MIIDDLE EAST TECHNICAL UNIVERSITY

ELECTRICAL-ELECTRONICS ENGINEERING

EE444 Introduction to Computer Networks

Mehmet ATAŞ 2304020

Submission Date: 27.05.2022

HW2 - Wireshark

Part 1 - Getting Familiar with Wireshark

To connect to the Internet, I utilize a wireless interface. I capture the packets in Wireshark for about 20 seconds, and the screen print of recorded packets is shown in Figure 1.

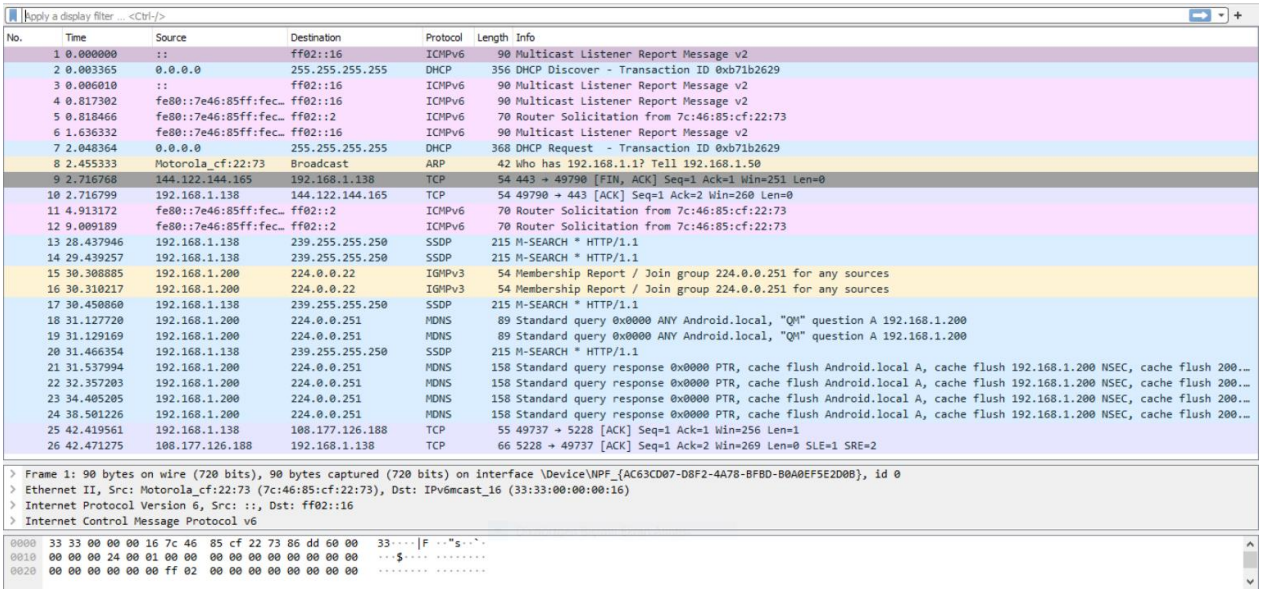


Figure 1: Screen Print of Captured Packets on Wireshark

The following protocols were observed:

TCP: Transmission Control Protocol

ARP: Address Resolution Protocol

DHCP: Dynamic Host Configuration Protocol

ICMP: Internet Control Message Protocol

IGMP: Internet Group Management Protocol

SSDP: Simple Service Discovery Protocol

MDNS: Multicast Domain Name System

Part 2 – HTTP, TCP, DNS

2.1.

TCP connections are created initially, followed by a DNS connection to www.metu.edu.tr with a typical query. TLS packets concerning client hello and client handshaking are also included. Following that, HTTP requests and HTTP answers are sent to the website /sites/eee.metu.edu.tr/files/images/eehistory.jpg using base HTML first, followed by HTTP connections with image files. At the conclusion, TCP connections are closed.

2.2.

As shown in Figure 2, the IP address of the real source of the picture file is 144.122.145.144, and the port number is 80. 192.168.43.91 is my IP address. The TCP stream index associated with the picture download is 10.

