168.100.4	192.168.100.5	HTTP	397	GET /Image%20-%206%20lockheed_sr_71_blackbird_4k-5120x2880.jpg HTTP/1.1
563	0.125151475	192.168.100.5	192.168.100.4	HTTP	50068	HTTP/1.1 200 OK (JPEG JFIF image)
574	0.128495445	192.168.100.4	192.168.100.5	HTTP	402	GET /Image%20-%207%20m11_mi_26_military_helicopter_4k-3840x2160.jpg HTTP/1.1
672	0.131938691	192.168.100.5	192.168.100.4	HTTP	9855	HTTP/1.1 200 OK (JPEG JFIF image)
677	0.157283670	192.168.100.4	192.168.100.5	HTTP	415	GET /Image%20-%208%20northrop_grumman_e_2_hawkeye_amercian_military_aircraft.jpg HTTP/1.1
730	0.167402433	192.168.100.4	192.168.100.5	HTTP	381	GET /Image%20-%209%20spacecraft_warp_drive.jpg HTTP/1.1
806	0.178583710	192.168.100.5	192.168.100.4	HTTP	6007	HTTP/1.1 200 OK (JPEG JFIF image)
808	0.181509715	192.168.100.4	192.168.100.5	HTTP	395	GET /Image%20-%2010%20wing_starfighter_4k_8k-7680x4320.jpg HTTP/1.1
859	0.196325407	192.168.100.5	192.168.100.4	HTTP	1036	HTTP/1.1 200 OK (JPEG JFIF image)
902	0.229320070	192.168.100.5	192.168.100.4	HTTP	1578	HTTP/1.1 200 OK (JPEG JFIF image)
906	0.359223963	192.168.100.4	192.168.100.5	HTTP	313	GET /favicon.ico HTTP/1.1
908	0.359490997	192.168.100.5	192.168.100.4	HTTP	523	HTTP/1.1 404 Not Found (text/html)
924	18.990652542	192.168.100.5	35.224.170.84	HTTP	143	GET / HTTP/1.1
926	19.226448089	35.224.170.84	192.168.100.5	HTTP	204	HTTP/1.1 204 No Content

Here it is $0.229320070 - 0.026264595 = 0.203055475$

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

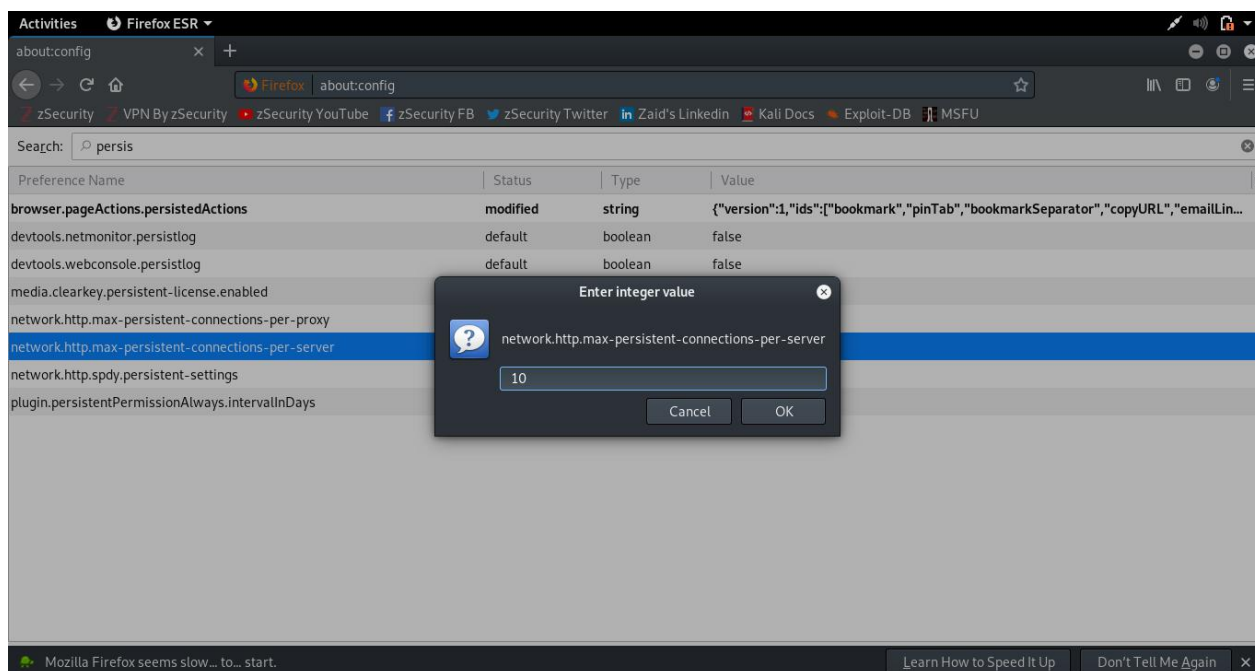


Step 6: Repeat the **steps 1-3** in the previous section.

