

**PES UNIVERSITY**  
**EC CAMPUS, BANGALORE**  
**COMPUTER NETWORK LABORATORY**  
**WEEK 3**

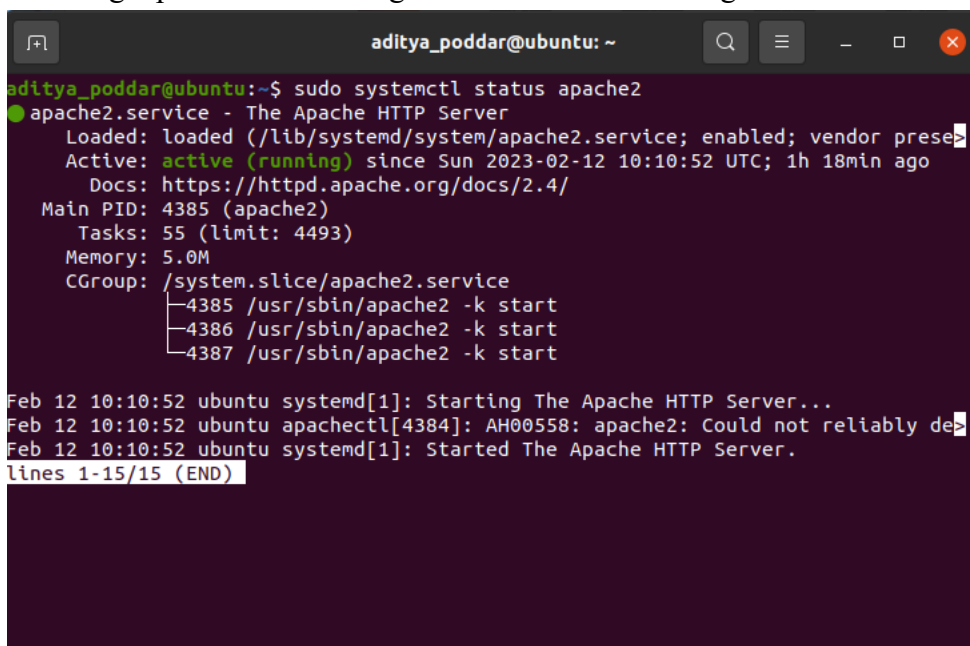
**Name: Aditya Poddar**

**Section: A**

**SRN: PES2UG21CS036**

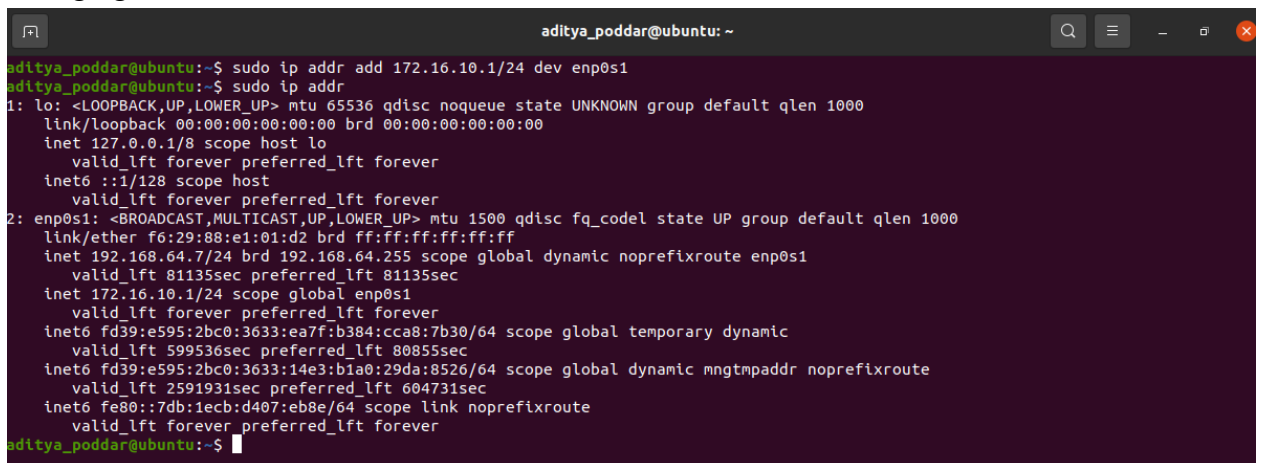
**AIM:** To understand persistent and non-persistent HTTP Connections and corresponding performance impact.