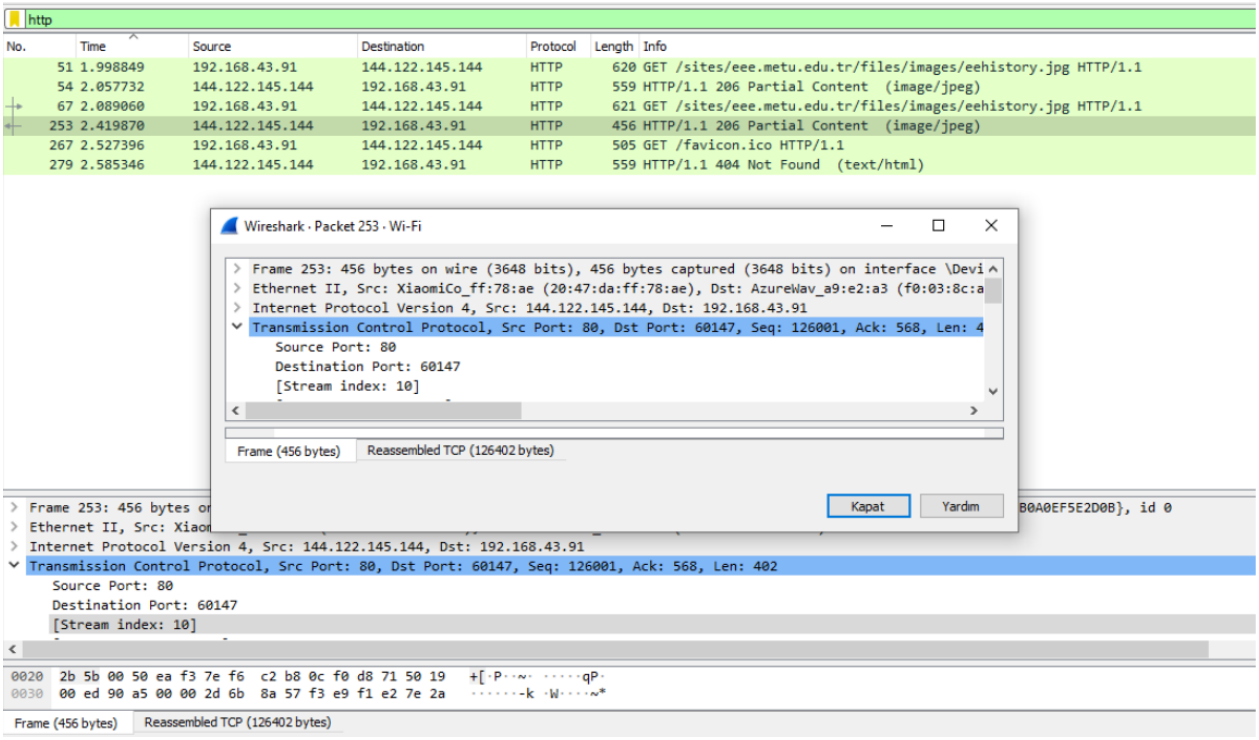


Figure 2: Screen Print of HTTP Traffic Only

2.3.

The internal Wireshark mapping for this TCP Stream 10 is [192.168.43.91, 60147, 144.122.145.144, 80]. As seen in Figure 3, all packets for this TCP stream value have the identical mapping field values.

3-way handshake for this TCP connection:

The first packet is a SYN packet from the client (me) to the server, and its sequence number (client Seq) is 0.

The second packet is the server's response (SYN+ACK) to the client; its sequence number (Seq of server) is 0, and its ACK number is 1 (which is Seq of client + 1).

The third packet is the client's response (ACK), and its sequence number (Seq of client) is 1. (which is equal to ACK coming from server). Its ACK number is 1 (which equals the server's Seq + 1).