http						
No.	Time	Source	Destination	Protocol	Length Info	
4	0.000226093	192.168.100.4	192.168.100.5	HTTP	398	GET /a.html HTTP/1.1
6	0.000620086	192.168.100.5	192.168.100.4	HTTP	789	HTTP/1.1 200 OK (text/html)
8	0.035616013	192.168.100.4	192.168.100.5	HTTP	416	GET /Image%20-%201%20airbus_a400m_atlas_military_transport_aircraft-5120x2880.jpg HTTP/1.1
39	0.036679013	192.168.100.4	192.168.100.5	HTTP	386	GET /Image%20-%202%20b_52_stratofortress_bomber.jpg HTTP/1.1
202	0.042110894	192.168.100.4	192.168.100.5	HTTP	392	GET /Image%20-%203%20blue_angels_us_navy_4k-3840x2160.jpg HTTP/1.1
295	0.048792749	192.168.100.4	192.168.100.5	HTTP	411	GET /Image%20-%204%20fairchild_republic_a_10_thunderbolt_ii_4k-3840x2160.jpg HTTP/1.1
423	0.060761002	192.168.100.5	192.168.100.4	HTTP	33281	HTTP/1.1 200 OK (JPEG JFIF image)
430	0.064658531	192.168.100.5	192.168.100.4	HTTP	10836	HTTP/1.1 200 OK (JPEG JFIF image)
434	0.065283811	192.168.100.4	192.168.100.5	HTTP	409	GET /Image%20-%205%20lockheed_martin_f_35_lightning_ii_stealth_fighter.jpg HTTP/1.1
510	0.084595218	192.168.100.5	192.168.100.4	HTTP	18587	HTTP/1.1 200 OK (JPEG JFIF image)
513	0.089278470	192.168.100.4	192.168.100.5	HTTP	397	GET /Image%20-%206%20lockheed_sr_71_blackbird_4k-5120x2880.jpg HTTP/1.1
597	0.103251864	192.168.100.5	192.168.100.4	HTTP	47849	HTTP/1.1 200 OK (JPEG JFIF image)
609	0.126667366	192.168.100.4	192.168.100.5	HTTP	402	GET /Image%20-%207%20mil_mi_26_military_helicopter_4k-3840x2160.jpg HTTP/1.1
621	0.135461486	192.168.100.4	192.168.100.5	HTTP	415	GET /Image%20-%208%20northrop_grumman_e_2_hawkeye_american_military_aircraft.jpg HTTP/1.1
686	0.138168477	192.168.100.5	192.168.100.4	HTTP	51847	HTTP/1.1 200 OK (JPEG JFIF image)
731	0.142917639	192.168.100.5	192.168.100.4	HTTP	947	HTTP/1.1 200 OK (JPEG JFIF image)
733	0.151084356	192.168.100.4	192.168.100.5	HTTP	381	GET /Image%20-%209%20spacecraft_warp_drive.jpg HTTP/1.1
806	0.166489609	192.168.100.5	192.168.100.4	HTTP	172	HTTP/1.1 200 OK (JPEG JFIF image)
808	0.169023436	192.168.100.4	192.168.100.5	HTTP	395	GET /Image%20-%2010%20x_wing_starfighter_4k-8k-7680x4320.jpg HTTP/1.1
917	0.186158046	192.168.100.5	192.168.100.4	HTTP	1628	HTTP/1.1 200 OK (JPEG JFIF image)
957	0.199064862	192.168.100.5	192.168.100.4	HTTP	2449	HTTP/1.1 200 OK (JPEG JFIF image)
1017	0.207194082	192.168.100.5	192.168.100.4	HTTP	13162	HTTP/1.1 200 OK (JPEG JFIF image)
1030	0.574683832	192.168.100.4	192.168.100.5	HTTP	313	GET /favicon.ico HTTP/1.1
1040	0.574928716	192.168.100.5	192.168.100.4	HTTP	523	HTTP/1.1 404 Not Found (text/html)

Here it is $0.207194082 - 0.035616013 = 0.171578069$

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.

