

Computer Network Laboratory 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,

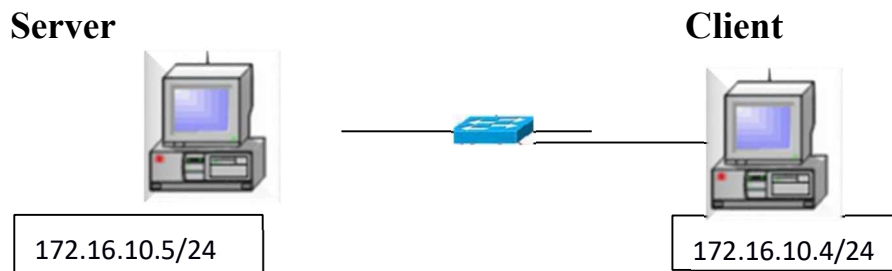
```
sudo apt-get install apache2
```

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 VMs on Virtualbox.



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 by typing:

sudo service apache2 status

```
prav@prav-VirtualBox:~$ sudo apt-get install apache2
Reading package lists... Done
Building dependency tree
Reading state information... Done
apache2 is already the newest version (2.4.41-4ubuntu3.1).
0 upgraded, 0 newly installed, 0 to remove and 330 not upgraded.
prav@prav-VirtualBox:~$ sudo service apache2 status
● apache2.service - The Apache HTTP Server
   Loaded: loaded (/lib/systemd/system/apache2.service; enabled; vendor preset: enabled)
   Active: active (running) since Thu 2021-02-04 20:06:57 IST; 4min 56s ago
     Docs: https://httpd.apache.org/docs/2.4/
   Process: 536 ExecStart=/usr/sbin/apachectl start (code=exited, status=0/SUCCESS)
   Main PID: 577 (apache2)
   Ubuntu Software (limit: 1109)
     Memory: 3.7M
     CGroup: /system.slice/apache2.service
             └─577 /usr/sbin/apache2 -k start
               └─579 /usr/sbin/apache2 -k start
                 └─580 /usr/sbin/apache2 -k start

Feb 04 20:06:56 prav-VirtualBox systemd[1]: Starting The Apache HTTP Server...
Feb 04 20:06:57 prav-VirtualBox apachectl[562]: AH00558: apache2: Could not re
Feb 04 20:06:57 prav-VirtualBox systemd[1]: Started The Apache HTTP Server.
lines 1-16/16 (END)
```

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: 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**

```
92 Timeout 300
93
94 #
95 # KeepAlive: Whether or not to allow persistent connections (more than
96 # one request per connection). Set to "Off" to deactivate.
97 #
98 KeepAlive On
99
100 #
101 # MaxKeepAliveRequests: The maximum number of requests to allow
102 # during a persistent connection. Set to 0 to allow an unlimited amount.
103 # We recommend you leave this number high, for maximum performance.
104 #
105 MaxKeepAliveRequests 2
106
107 #
108 # KeepAliveTimeout: Number of seconds to wait for the next request from the
109 # same client on the same connection.
110 #
111 KeepAliveTimeout 5
112
113
114 # These need to be set in /etc/apache2/envvars
115 User ${APACHE_RUN_USER}
116 Group ${APACHE_RUN_GROUP}
117
118 #
119 # HostnameLookups: Log the names of clients or just their IP addresses
```

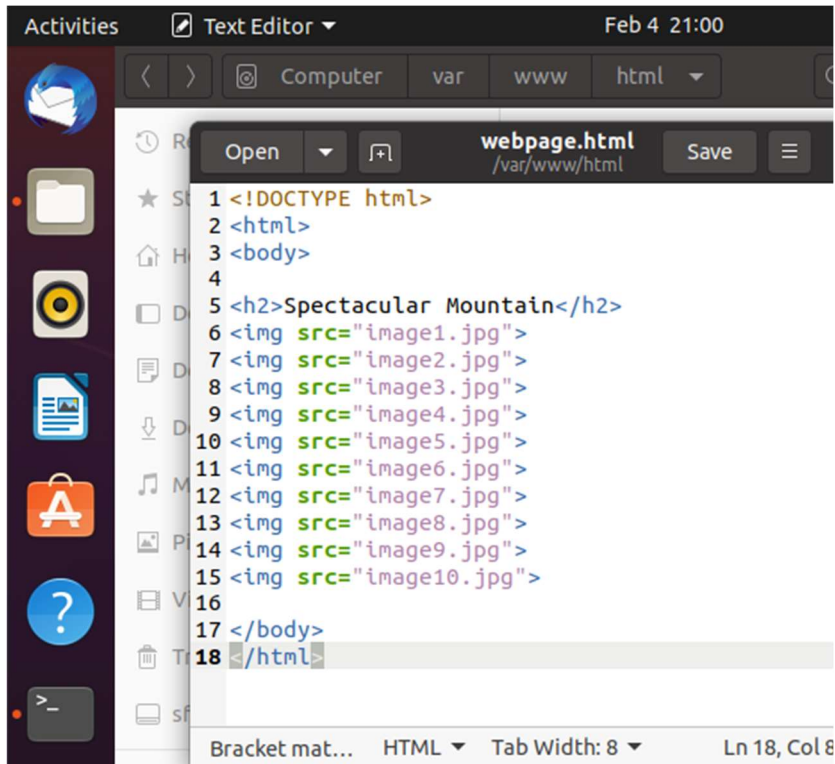
Plain Text ▾ Tab Width: 4 ▾ Ln 105, Col 23 ▾ INS

Step 4: 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 5: Prepare a web page. The html file needs to add 10 images.

A screenshot of a Linux desktop environment. The top panel shows the 'Activities' button, a 'Text Editor' window title, and the date 'Feb 4 21:00'. The left sidebar contains several application icons. The main window is a text editor displaying an HTML file named 'webpage.html' located at '/var/www/html'. The code in the editor is as follows:

```
1 <!DOCTYPE html>
2 <html>
3 <body>
4
5 <h2>Spectacular Mountain</h2>
6 
7 
8 
9 
10 
11 
12 
13 
14 
15 
16
17 </body>
18 </html>
```

The status bar at the bottom indicates 'Bracket mat...', 'HTML', 'Tab Width: 8', and 'Ln 18, Col 8'.

Client side:

There are broadly two parts of execution:

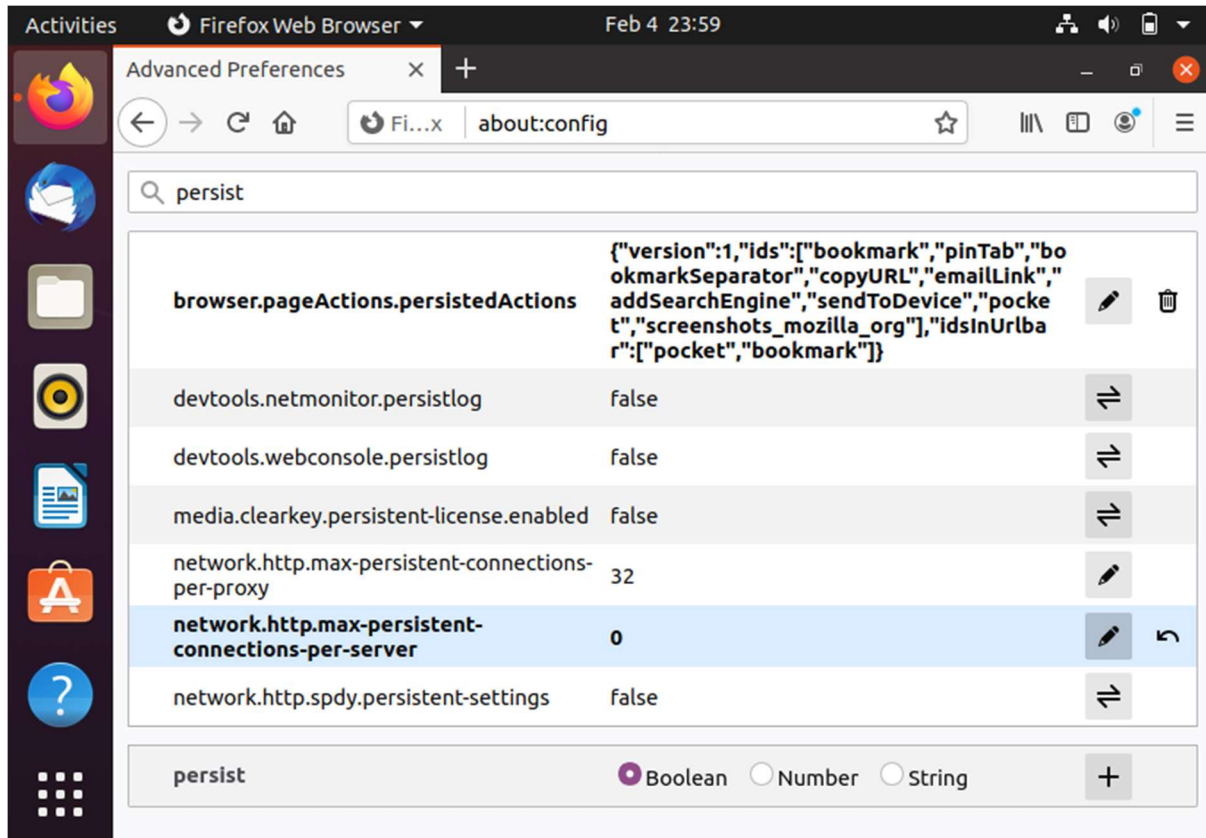
1. Dealing with non-persistent connections
2. Dealing with persistent connections