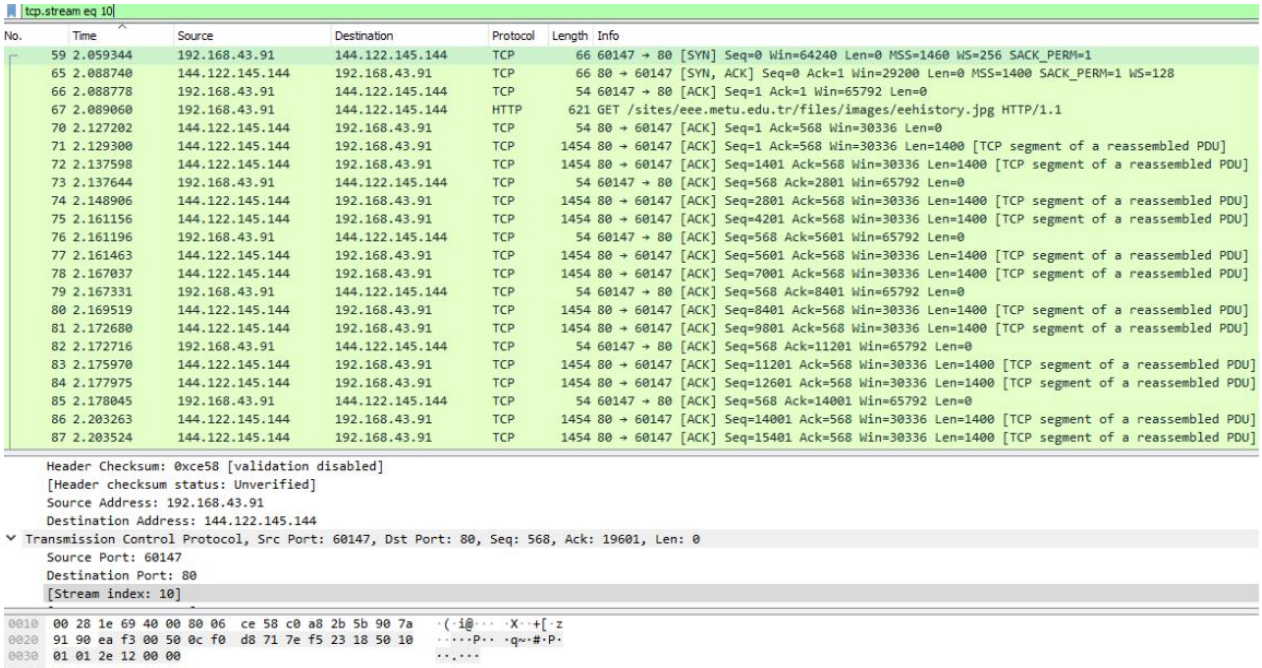


Figure 3: Screen Print of TCP Stream 10

2.4.

Figure 4 shows how 1400 bytes are utilized to encapsulate the largest frame (frame 251).