No.	Time	Source	Destination	Protocol	Length	Info
4	0.000376969	192.168.100.4	192.168.100.5	HTTP	398	GET /a.html HTTP/1.1
6	0.000848501	192.168.100.5	192.168.100.4	HTTP	789	HTTP/1.1 200 OK (text/html)
8	0.032670794	192.168.100.4	192.168.100.5	HTTP	416	GET /Image%20-%201%20airbus_a400m_atlas_military_transport_aircraft-5120x2880.jpg HTTP/1.1
35	0.034833455	192.168.100.4	192.168.100.5	HTTP	386	GET /Image%20-%202%20b_52_stratofortress_bomber.jpg HTTP/1.1
162	0.038196677	192.168.100.4	192.168.100.5	HTTP	392	GET /Image%20-%203%20blue_angels_us_navy_4k-3840x2160.jpg HTTP/1.1
263	0.039233192	192.168.100.5	192.168.100.4	HTTP	29068	HTTP/1.1 200 OK (JPEG JFIF image)
261	0.044041627	192.168.100.4	192.168.100.5	HTTP	411	GET /Image%20-%204%20fairchild_republic_a10_thunderbolt_ii_4k-3840x2160.jpg HTTP/1.1
426	0.048028726	192.168.100.5	192.168.100.4	HTTP	39915	HTTP/1.1 200 OK (JPEG JFIF image)
556	0.052996802	192.168.100.5	192.168.100.4	HTTP	61017	HTTP/1.1 200 OK (JPEG JFIF image)
576	0.059084998	192.168.100.4	192.168.100.5	HTTP	409	GET /Image%20-%205%20lockheed_martin_f_35_lightning_ii_stealth_fighter.jpg HTTP/1.1
649	0.073435090	192.168.100.4	192.168.100.5	HTTP	397	GET /Image%20-%206%20lockheed_sr_71_blackbird_4k-5120x2880.jpg HTTP/1.1
748	0.083199734	192.168.100.5	192.168.100.4	HTTP	10201	HTTP/1.1 200 OK (JPEG JFIF image)
755	0.084712471	192.168.100.4	192.168.100.5	HTTP	402	GET /Image%20-%207%20mil_mi_26_military_helicopter_4k-3840x2160.jpg HTTP/1.1
840	0.087375128	192.168.100.5	192.168.100.4	HTTP	47503	HTTP/1.1 200 OK (JPEG JFIF image)
843	0.096304457	192.168.100.4	192.168.100.5	HTTP	415	GET /Image%20-%208%20northrop_grumman_e_2_hawkeye_amercian_military_aircraft.jpg HTTP/1.1
900	0.104776152	192.168.100.5	192.168.100.4	HTTP	27011	HTTP/1.1 200 OK (JPEG JFIF image)
904	0.109523070	192.168.100.4	192.168.100.5	HTTP	381	GET /Image%20-%209%20spacecraft_warp_drive.jpg HTTP/1.1
1005	0.117522997	192.168.100.5	192.168.100.4	HTTP	13204	HTTP/1.1 200 OK (JPEG JFIF image)
1008	0.119887555	192.168.100.4	192.168.100.5	HTTP	395	GET /Image%20-%2010%20x_wing_starfighter_4k_8k-7680x4320.jpg HTTP/1.1
1085	0.147561698	192.168.100.5	192.168.100.4	HTTP	19004	HTTP/1.1 200 OK (JPEG JFIF image)
1134	0.157787839	192.168.100.5	192.168.100.4	HTTP	35753	HTTP/1.1 200 OK (JPEG JFIF image)
1212	0.170696972	192.168.100.5	192.168.100.4	HTTP	130	HTTP/1.1 200 OK (JPEG JFIF image)
1220	0.282082645	192.168.100.4	192.168.100.5	HTTP	313	GET /favicon.ico HTTP/1.1
1222	0.282459326	192.168.100.5	192.168.100.4	HTTP	523	HTTP/1.1 404 Not Found (text/html)

Here is it 0.170696972-0.032670794=0.138026178

OBSERVATIONS REQUIRED ON EDMODO:

Find out the time taken to load images for 2 4 6 persistent connections is lesser or greater than 10 persistent compared to non-persistent. Why? Find out the optimal persistent connections.

ANS: Time taken to load images for 2,4,6 is greater than the time taken to load images for 10 persistent connections because 10 connections takes lesser time to load than the rest.so the optimal persistent is 10