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-connectionsper-server** has the value set to **0** and **persistent-settings** value set to false.
- While using persistent connection experiment, the **max-persistent-connections-perserver** 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:

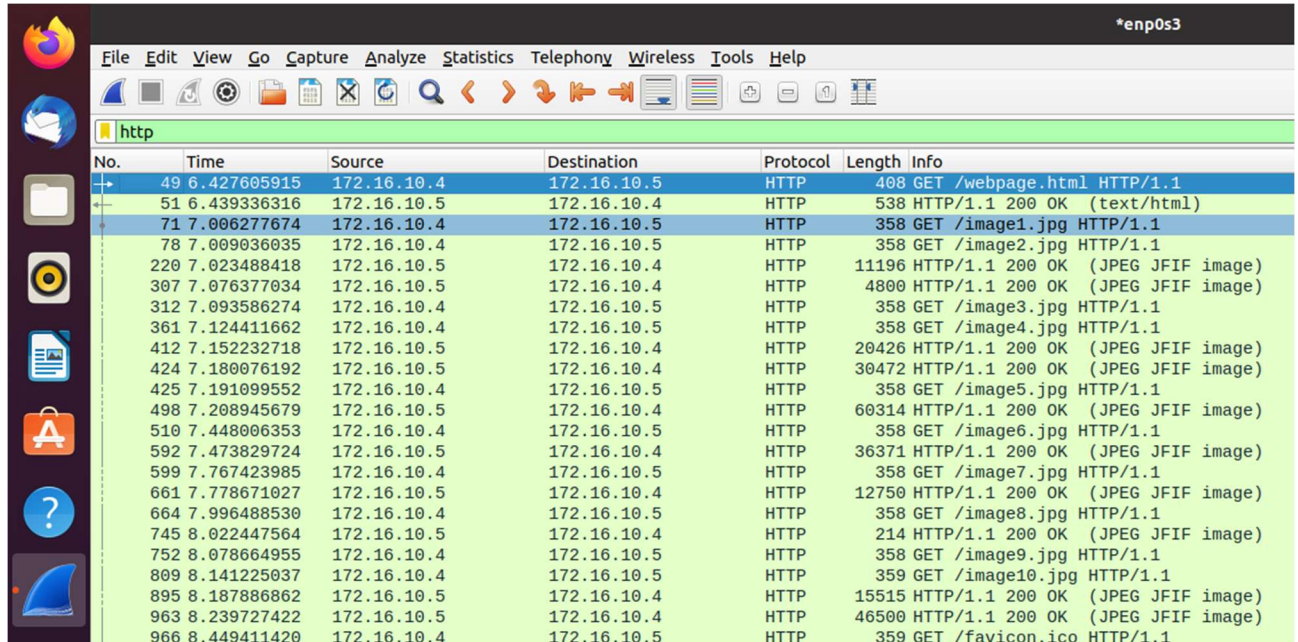
172.16.10.5/file_name.html where--> **172.16.10.5** is Server's IP

Here the file name is **webpage.html** present in server.

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.



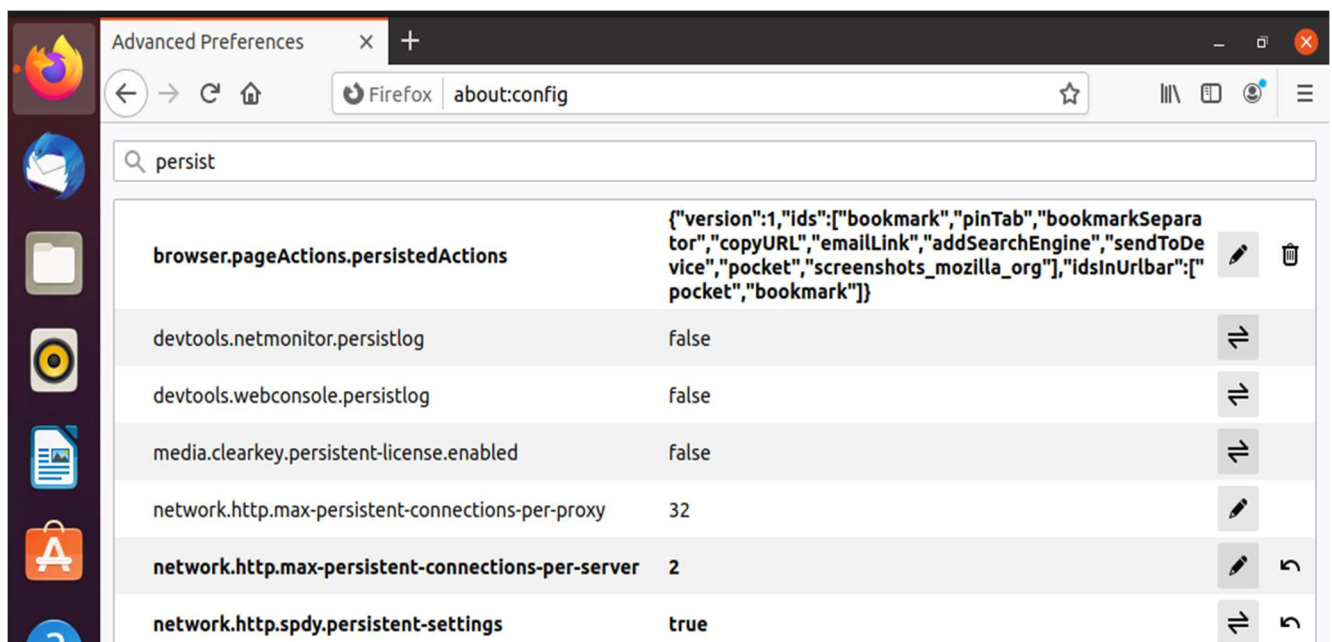
The image shows a Wireshark capture of network traffic on the *enp0s3 interface. A filter 'http' is applied. The packet list shows 19 packets, all of which are HTTP requests from 172.16.10.4 to 172.16.10.5. The first packet is a GET request for /webpage.html. The subsequent 18 packets are GET requests for various image files (image1.jpg through image10.jpg and favicon.ico). The packet details pane on the right shows the structure of the HTTP requests, including the method (GET), the request line, and the status code (200 OK) for the responses.