1. Installing Apache2 and making sure the server is running.



```
aditya_poddar@ubuntu: ~  
aditya_poddar@ubuntu:~$ sudo systemctl status apache2  
● apache2.service - The Apache HTTP Server  
   Loaded: loaded (/lib/systemd/system/apache2.service; enabled; vendor prese  
   Active: active (running) since Sun 2023-02-12 10:10:52 UTC; 1h 18min ago  
     Docs: https://httpd.apache.org/docs/2.4/  
   Main PID: 4385 (apache2)  
     Tasks: 55 (limit: 4493)  
    Memory: 5.0M  
    CGroup: /system.slice/apache2.service  
            └─4385 /usr/sbin/apache2 -k start  
              └─4386 /usr/sbin/apache2 -k start  
                └─4387 /usr/sbin/apache2 -k start  
  
Feb 12 10:10:52 ubuntu systemd[1]: Starting The Apache HTTP Server...  
Feb 12 10:10:52 ubuntu apachectl[4384]: AH00558: apache2: Could not reliably de  
Feb 12 10:10:52 ubuntu systemd[1]: Started The Apache HTTP Server.  
lines 1-15/15 (END)
```

2. Changing the IP address of server machine.



```
aditya_poddar@ubuntu: ~  
aditya_poddar@ubuntu:~$ sudo ip addr add 172.16.10.1/24 dev enp0s1  
aditya_poddar@ubuntu:~$ 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: enp0s1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
   link/ether f6:29:88:e1:01:d2 brd ff:ff:ff:ff:ff:ff  
   inet 192.168.64.7/24 brd 192.168.64.255 scope global dynamic noprefixroute enp0s1  
     valid_lft 81135sec preferred_lft 81135sec  
   inet 172.16.10.1/24 scope global enp0s1  
     valid_lft forever preferred_lft forever  
   inet6 fd39:e595:2bc0:3633:ea7f:b384:cca8:7b30/64 scope global temporary dynamic  
     valid_lft 599536sec preferred_lft 80855sec  
   inet6 fd39:e595:2bc0:3633:14e3:b1a0:29da:8526/64 scope global dynamic mngtmpaddr noprefixroute  
     valid_lft 2591931sec preferred_lft 604731sec  
   inet6 fe80::7db:1ecb:d407:eb8e/64 scope link noprefixroute  
     valid_lft forever preferred_lft forever  
aditya_poddar@ubuntu:~$
```

### 3. In apache2.conf

- KeepAlive was set to ON
- MaxKeepAliveRequests to 2

```
GNU nano 4.8 /etc/apache2/apache2.conf
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

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

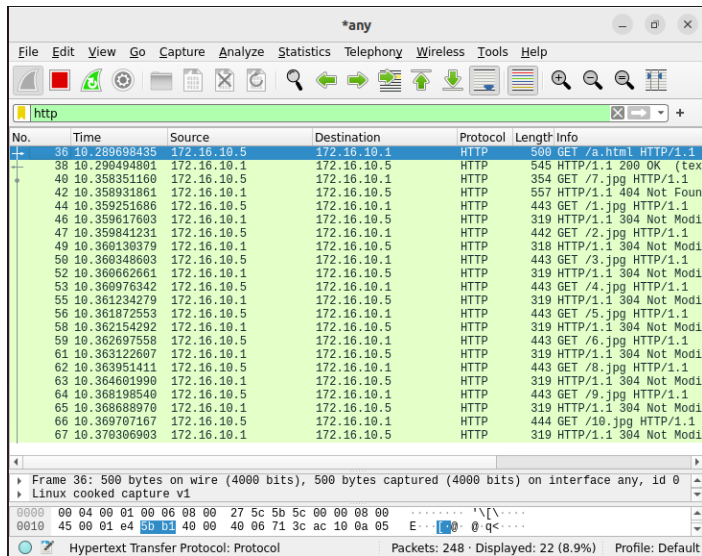
#
# HostnameLookups: Log the names of clients or just their IP addresses
#
# Get Help      ^O Write Out   ^W Where Is    ^K Cut Text    ^J Justify     ^C Cur Pos    M-U Undo       M-A Mark Text
# Exit          ^X Read File   ^_ Replace     ^U Paste Text ^T To Spell    ^_ Go To Line M-E Redo       M-V Copy Text
```