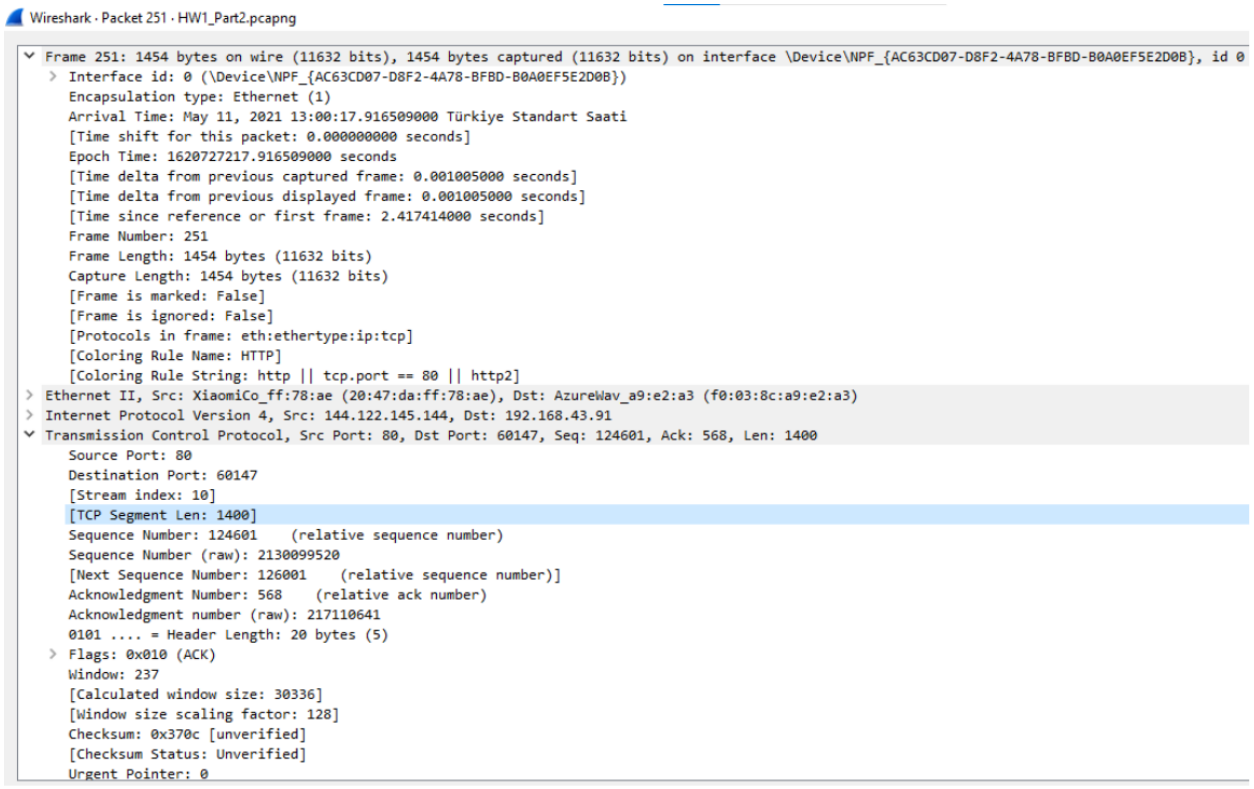


Figure 4: Information about Frame 251

There are two approaches for calculating this. The first approach is as follows:

Next Sequential Number – Sequential Number = 126001 – 124601 = 1400

(these values are seen in Figure 4) The bytes required to encapsulate this frame are merely the difference between the sequence numbers in TCP requests and answers.

The second way is to count the number of headers in a single frame. As seen in Figure 4, there are 1454 bytes in wire. However, not all of the 1454 bytes constitute data; some are headers. Let us compute the data length:

1454 kilobytes (length of the frame) – twenty bytes (IPv4) - TCP + checksum = 20 bytes DATA = 1400 bytes – 14 bytes (Ethernet) (and 54 B Overhead of TCP, IP and Ethernet)

2.5.

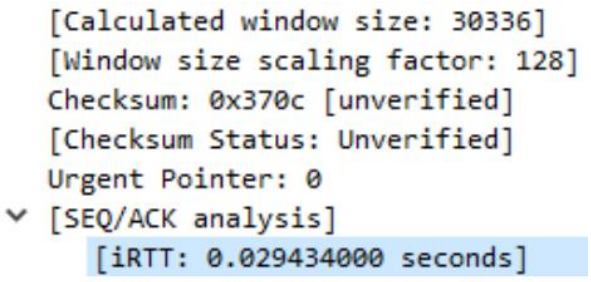


Figure 5: Window Size and RTT Values

W / RTT can be used to calculate throughput. The sender window size is W, and the round trip time is RTT.

With these numbers as shown in Figure 5, we can compute the throughput as follows:

W = 30336 bits

RTT = 0.02943 seconds

Throughput = 30336 / 0.02943 = 1030784 bits/seconds

However, this throughput is just for a single frame. To determine the throughput of this stream, sum all the lengths of received data, as shown in Figure 3, and divide by the time elapsed:

Received Data Length = 1454 bytes * 90 + 54 bytes *7 + 66 bytes *5 =131568 bytes

Passed Time = 2.616978 – 1.838629 = 0.778349

Throughput = 169034 bytes / seconds for this stream.

2.6.