No.	Time	Source	Destination	Protocol	Length	Info
49	6.427605915	172.16.10.4	172.16.10.5	HTTP	408	GET /webpage.html HTTP/1.1
51	6.439336316	172.16.10.5	172.16.10.4	HTTP	538	HTTP/1.1 200 OK (text/html)
71	7.006277674	172.16.10.4	172.16.10.5	HTTP	358	GET /image1.jpg HTTP/1.1
78	7.009036035	172.16.10.4	172.16.10.5	HTTP	358	GET /image2.jpg HTTP/1.1
220	7.023488418	172.16.10.5	172.16.10.4	HTTP	11196	HTTP/1.1 200 OK (JPEG JFIF image)
307	7.076377034	172.16.10.5	172.16.10.4	HTTP	4800	HTTP/1.1 200 OK (JPEG JFIF image)
312	7.093586274	172.16.10.4	172.16.10.5	HTTP	358	GET /image3.jpg HTTP/1.1
361	7.124411662	172.16.10.4	172.16.10.5	HTTP	358	GET /image4.jpg HTTP/1.1
412	7.152232718	172.16.10.5	172.16.10.4	HTTP	20426	HTTP/1.1 200 OK (JPEG JFIF image)
424	7.180076192	172.16.10.5	172.16.10.4	HTTP	30472	HTTP/1.1 200 OK (JPEG JFIF image)
425	7.191099552	172.16.10.4	172.16.10.5	HTTP	358	GET /image5.jpg HTTP/1.1
498	7.208945679	172.16.10.5	172.16.10.4	HTTP	60314	HTTP/1.1 200 OK (JPEG JFIF image)
510	7.448006353	172.16.10.4	172.16.10.5	HTTP	358	GET /image6.jpg HTTP/1.1
592	7.473829724	172.16.10.5	172.16.10.4	HTTP	36371	HTTP/1.1 200 OK (JPEG JFIF image)
599	7.767423985	172.16.10.4	172.16.10.5	HTTP	358	GET /image7.jpg HTTP/1.1
661	7.778671027	172.16.10.5	172.16.10.4	HTTP	12750	HTTP/1.1 200 OK (JPEG JFIF image)
664	7.996488530	172.16.10.4	172.16.10.5	HTTP	358	GET /image8.jpg HTTP/1.1
745	8.022447564	172.16.10.5	172.16.10.4	HTTP	214	HTTP/1.1 200 OK (JPEG JFIF image)
752	8.078664955	172.16.10.4	172.16.10.5	HTTP	358	GET /image9.jpg HTTP/1.1
809	8.141225037	172.16.10.4	172.16.10.5	HTTP	359	GET /image10.jpg HTTP/1.1
895	8.187886862	172.16.10.5	172.16.10.4	HTTP	15515	HTTP/1.1 200 OK (JPEG JFIF image)
963	8.239727422	172.16.10.5	172.16.10.4	HTTP	46500	HTTP/1.1 200 OK (JPEG JFIF image)
966	8.449411420	172.16.10.4	172.16.10.5	HTTP	359	GET /favicon.ico HTTP/1.1

Here it is $8.239727422 - 6.427605915 = 1.812121507s$

PART 2: PERSISTENT CONNECTIONS

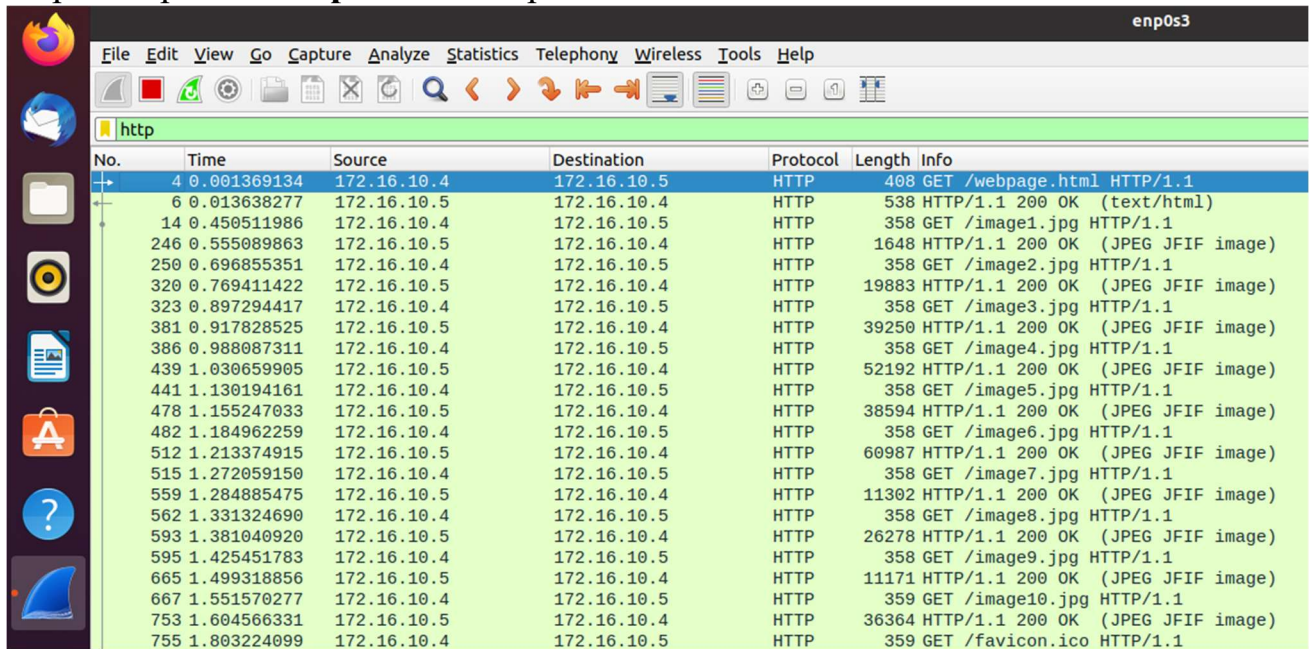
Step 1: For 2 persistent connections, set the value of **max-persistent-connection-per-server** to **2** in the client computer.



The image shows the Firefox Advanced Preferences window. The search bar contains the word 'persist'. The settings list shows various preferences related to persistent connections. The 'network.http.max-persistent-connections-per-server' setting is highlighted, showing a value of 2.

Setting	Value	Editable	Reset
browser.pageActions.persistedActions	{ "version": 1, "ids": ["bookmark", "pinTab", "bookmarkSeparator", "copyURL", "emailLink", "addSearchEngine", "sendToDevice", "pocket", "screenshots_mozilla_org", "idsinUrlbar": ["pocket", "bookmark"]] }		
devtools.netmonitor.persistlog	false		
devtools.webconsole.persistlog	false		
media.clearkey.persistent-license.enabled	false		
network.http.max-persistent-connections-per-proxy	32		
network.http.max-persistent-connections-per-server	2		
network.http.spdy.persistent-settings	true		