### 4. Store images and create html file.

```
Open Week3_File.html ~ /var/www/html Save
1 <!DOCTYPE html>
2 <html>
3 <head>
4 </head>
5
6 <body>
7     
8     
9     
10    
11    
12    
13    
14    
15    
16    
17 </body>
18 </html>
```

## Observations:

### 1. Non-Persistent

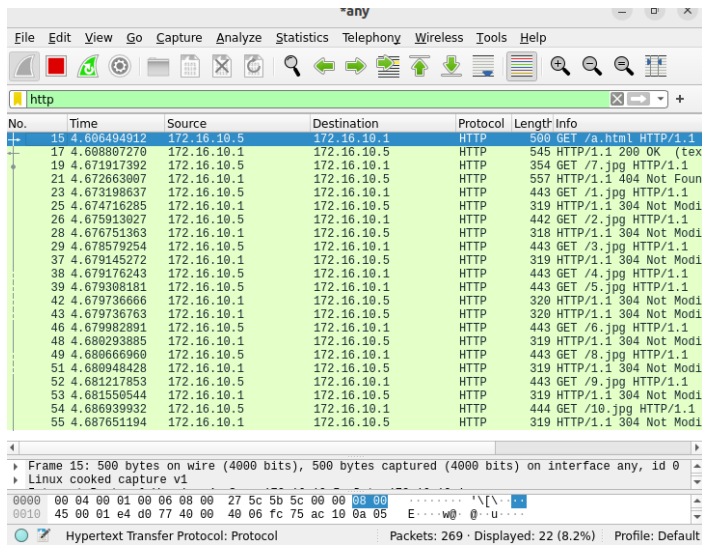


The screenshot shows a Wireshark capture of HTTP traffic on interface 'any'. The packet list displays 67 packets, all of which are GET requests to various image files (e.g., /a.html, /7.jpg, /1.jpg, /2.jpg, /3.jpg, /4.jpg, /5.jpg, /6.jpg, /8.jpg, /9.jpg, /10.jpg). Each request is followed by a 304 Not Modified response. The packet details pane shows the selected packet (No. 36) as a GET request for /a.html. The packet bytes pane shows the raw data of the packet, including the HTTP request line and headers.

No.	Time	Source	Destination	Protocol	Length	Info
36	10.289698435	172.16.10.5	172.16.10.1	HTTP	500	GET /a.html HTTP/1.1
37	10.290494801	172.16.10.1	172.16.10.5	HTTP	545	HTTP/1.1 200 OK (text/css)
40	10.358351160	172.16.10.5	172.16.10.1	HTTP	354	GET /7.jpg HTTP/1.1
42	10.358931861	172.16.10.1	172.16.10.5	HTTP	557	HTTP/1.1 404 Not Found
44	10.359251686	172.16.10.5	172.16.10.1	HTTP	443	GET /1.jpg HTTP/1.1
46	10.359617603	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
47	10.359841231	172.16.10.5	172.16.10.1	HTTP	442	GET /2.jpg HTTP/1.1
49	10.360139379	172.16.10.1	172.16.10.5	HTTP	318	HTTP/1.1 304 Not Modified
50	10.360348603	172.16.10.5	172.16.10.1	HTTP	443	GET /3.jpg HTTP/1.1
52	10.360662661	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
53	10.360976342	172.16.10.5	172.16.10.1	HTTP	443	GET /4.jpg HTTP/1.1
55	10.361234279	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
56	10.361872553	172.16.10.5	172.16.10.1	HTTP	443	GET /5.jpg HTTP/1.1
58	10.362154292	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
59	10.362697558	172.16.10.5	172.16.10.1	HTTP	443	GET /6.jpg HTTP/1.1
61	10.363122607	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
62	10.363951411	172.16.10.5	172.16.10.1	HTTP	443	GET /8.jpg HTTP/1.1
63	10.364601990	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
64	10.368198540	172.16.10.5	172.16.10.1	HTTP	443	GET /9.jpg HTTP/1.1
65	10.368688970	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
66	10.369707167	172.16.10.5	172.16.10.1	HTTP	444	GET /10.jpg HTTP/1.1
67	10.370306903	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified

$$\begin{aligned}\text{Time} &= 10.370306903 - 10.289698435 \\ &= 0.080608468\end{aligned}$$