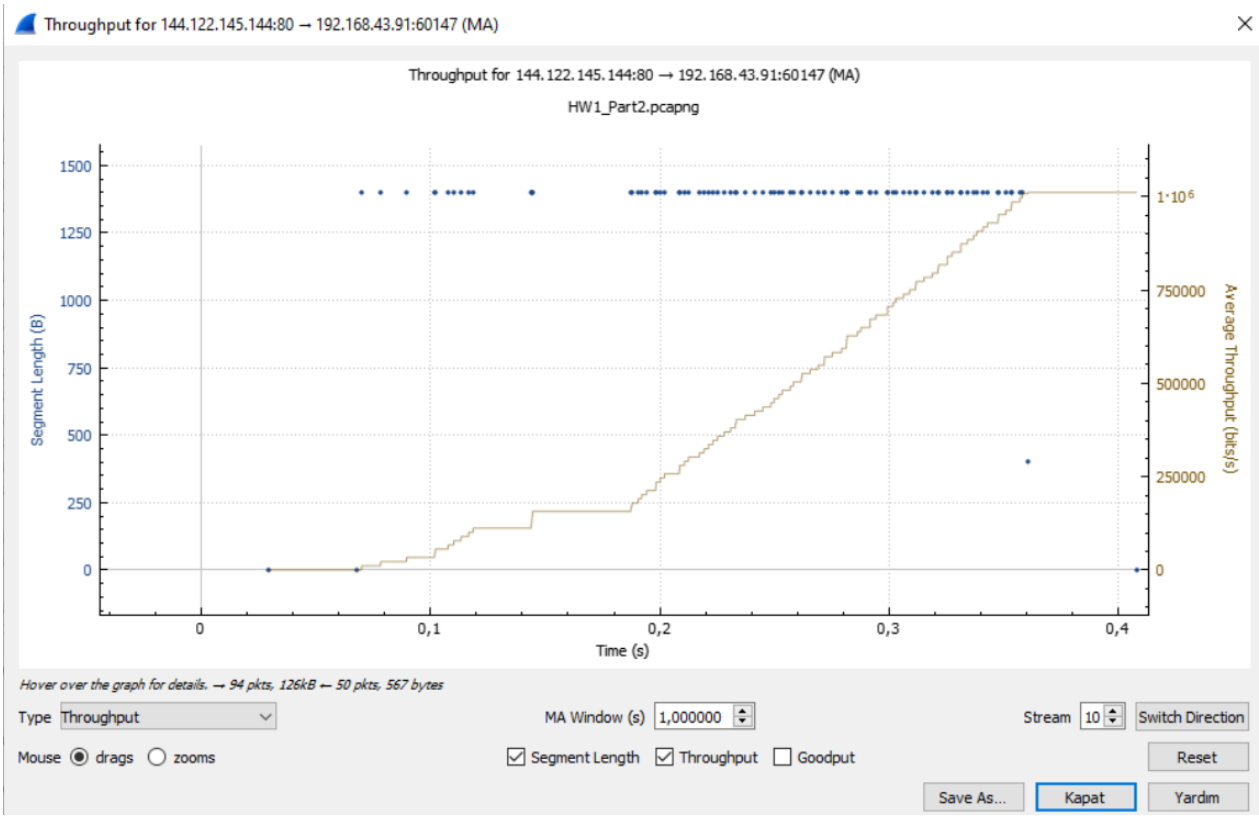


Figure 6: Throughput of TCP connection on Wireshark

2.7.

As seen in Figure 7, I clicked the HTTP frame linked with the basic HTML file. I checked if the Connection is "keepalive" to see whether the HTTP is durable or not (if it keeps the connection alive). Because it did, I deduced that it is persistent HTTP. If it were non-persistent HTTP, the connection would be "closed" and re-established each time.