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

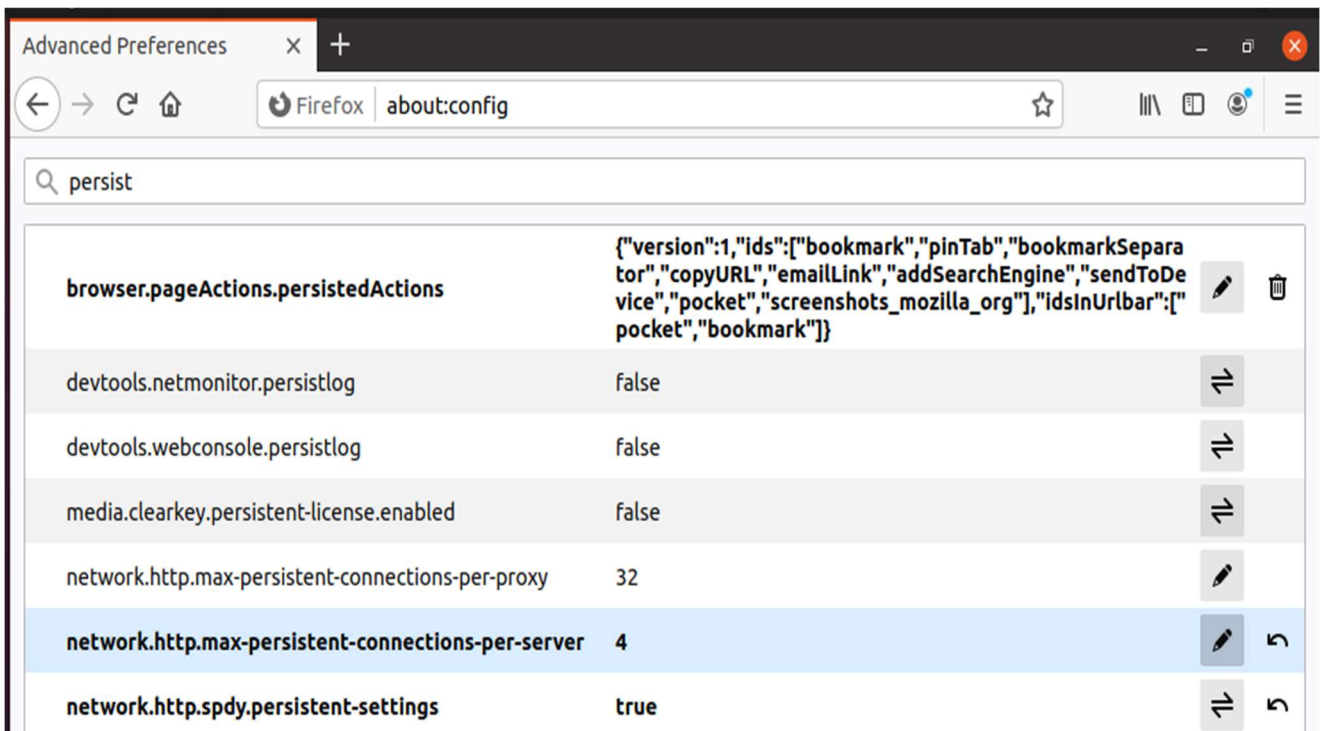


No.	Time	Source	Destination	Protocol	Length	Info
4	0.001369134	172.16.10.4	172.16.10.5	HTTP	408	GET /webpage.html HTTP/1.1
6	0.013638277	172.16.10.5	172.16.10.4	HTTP	538	HTTP/1.1 200 OK (text/html)
14	0.450511986	172.16.10.4	172.16.10.5	HTTP	358	GET /image1.jpg HTTP/1.1
246	0.555089863	172.16.10.5	172.16.10.4	HTTP	1648	HTTP/1.1 200 OK (JPEG JFIF image)
250	0.696855351	172.16.10.4	172.16.10.5	HTTP	358	GET /image2.jpg HTTP/1.1
320	0.769411422	172.16.10.5	172.16.10.4	HTTP	19883	HTTP/1.1 200 OK (JPEG JFIF image)
323	0.897294417	172.16.10.4	172.16.10.5	HTTP	358	GET /image3.jpg HTTP/1.1
381	0.917828525	172.16.10.5	172.16.10.4	HTTP	39250	HTTP/1.1 200 OK (JPEG JFIF image)
386	0.988087311	172.16.10.4	172.16.10.5	HTTP	358	GET /image4.jpg HTTP/1.1
439	1.030659905	172.16.10.5	172.16.10.4	HTTP	52192	HTTP/1.1 200 OK (JPEG JFIF image)
441	1.130194161	172.16.10.4	172.16.10.5	HTTP	358	GET /image5.jpg HTTP/1.1
478	1.155247033	172.16.10.5	172.16.10.4	HTTP	38594	HTTP/1.1 200 OK (JPEG JFIF image)
482	1.184962259	172.16.10.4	172.16.10.5	HTTP	358	GET /image6.jpg HTTP/1.1
512	1.213374915	172.16.10.5	172.16.10.4	HTTP	60987	HTTP/1.1 200 OK (JPEG JFIF image)
515	1.272059150	172.16.10.4	172.16.10.5	HTTP	358	GET /image7.jpg HTTP/1.1
559	1.284885475	172.16.10.5	172.16.10.4	HTTP	11302	HTTP/1.1 200 OK (JPEG JFIF image)
562	1.331324690	172.16.10.4	172.16.10.5	HTTP	358	GET /image8.jpg HTTP/1.1
593	1.381040920	172.16.10.5	172.16.10.4	HTTP	26278	HTTP/1.1 200 OK (JPEG JFIF image)
595	1.425451783	172.16.10.4	172.16.10.5	HTTP	358	GET /image9.jpg HTTP/1.1
665	1.499318856	172.16.10.5	172.16.10.4	HTTP	11171	HTTP/1.1 200 OK (JPEG JFIF image)
667	1.551570277	172.16.10.4	172.16.10.5	HTTP	359	GET /image10.jpg HTTP/1.1
753	1.604566331	172.16.10.5	172.16.10.4	HTTP	36364	HTTP/1.1 200 OK (JPEG JFIF image)
755	1.803224099	172.16.10.4	172.16.10.5	HTTP	359	GET /favicon.ico HTTP/1.1

Here it is $1.604566331 - 0.001369134 = 1.603197197s$

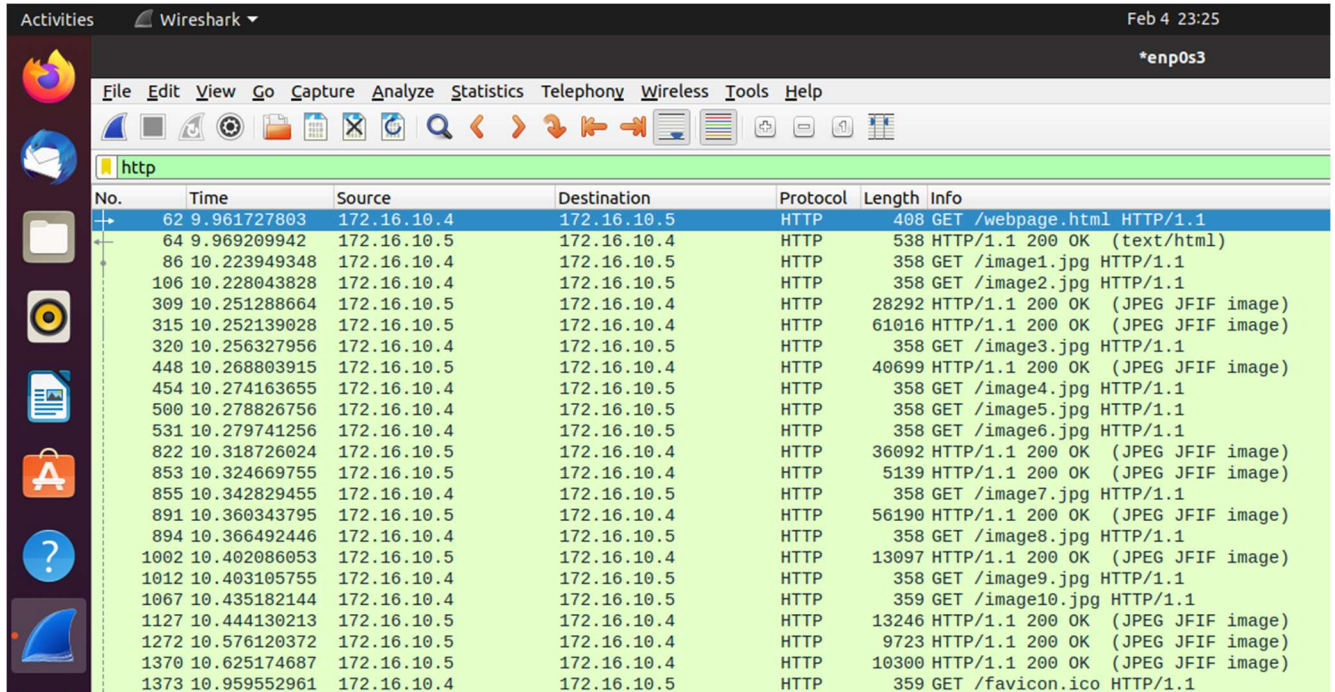
Step 1: For 4 persistent connections,

Set the value of **max-persistent-connection-per-server** to **4** in the client computer.