### 2. Persistent-2



The screenshot shows a Wireshark capture of HTTP traffic on interface 'any'. The packet list displays 55 packets, all of which are GET requests to various image files (e.g., /a.html, /7.jpg, /1.jpg, /2.jpg, /3.jpg, /4.jpg, /5.jpg, /6.jpg, /8.jpg, /9.jpg, /10.jpg). Each request is followed by a 304 Not Modified response. The packet details pane shows the selected packet (No. 15) as a GET request for /a.html. The packet bytes pane shows the raw data of the packet, including the HTTP request line and headers.

No.	Time	Source	Destination	Protocol	Length	Info
15	4.606494912	172.16.10.5	172.16.10.1	HTTP	500	GET /a.html HTTP/1.1
17	4.609807270	172.16.10.1	172.16.10.5	HTTP	545	HTTP/1.1 200 OK (text/css)
19	4.671917392	172.16.10.5	172.16.10.1	HTTP	354	GET /7.jpg HTTP/1.1
21	4.672663907	172.16.10.1	172.16.10.5	HTTP	557	HTTP/1.1 404 Not Found
23	4.673198637	172.16.10.5	172.16.10.1	HTTP	443	GET /1.jpg HTTP/1.1
25	4.674716285	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
26	4.675913827	172.16.10.5	172.16.10.1	HTTP	442	GET /2.jpg HTTP/1.1
28	4.676751363	172.16.10.1	172.16.10.5	HTTP	318	HTTP/1.1 304 Not Modified
29	4.678579254	172.16.10.5	172.16.10.1	HTTP	443	GET /3.jpg HTTP/1.1
37	4.679145272	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
38	4.679176243	172.16.10.5	172.16.10.1	HTTP	443	GET /4.jpg HTTP/1.1
39	4.679308181	172.16.10.5	172.16.10.1	HTTP	443	GET /5.jpg HTTP/1.1
42	4.679736666	172.16.10.1	172.16.10.5	HTTP	320	HTTP/1.1 304 Not Modified
43	4.679736763	172.16.10.1	172.16.10.5	HTTP	320	HTTP/1.1 304 Not Modified
46	4.679982891	172.16.10.5	172.16.10.1	HTTP	443	GET /6.jpg HTTP/1.1
48	4.680293885	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
49	4.680666960	172.16.10.5	172.16.10.1	HTTP	443	GET /8.jpg HTTP/1.1
51	4.680948428	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
52	4.681217853	172.16.10.5	172.16.10.1	HTTP	443	GET /9.jpg HTTP/1.1
53	4.681558544	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
54	4.686939932	172.16.10.5	172.16.10.1	HTTP	444	GET /10.jpg HTTP/1.1
55	4.687651194	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified

$$\begin{aligned}\text{Time} &= 4.686939932 - 4.606494912 \\ &= 0.08044502\end{aligned}$$