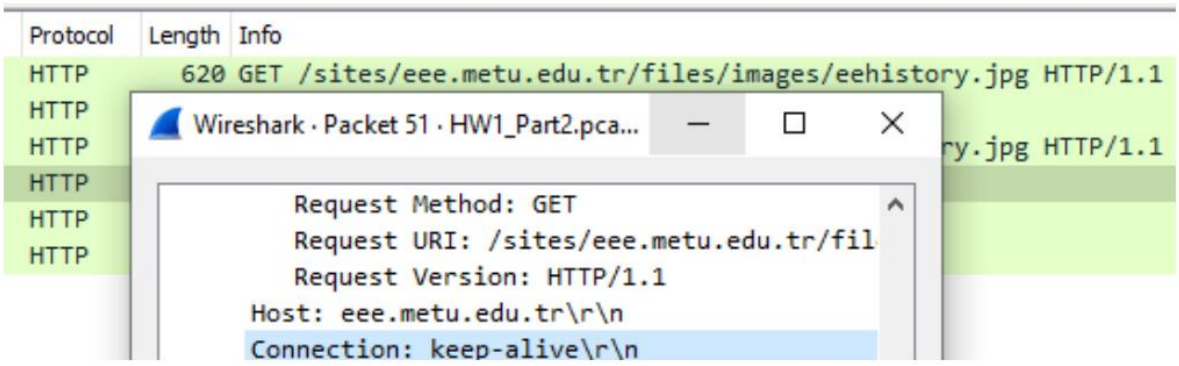
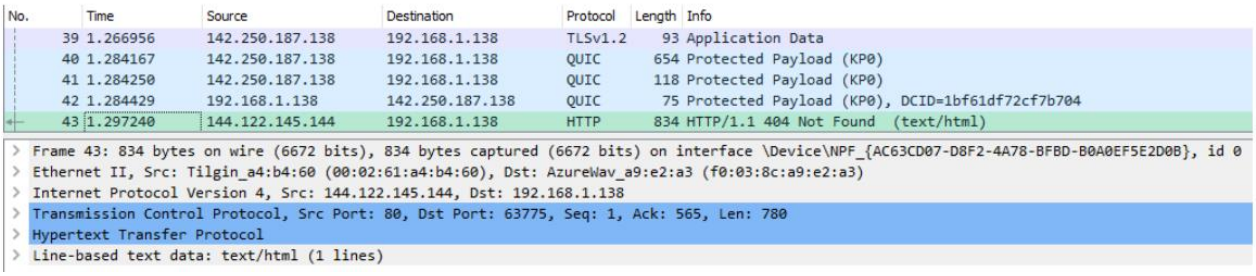


Figure 7: Connection: keep-alive

2.8.

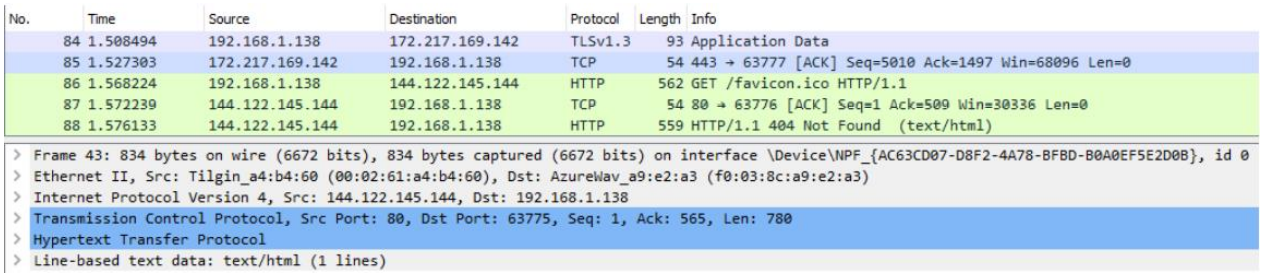
The status code or error number for the website http://eee.metu.edu.tr/sites/eee.metu.edu.tr/files/images/eehistory.jpeg is 404, which indicates that a file does not exist. Figures 8 and 9 show the fields that are connected.



No.	Time	Source	Destination	Protocol	Length	Info
39	1.266956	142.250.187.138	192.168.1.138	TLSv1.2	93	Application Data
40	1.284167	142.250.187.138	192.168.1.138	QUIC	654	Protected Payload (KP0)
41	1.284250	142.250.187.138	192.168.1.138	QUIC	118	Protected Payload (KP0)
42	1.284429	192.168.1.138	142.250.187.138	QUIC	75	Protected Payload (KP0), DCID=1bf61df72cf7b704
43	1.297240	144.122.145.144	192.168.1.138	HTTP	834	HTTP/1.1 404 Not Found (text/html)

```
> Frame 43: 834 bytes on wire (6672 bits), 834 bytes captured (6672 bits) on interface \Device\NPF_{AC63CD07-D8F2-4A78-BFBD-B0A0EF5E2D0B}, id 0
> Ethernet II, Src: Tilgin_a4:b4:60 (00:02:61:a4:b4:60), Dst: AzureWav_a9:e2:a3 (f0:03:8c:a9:e2:a3)
> Internet Protocol Version 4, Src: 144.122.145.144, Dst: 192.168.1.138
> Transmission Control Protocol, Src Port: 80, Dst Port: 63775, Seq: 1, Ack: 565, Len: 780
> Hypertext Transfer Protocol
> Line-based text data: text/html (1 lines)
```