Advanced Preferences	
browser.pageActions.persistedActions	<code>{"version":1,"ids":["bookmark","pinTab","bookmarkSeparator","copyURL","emailLink","addSearchEngine","sendToDevice","pocket","screenshots_mozilla_org"],"idsInUrlbar":["pocket","bookmark"]}</code>
devtools.netmonitor.persistlog	false
devtools.webconsole.persistlog	false
media.clearkey.persistent-license.enabled	false
network.http.max-persistent-connections-per-proxy	32
network.http.max-persistent-connections-per-server	4
network.http.spdy.persistent-settings	true

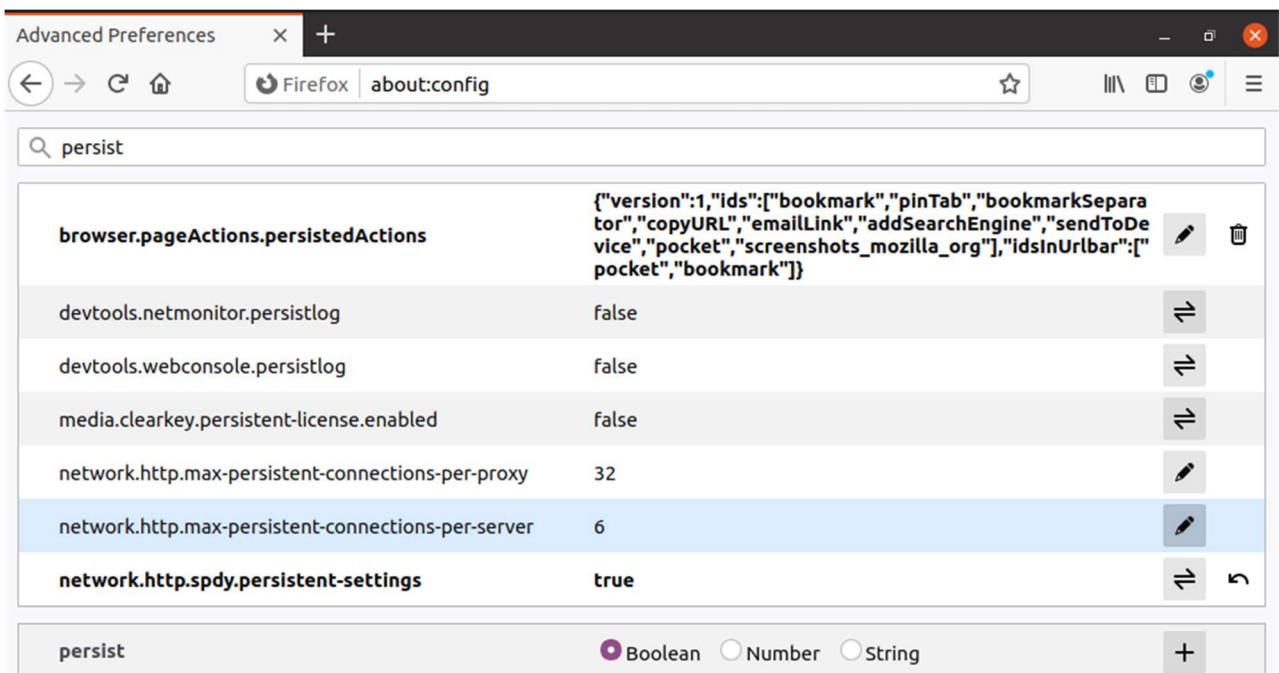
Step 2: Repeat the **steps 1-3** in the previous section.



No.	Time	Source	Destination	Protocol	Length	Info
62	9.961727803	172.16.10.4	172.16.10.5	HTTP	408	GET /webpage.html HTTP/1.1
64	9.969209942	172.16.10.5	172.16.10.4	HTTP	538	HTTP/1.1 200 OK (text/html)
86	10.223949348	172.16.10.4	172.16.10.5	HTTP	358	GET /image1.jpg HTTP/1.1
106	10.228043828	172.16.10.4	172.16.10.5	HTTP	358	GET /image2.jpg HTTP/1.1
309	10.251288664	172.16.10.5	172.16.10.4	HTTP	28292	HTTP/1.1 200 OK (JPEG JFIF image)
315	10.252139028	172.16.10.5	172.16.10.4	HTTP	61016	HTTP/1.1 200 OK (JPEG JFIF image)
320	10.256327956	172.16.10.4	172.16.10.5	HTTP	358	GET /image3.jpg HTTP/1.1
448	10.268803915	172.16.10.5	172.16.10.4	HTTP	40699	HTTP/1.1 200 OK (JPEG JFIF image)
454	10.274163655	172.16.10.4	172.16.10.5	HTTP	358	GET /image4.jpg HTTP/1.1
500	10.278826756	172.16.10.4	172.16.10.5	HTTP	358	GET /image5.jpg HTTP/1.1
531	10.279741256	172.16.10.4	172.16.10.5	HTTP	358	GET /image6.jpg HTTP/1.1
822	10.318726024	172.16.10.5	172.16.10.4	HTTP	36092	HTTP/1.1 200 OK (JPEG JFIF image)
853	10.324669755	172.16.10.5	172.16.10.4	HTTP	5139	HTTP/1.1 200 OK (JPEG JFIF image)
855	10.342829455	172.16.10.4	172.16.10.5	HTTP	358	GET /image7.jpg HTTP/1.1
891	10.360343795	172.16.10.5	172.16.10.4	HTTP	56190	HTTP/1.1 200 OK (JPEG JFIF image)
894	10.366492446	172.16.10.4	172.16.10.5	HTTP	358	GET /image8.jpg HTTP/1.1
1002	10.402086053	172.16.10.5	172.16.10.4	HTTP	13097	HTTP/1.1 200 OK (JPEG JFIF image)
1012	10.403105755	172.16.10.4	172.16.10.5	HTTP	358	GET /image9.jpg HTTP/1.1
1067	10.435182144	172.16.10.4	172.16.10.5	HTTP	359	GET /image10.jpg HTTP/1.1
1127	10.444130213	172.16.10.5	172.16.10.4	HTTP	13246	HTTP/1.1 200 OK (JPEG JFIF image)
1272	10.576120372	172.16.10.5	172.16.10.4	HTTP	9723	HTTP/1.1 200 OK (JPEG JFIF image)
1370	10.625174687	172.16.10.5	172.16.10.4	HTTP	10300	HTTP/1.1 200 OK (JPEG JFIF image)
1373	10.95952961	172.16.10.4	172.16.10.5	HTTP	359	GET /favicon.ico HTTP/1.1

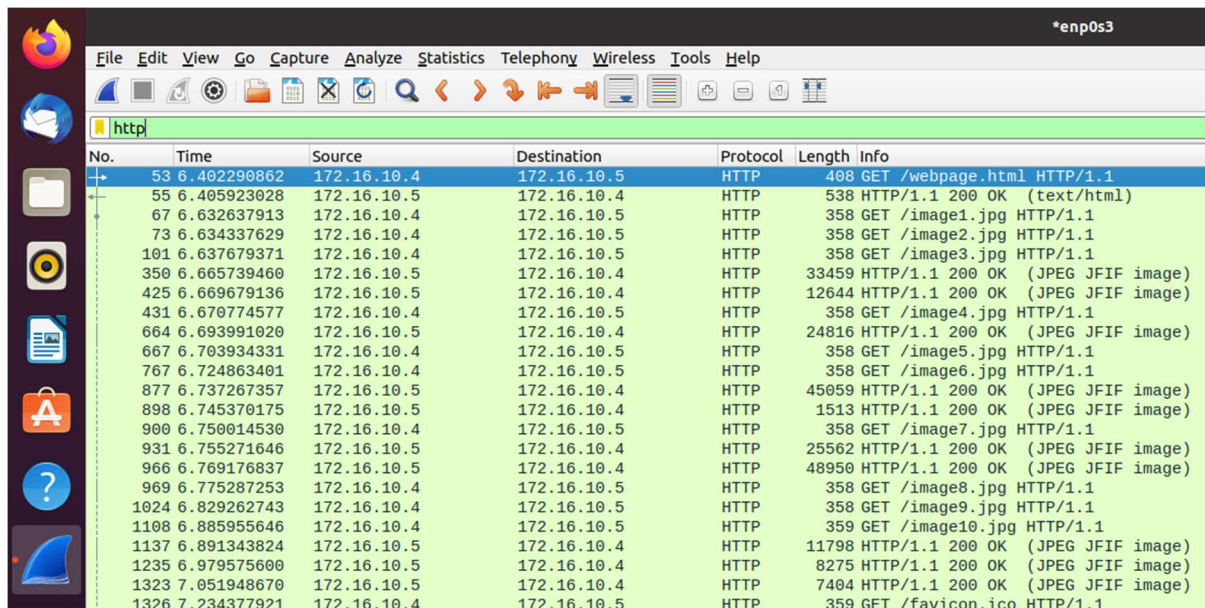
Here is it $10.625174687 - 9.961727803 = 0.663446884s$

Step 1: For 6 persistent connections, set the value of **max-persistent-connection-per-server** to 6 in the server computer.