### 3. Persistent-4

No.	Time	Source	Destination	Protocol	Length	Info
1246	177.196071657	172.16.10.5	172.16.10.1	HTTP	500	GET /a.html HTTP/1.1
1248	177.196725596	172.16.10.1	172.16.10.5	HTTP	545	HTTP/1.1 200 OK (text/html)
1250	177.220490098	172.16.10.5	172.16.10.1	HTTP	354	GET /7.jpg HTTP/1.1
1252	177.220912181	172.16.10.1	172.16.10.5	HTTP	557	HTTP/1.1 404 Not Found
1253	177.225158647	172.16.10.5	172.16.10.1	HTTP	443	GET /1.jpg HTTP/1.1
1258	177.225679854	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
1259	177.227045354	172.16.10.5	172.16.10.1	HTTP	442	GET /2.jpg HTTP/1.1
1260	177.227143401	172.16.10.5	172.16.10.1	HTTP	443	GET /3.jpg HTTP/1.1
1263	177.227580526	172.16.10.1	172.16.10.5	HTTP	320	HTTP/1.1 304 Not Modified
1265	177.227748680	172.16.10.1	172.16.10.5	HTTP	318	HTTP/1.1 304 Not Modified
1266	177.227777084	172.16.10.5	172.16.10.1	HTTP	443	GET /4.jpg HTTP/1.1
1268	177.227898826	172.16.10.5	172.16.10.1	HTTP	443	GET /5.jpg HTTP/1.1
1269	177.227967941	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
1271	177.228200762	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
1272	177.228399547	172.16.10.5	172.16.10.1	HTTP	443	GET /6.jpg HTTP/1.1
1273	177.228423173	172.16.10.5	172.16.10.1	HTTP	443	GET /8.jpg HTTP/1.1
1276	177.228721294	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
1277	177.228762403	172.16.10.5	172.16.10.1	HTTP	443	GET /9.jpg HTTP/1.1
1278	177.229000583	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
1280	177.229000695	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified
1281	177.229151559	172.16.10.5	172.16.10.1	HTTP	444	GET /10.jpg HTTP/1.1
1283	177.229388454	172.16.10.1	172.16.10.5	HTTP	319	HTTP/1.1 304 Not Modified

Frame 82: 500 bytes on wire (4000 bits), 500 bytes captured (4000 bits) on interface any, id 0  
 Linux cooked capture v1  
 Internet Protocol Version 4, Src: 172.16.10.5, Dst: 172.16.10.1  
 0040 cf 86 57 cf 47 45 54 20 2f 61 28 68 74 6d 6c 20 GET /a.html  
 0050 48 54 54 50 2f 31 2e 31 0d 0a 48 6f 73 74 3a 20 HTTP/1.1 .Host:  
 Hypertext Transfer Protocol: Protocol Packets: 1622 · Displayed: 30 (1.8%) Profile: Default

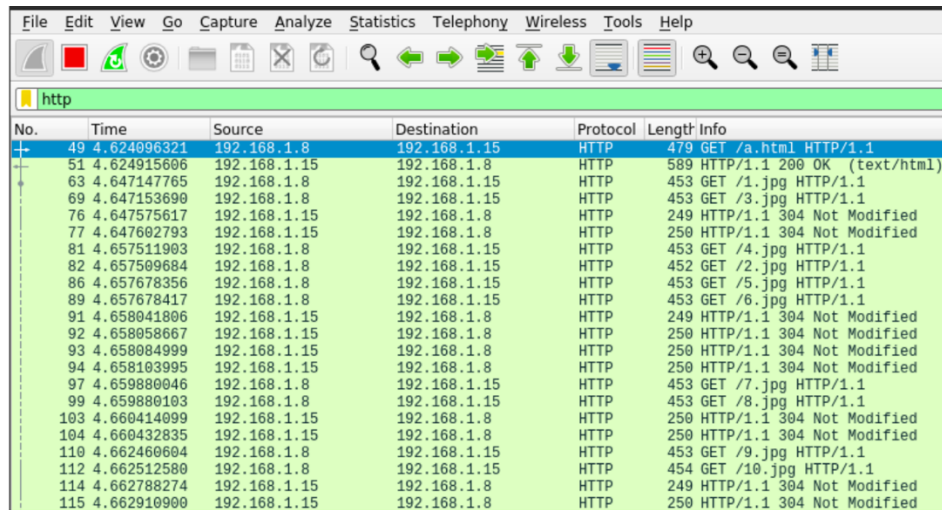
$$\begin{aligned} \text{Time} &= 177.229151559 - 177.196071657 \\ &= 0.033079902 \end{aligned}$$