Figure 8: 404 Error

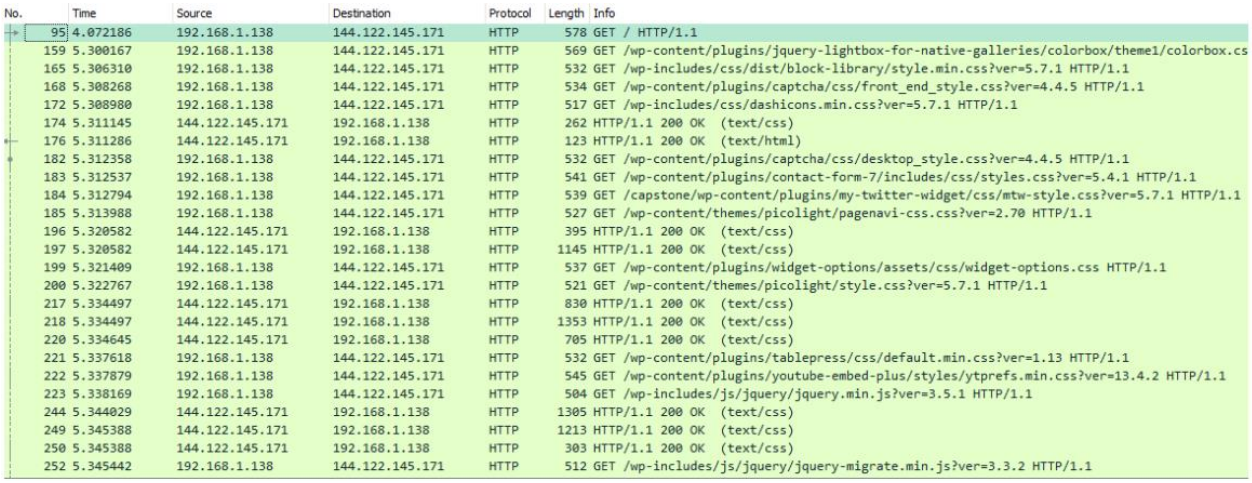


No.	Time	Source	Destination	Protocol	Length	Info
84	1.508494	192.168.1.138	172.217.169.142	TLSv1.3	93	Application Data
85	1.527303	172.217.169.142	192.168.1.138	TCP	54	443 → 63777 [ACK] Seq=5010 Ack=1497 Win=68096 Len=0
86	1.568224	192.168.1.138	144.122.145.144	HTTP	562	GET /favicon.ico HTTP/1.1
87	1.572239	144.122.145.144	192.168.1.138	TCP	54	80 → 63776 [ACK] Seq=1 Ack=509 Win=30336 Len=0
88	1.576133	144.122.145.144	192.168.1.138	HTTP	559	HTTP/1.1 404 Not Found (text/html)

```
> Frame 43: 834 bytes on wire (6672 bits), 834 bytes captured (6672 bits) on interface \Device\NPF_{AC63CD07-D8F2-4A78-BFBD-B0A0EF5E2D0B}, id 0
> Ethernet II, Src: Tilgin_a4:b4:60 (00:02:61:a4:b4:60), Dst: AzureWav_a9:e2:a3 (f0:03:8c:a9:e2:a3)
> Internet Protocol Version 4, Src: 144.122.145.144, Dst: 192.168.1.138
> Transmission Control Protocol, Src Port: 80, Dst Port: 63775, Seq: 1, Ack: 565, Len: 780
> Hypertext Transfer Protocol
> Line-based text data: text/html (1 lines)
```

Figure 9: 404 Error

The URL http://capstone.eee.metu.edu.tr/ is then accessed. Figure 10 shows the status code "200 OK," which indicates that the request was successful.