Setting	Value	Type
browser.pageActions.persistedActions	<code>{"version":1,"ids":["bookmark","pinTab","bookmarkSeparator","copyURL","emailLink","addSearchEngine","sendToDevice","pocket","screenshots_mozilla_org"],"idsinUrlbar":["pocket","bookmark"]}</code>	String
devtools.netmonitor.persistlog	false	Boolean
devtools.webconsole.persistlog	false	Boolean
media.clearkey.persistent-license.enabled	false	Boolean
network.http.max-persistent-connections-per-proxy	32	Number
network.http.max-persistent-connections-per-server	6	Number
network.http.spdy.persistent-settings	true	Boolean

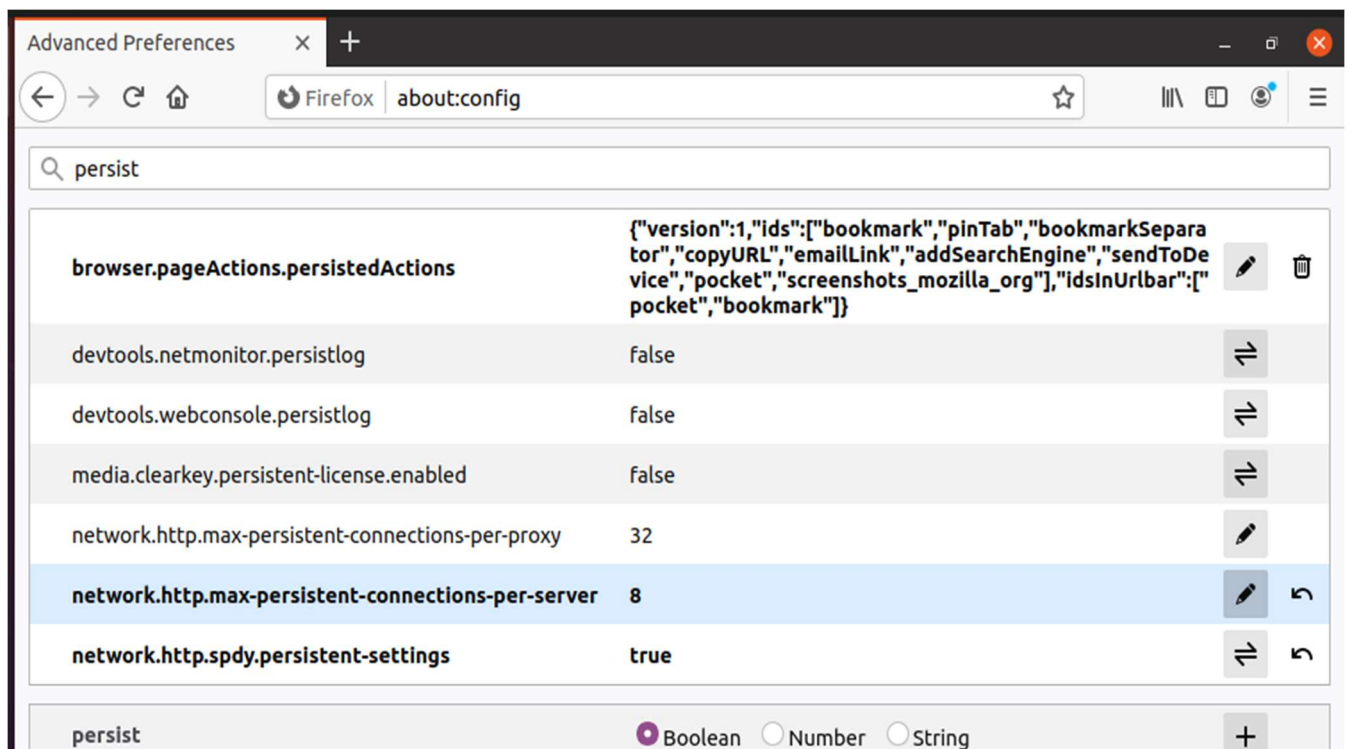
Step 2: Repeat the **steps 1-3** in the previous section.



No.	Time	Source	Destination	Protocol	Length	Info
53	6.402290862	172.16.10.4	172.16.10.5	HTTP	408	GET /webpage.html HTTP/1.1
55	6.405923028	172.16.10.5	172.16.10.4	HTTP	538	HTTP/1.1 200 OK (text/html)
67	6.632637913	172.16.10.4	172.16.10.5	HTTP	358	GET /image1.jpg HTTP/1.1
73	6.634337629	172.16.10.4	172.16.10.5	HTTP	358	GET /image2.jpg HTTP/1.1
101	6.637679371	172.16.10.4	172.16.10.5	HTTP	358	GET /image3.jpg HTTP/1.1
350	6.665739460	172.16.10.5	172.16.10.4	HTTP	33459	HTTP/1.1 200 OK (JPEG JFIF image)
425	6.669679136	172.16.10.5	172.16.10.4	HTTP	12644	HTTP/1.1 200 OK (JPEG JFIF image)
431	6.670774577	172.16.10.4	172.16.10.5	HTTP	358	GET /image4.jpg HTTP/1.1
664	6.693991020	172.16.10.5	172.16.10.4	HTTP	24816	HTTP/1.1 200 OK (JPEG JFIF image)
667	6.703934331	172.16.10.4	172.16.10.5	HTTP	358	GET /image5.jpg HTTP/1.1
767	6.724863401	172.16.10.4	172.16.10.5	HTTP	358	GET /image6.jpg HTTP/1.1
877	6.737267357	172.16.10.5	172.16.10.4	HTTP	45059	HTTP/1.1 200 OK (JPEG JFIF image)
898	6.745370175	172.16.10.5	172.16.10.4	HTTP	1513	HTTP/1.1 200 OK (JPEG JFIF image)
900	6.750014530	172.16.10.4	172.16.10.5	HTTP	358	GET /image7.jpg HTTP/1.1
931	6.755271646	172.16.10.5	172.16.10.4	HTTP	25562	HTTP/1.1 200 OK (JPEG JFIF image)
966	6.769176837	172.16.10.5	172.16.10.4	HTTP	48950	HTTP/1.1 200 OK (JPEG JFIF image)
969	6.775287253	172.16.10.4	172.16.10.5	HTTP	358	GET /image8.jpg HTTP/1.1
1024	6.829262743	172.16.10.4	172.16.10.5	HTTP	358	GET /image9.jpg HTTP/1.1
1108	6.885955646	172.16.10.4	172.16.10.5	HTTP	359	GET /image10.jpg HTTP/1.1
1137	6.891343824	172.16.10.5	172.16.10.4	HTTP	11798	HTTP/1.1 200 OK (JPEG JFIF image)
1235	6.979575600	172.16.10.5	172.16.10.4	HTTP	8275	HTTP/1.1 200 OK (JPEG JFIF image)
1323	7.051948670	172.16.10.5	172.16.10.4	HTTP	7404	HTTP/1.1 200 OK (JPEG JFIF image)
1326	7.234377921	172.16.10.4	172.16.10.5	HTTP	359	GET /favicon.ico HTTP/1.1