### 4. Persistent-6

No.	Time	Source	Destination	Protocol	Length	Info
36	8.515465141	192.168.1.8	192.168.1.15	HTTP	470	GET /a.html HTTP/1.1
38	8.516332425	192.168.1.15	192.168.1.8	HTTP	589	HTTP/1.1 200 OK (text/html)
47	8.532432291	192.168.1.8	192.168.1.15	HTTP	453	GET /1.jpg HTTP/1.1
50	8.532432517	192.168.1.8	192.168.1.15	HTTP	452	GET /2.jpg HTTP/1.1
53	8.532886211	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
54	8.532906953	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
55	8.534528143	192.168.1.8	192.168.1.15	HTTP	453	GET /3.jpg HTTP/1.1
57	8.534528473	192.168.1.8	192.168.1.15	HTTP	453	GET /4.jpg HTTP/1.1
60	8.534953432	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
61	8.535015174	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
63	8.538337400	192.168.1.8	192.168.1.15	HTTP	453	GET /5.jpg HTTP/1.1
65	8.538337623	192.168.1.8	192.168.1.15	HTTP	453	GET /6.jpg HTTP/1.1
68	8.538649006	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
69	8.538666261	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
70	8.540992508	192.168.1.8	192.168.1.15	HTTP	453	GET /7.jpg HTTP/1.1
72	8.540992732	192.168.1.8	192.168.1.15	HTTP	453	GET /8.jpg HTTP/1.1
74	8.541323255	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
75	8.541357501	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
76	8.554812843	192.168.1.8	192.168.1.15	HTTP	453	GET /9.jpg HTTP/1.1
78	8.554813130	192.168.1.8	192.168.1.15	HTTP	454	GET /10.jpg HTTP/1.1
80	8.555225468	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
81	8.555273740	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified

$$\begin{aligned} \text{Time} &= 8.554813130 - 8.532432291 \\ &= 0.022380839 \end{aligned}$$

## 5. Persistent-10



No.	Time	Source	Destination	Protocol	Length	Info
49	4.624096321	192.168.1.8	192.168.1.15	HTTP	479	GET /a.html HTTP/1.1
51	4.624915606	192.168.1.15	192.168.1.8	HTTP	589	HTTP/1.1 200 OK (text/html)
63	4.647147765	192.168.1.8	192.168.1.15	HTTP	453	GET /1.jpg HTTP/1.1
69	4.647153690	192.168.1.8	192.168.1.15	HTTP	453	GET /3.jpg HTTP/1.1
76	4.647575617	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
77	4.647602793	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
81	4.657511903	192.168.1.8	192.168.1.15	HTTP	453	GET /4.jpg HTTP/1.1
82	4.657509684	192.168.1.8	192.168.1.15	HTTP	452	GET /2.jpg HTTP/1.1
86	4.657678356	192.168.1.8	192.168.1.15	HTTP	453	GET /5.jpg HTTP/1.1
89	4.657678417	192.168.1.8	192.168.1.15	HTTP	453	GET /6.jpg HTTP/1.1
91	4.658041806	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
92	4.658058667	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
93	4.658084999	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
94	4.658103995	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
97	4.659880046	192.168.1.8	192.168.1.15	HTTP	453	GET /7.jpg HTTP/1.1
99	4.659880103	192.168.1.8	192.168.1.15	HTTP	453	GET /8.jpg HTTP/1.1
103	4.660414099	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
104	4.660432835	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified
110	4.662460604	192.168.1.8	192.168.1.15	HTTP	453	GET /9.jpg HTTP/1.1
112	4.662512580	192.168.1.8	192.168.1.15	HTTP	454	GET /10.jpg HTTP/1.1
114	4.662788274	192.168.1.15	192.168.1.8	HTTP	249	HTTP/1.1 304 Not Modified
115	4.662910900	192.168.1.15	192.168.1.8	HTTP	250	HTTP/1.1 304 Not Modified

$$\begin{aligned}\text{Time} &= 4.662512580 - 4.647147765 \\ &= 0.015364815\end{aligned}$$

### Conclusion:

Q1.Explain the response time difference.

Ans) Non-persistent and persistent are the two types of HTTP connections used to connect the client with the webserver. The non-persistent connection has connection type 1.0 and persistent connection has connection type 1.1. After the client receives the object in non-persistent, the connection is closed. On the other hand the persistent connection ensures the transfer of multiple objects over a single connection.

RTT is the time taken to request the object from the client to the server and then retrieve it from the server back to the client. The non-persistent connection takes the connection time of 2RTT + each file transmission time. A persistent connection takes the connection time of 2RTT + transfers all objects at a go over the single connection. This is the reason why a persistent connection is faster.

Q2. What is the optimal number of persistent connections for best performance?

Ans) Higher the number of persistent connections, lower is the time taken. The optimal connection is 4 or 6. For best case, use 10. Clients should have **at most 2** persistent connections to any server to prevent the server from being overloaded. A non-persistent connection takes the most time.