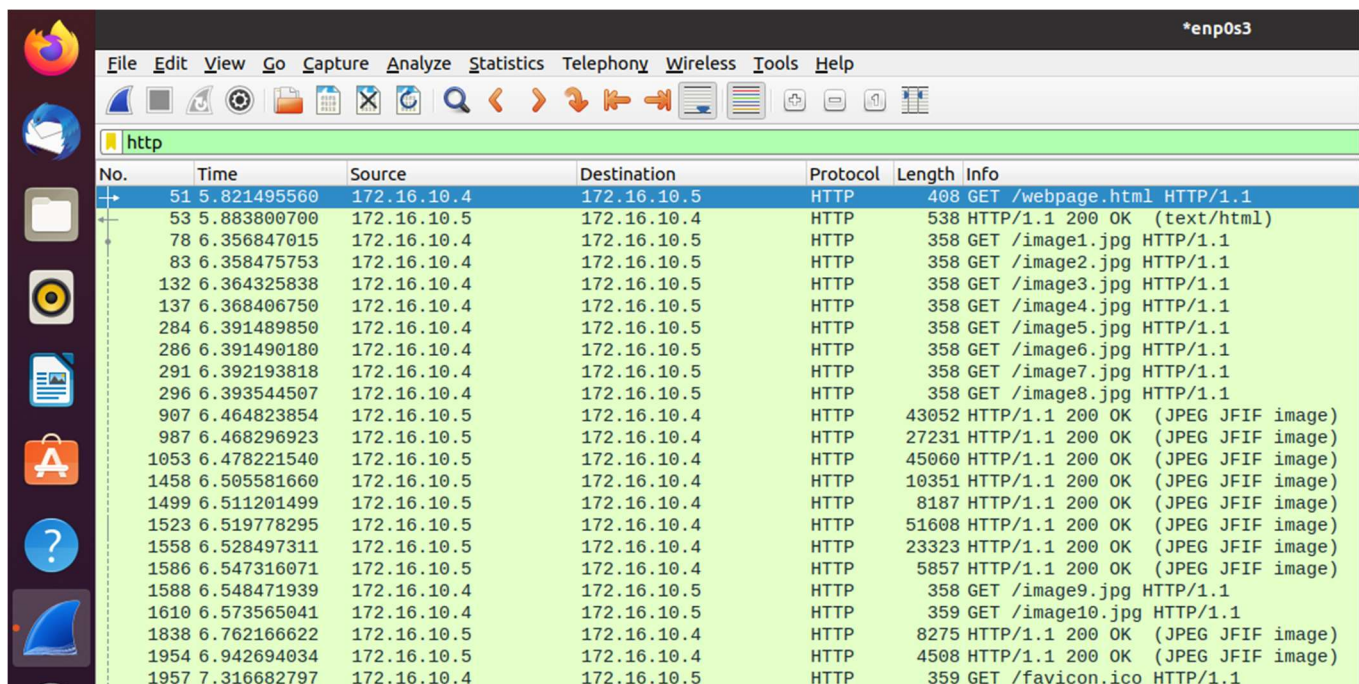
Here it is $7.051948670 - 6.402290862 = 0.649657808$

Step 1: For 8 persistent connections, set the value of **max-persistent-connection-perserver** to **8** in the client computer.



Setting	Value	Type
browser.pageActions.persistedActions	<code>{"version":1,"ids":["bookmark","pinTab","bookmarkSeparator","copyURL","emailLink","addSearchEngine","sendToDevice","pocket","screenshots_mozilla_org"],"idsInUrlbar":["pocket","bookmark"]}</code>	String
devtools.netmonitor.persistlog	false	Boolean
devtools.webconsole.persistlog	false	Boolean
media.clearkey.persistent-license.enabled	false	Boolean
network.http.max-persistent-connections-per-proxy	32	Number
network.http.max-persistent-connections-per-server	8	Number
network.http.spdy.persistent-settings	true	Boolean

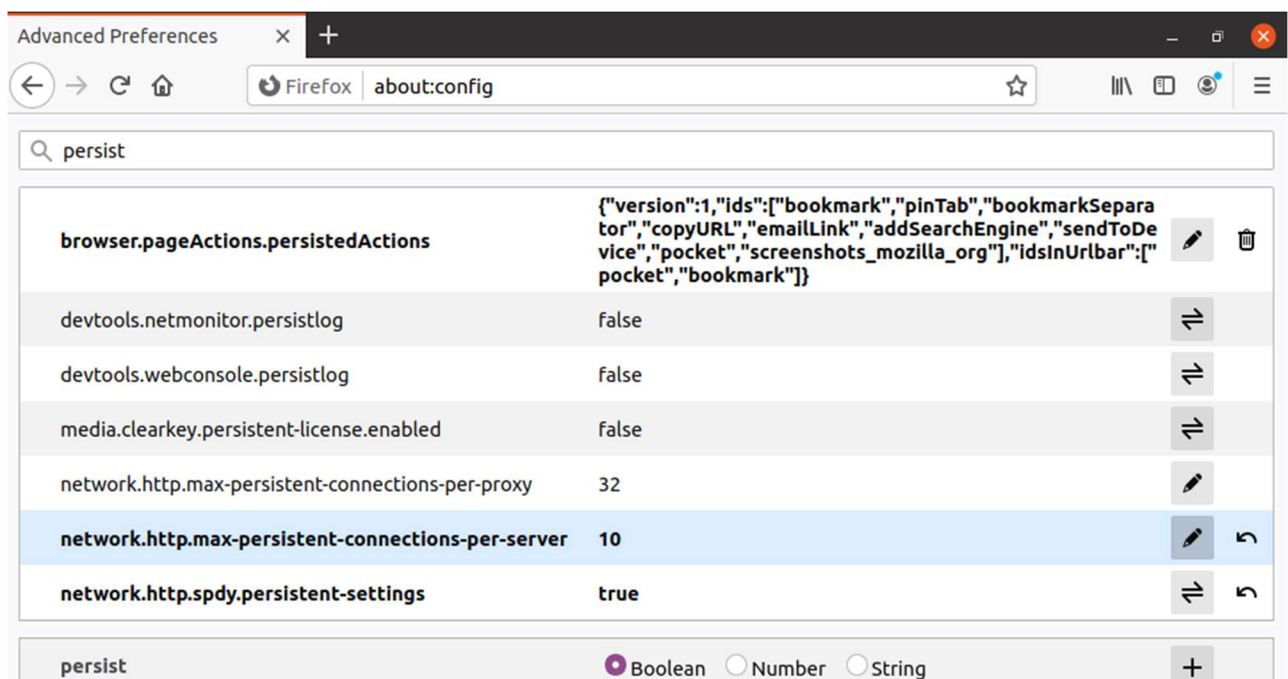
Step 2: Repeat the **steps 1-3** in the previous section.



No.	Time	Source	Destination	Protocol	Length	Info
51	5.821495560	172.16.10.4	172.16.10.5	HTTP	408	GET /webpage.html HTTP/1.1
53	5.883800700	172.16.10.5	172.16.10.4	HTTP	538	HTTP/1.1 200 OK (text/html)
78	6.356847015	172.16.10.4	172.16.10.5	HTTP	358	GET /image1.jpg HTTP/1.1
83	6.358475753	172.16.10.4	172.16.10.5	HTTP	358	GET /image2.jpg HTTP/1.1
132	6.364325838	172.16.10.4	172.16.10.5	HTTP	358	GET /image3.jpg HTTP/1.1
137	6.368406750	172.16.10.4	172.16.10.5	HTTP	358	GET /image4.jpg HTTP/1.1
284	6.391489850	172.16.10.4	172.16.10.5	HTTP	358	GET /image5.jpg HTTP/1.1
286	6.391490180	172.16.10.4	172.16.10.5	HTTP	358	GET /image6.jpg HTTP/1.1
291	6.392193818	172.16.10.4	172.16.10.5	HTTP	358	GET /image7.jpg HTTP/1.1
296	6.393544507	172.16.10.4	172.16.10.5	HTTP	358	GET /image8.jpg HTTP/1.1
907	6.464823854	172.16.10.5	172.16.10.4	HTTP	43052	HTTP/1.1 200 OK (JPEG JFIF image)
987	6.468296923	172.16.10.5	172.16.10.4	HTTP	27231	HTTP/1.1 200 OK (JPEG JFIF image)
1053	6.478221540	172.16.10.5	172.16.10.4	HTTP	45060	HTTP/1.1 200 OK (JPEG JFIF image)
1458	6.505581660	172.16.10.5	172.16.10.4	HTTP	10351	HTTP/1.1 200 OK (JPEG JFIF image)
1499	6.511201499	172.16.10.5	172.16.10.4	HTTP	8187	HTTP/1.1 200 OK (JPEG JFIF image)
1523	6.519778295	172.16.10.5	172.16.10.4	HTTP	51608	HTTP/1.1 200 OK (JPEG JFIF image)
1558	6.528497311	172.16.10.5	172.16.10.4	HTTP	23323	HTTP/1.1 200 OK (JPEG JFIF image)
1586	6.547316071	172.16.10.5	172.16.10.4	HTTP	5857	HTTP/1.1 200 OK (JPEG JFIF image)
1588	6.548471939	172.16.10.4	172.16.10.5	HTTP	358	GET /image9.jpg HTTP/1.1
1610	6.573565041	172.16.10.4	172.16.10.5	HTTP	359	GET /image10.jpg HTTP/1.1
1838	6.762166622	172.16.10.5	172.16.10.4	HTTP	8275	HTTP/1.1 200 OK (JPEG JFIF image)
1954	6.942694034	172.16.10.5	172.16.10.4	HTTP	4508	HTTP/1.1 200 OK (JPEG JFIF image)
1957	7.316682797	172.16.10.4	172.16.10.5	HTTP	359	GET /favicon.ico HTTP/1.1

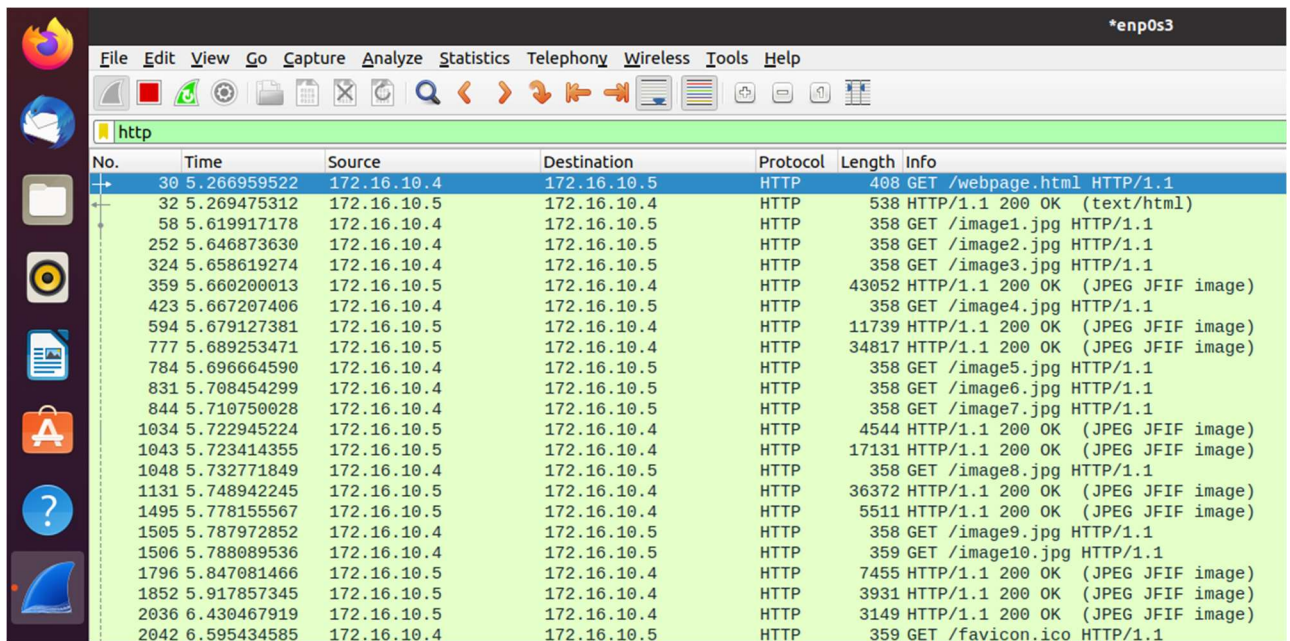
Here it is $6.942694034 - 5.821495560 = 1.121198474$

Step 1: For 10 persistent connections, set the value of **max-persistent-connection-perserver** to **10** in the client computer.



Setting	Value	Type
browser.pageActions.persistedActions	{ "version": 1, "ids": ["bookmark", "pinTab", "bookmarkSeparator", "copyURL", "emailLink", "addSearchEngine", "sendToDevice", "pocket", "screenshots_mozilla_org", "idsInUrlbar": ["pocket", "bookmark"]] }	Boolean
devtools.netmonitor.persistlog	false	Boolean
devtools.webconsole.persistlog	false	Boolean
media.clearkey.persistent-license.enabled	false	Boolean
network.http.max-persistent-connections-per-proxy	32	Number
network.http.max-persistent-connections-per-server	10	Number
network.http.spdy.persistent-settings	true	Boolean

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



No.	Time	Source	Destination	Protocol	Length	Info
30	5.266959522	172.16.10.4	172.16.10.5	HTTP	408	GET /webpage.html HTTP/1.1
32	5.269475312	172.16.10.5	172.16.10.4	HTTP	538	HTTP/1.1 200 OK (text/html)
58	5.619917178	172.16.10.4	172.16.10.5	HTTP	358	GET /image1.jpg HTTP/1.1
252	5.646873630	172.16.10.4	172.16.10.5	HTTP	358	GET /image2.jpg HTTP/1.1
324	5.658619274	172.16.10.4	172.16.10.5	HTTP	358	GET /image3.jpg HTTP/1.1
359	5.660200013	172.16.10.5	172.16.10.4	HTTP	43052	HTTP/1.1 200 OK (JPEG JFIF image)
423	5.667207406	172.16.10.4	172.16.10.5	HTTP	358	GET /image4.jpg HTTP/1.1
594	5.679127381	172.16.10.5	172.16.10.4	HTTP	11739	HTTP/1.1 200 OK (JPEG JFIF image)
777	5.689253471	172.16.10.5	172.16.10.4	HTTP	34817	HTTP/1.1 200 OK (JPEG JFIF image)
784	5.696664590	172.16.10.4	172.16.10.5	HTTP	358	GET /image5.jpg HTTP/1.1
831	5.708454299	172.16.10.4	172.16.10.5	HTTP	358	GET /image6.jpg HTTP/1.1
844	5.710750028	172.16.10.4	172.16.10.5	HTTP	358	GET /image7.jpg HTTP/1.1
1034	5.722945224	172.16.10.5	172.16.10.4	HTTP	4544	HTTP/1.1 200 OK (JPEG JFIF image)
1043	5.723414355	172.16.10.5	172.16.10.4	HTTP	17131	HTTP/1.1 200 OK (JPEG JFIF image)
1048	5.732771849	172.16.10.4	172.16.10.5	HTTP	358	GET /image8.jpg HTTP/1.1
1131	5.748942245	172.16.10.5	172.16.10.4	HTTP	36372	HTTP/1.1 200 OK (JPEG JFIF image)
1495	5.778155567	172.16.10.5	172.16.10.4	HTTP	5511	HTTP/1.1 200 OK (JPEG JFIF image)
1505	5.787972852	172.16.10.4	172.16.10.5	HTTP	358	GET /image9.jpg HTTP/1.1
1506	5.788089536	172.16.10.4	172.16.10.5	HTTP	359	GET /image10.jpg HTTP/1.1
1796	5.847081466	172.16.10.5	172.16.10.4	HTTP	7455	HTTP/1.1 200 OK (JPEG JFIF image)
1852	5.917857345	172.16.10.5	172.16.10.4	HTTP	3931	HTTP/1.1 200 OK (JPEG JFIF image)
2036	6.430467919	172.16.10.5	172.16.10.4	HTTP	3149	HTTP/1.1 200 OK (JPEG JFIF image)
2042	6.595434585	172.16.10.4	172.16.10.5	HTTP	359	GET /favicon.ico HTTP/1.1

Here it is $6.430467919 - 5.266959522 = 1.163508397$

OBSERVATIONS REQUIRED ON EDMODO:

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.

- Non-persistent connection (0): 1.812121507s
- 2 persistent connections: 1.603197197s
- 4 persistent connections: 0.663446884s
- 6 persistent connections: 0.649657808
- 8 persistent connections: 1.121198474
- 10 persistent connections: 1.163508397

Non-persistent connections take more time than persistent connections as each request/response pair is sent over separate TCP connections i.e, each TCP connection transports exactly one request and response message.

Whereas, Persistent connections take lesser time compared to Non-Persistent connections as all requests and their corresponding responses are sent over the same TCP connection.

Here the time taken by 4,6,8 persistent connections is lesser than 10, but time taken by 2 persistent connections is greater than 10. But the most time is taken by the non-persistent connection. The pattern goes as,

Non-persistent (0) connection => more time

2 persistent connections => lesser time

4 persistent connections => lesser time

6 persistent connections => lesser time

8 persistent connections => comparatively more time

10 persistent connections => increase in time from previous

Thus, in this case the optimal number of persistent connections would be 6 as it takes the least time.