No.	Time	Source	Destination	Protocol	Length	Info
95	4.072186	192.168.1.138	144.122.145.171	HTTP	578	GET / HTTP/1.1
159	5.300167	192.168.1.138	144.122.145.171	HTTP	569	GET /wp-content/plugins/jquery-lightbox-for-native-galleries/colorbox/theme1/colorbox.cs
165	5.306310	192.168.1.138	144.122.145.171	HTTP	532	GET /wp-includes/css/dist/block-library/style.min.css?ver=5.7.1 HTTP/1.1
168	5.308268	192.168.1.138	144.122.145.171	HTTP	534	GET /wp-content/plugins/captcha/css/front_end_style.css?ver=4.4.5 HTTP/1.1
172	5.308980	192.168.1.138	144.122.145.171	HTTP	517	GET /wp-includes/css/dashicons.min.css?ver=5.7.1 HTTP/1.1
174	5.311145	144.122.145.171	192.168.1.138	HTTP	262	HTTP/1.1 200 OK (text/css)
176	5.311286	144.122.145.171	192.168.1.138	HTTP	123	HTTP/1.1 200 OK (text/html)
182	5.312358	192.168.1.138	144.122.145.171	HTTP	532	GET /wp-content/plugins/captcha/css/desktop_style.css?ver=4.4.5 HTTP/1.1
183	5.312537	192.168.1.138	144.122.145.171	HTTP	541	GET /wp-content/plugins/contact-form-7/includes/css/styles.css?ver=5.4.1 HTTP/1.1
184	5.312794	192.168.1.138	144.122.145.171	HTTP	539	GET /capstone/wp-content/plugins/my-twitter-widget/css/mtw-style.css?ver=5.7.1 HTTP/1.1
185	5.313988	192.168.1.138	144.122.145.171	HTTP	527	GET /wp-content/themes/picolight/pagenavi-css.css?ver=2.70 HTTP/1.1
196	5.320582	144.122.145.171	192.168.1.138	HTTP	395	HTTP/1.1 200 OK (text/css)
197	5.320582	144.122.145.171	192.168.1.138	HTTP	1145	HTTP/1.1 200 OK (text/css)
199	5.321409	192.168.1.138	144.122.145.171	HTTP	537	GET /wp-content/plugins/widget-options/assets/css/widget-options.css HTTP/1.1
200	5.322767	192.168.1.138	144.122.145.171	HTTP	521	GET /wp-content/themes/picolight/style.css?ver=5.7.1 HTTP/1.1
217	5.334497	144.122.145.171	192.168.1.138	HTTP	830	HTTP/1.1 200 OK (text/css)
218	5.334497	144.122.145.171	192.168.1.138	HTTP	1353	HTTP/1.1 200 OK (text/css)
220	5.334645	144.122.145.171	192.168.1.138	HTTP	705	HTTP/1.1 200 OK (text/css)
221	5.337618	192.168.1.138	144.122.145.171	HTTP	532	GET /wp-content/plugins/tablepress/css/default.min.css?ver=1.13 HTTP/1.1
222	5.337879	192.168.1.138	144.122.145.171	HTTP	545	GET /wp-content/plugins/youtube-embed-plus/styles/ytprefs.min.css?ver=13.4.2 HTTP/1.1
223	5.338169	192.168.1.138	144.122.145.171	HTTP	504	GET /wp-includes/js/jquery/jquery.min.js?ver=3.5.1 HTTP/1.1
244	5.344029	144.122.145.171	192.168.1.138	HTTP	1305	HTTP/1.1 200 OK (text/css)
249	5.345388	144.122.145.171	192.168.1.138	HTTP	1213	HTTP/1.1 200 OK (text/css)
250	5.345388	144.122.145.171	192.168.1.138	HTTP	303	HTTP/1.1 200 OK (text/css)
252	5.345442	192.168.1.138	144.122.145.171	HTTP	512	GET /wp-includes/js/jquery/jquery-migrate.min.js?ver=3.3.2 HTTP/1.1

Figure 10: 200 OK

The URL http://mackolik.com is then viewed. Figure 11 shows the status code "301 Relocated Permanently," which indicates that the requested item was moved and a new location was supplied later in this message (Location:). Figure 11 depicts the newly defined position.

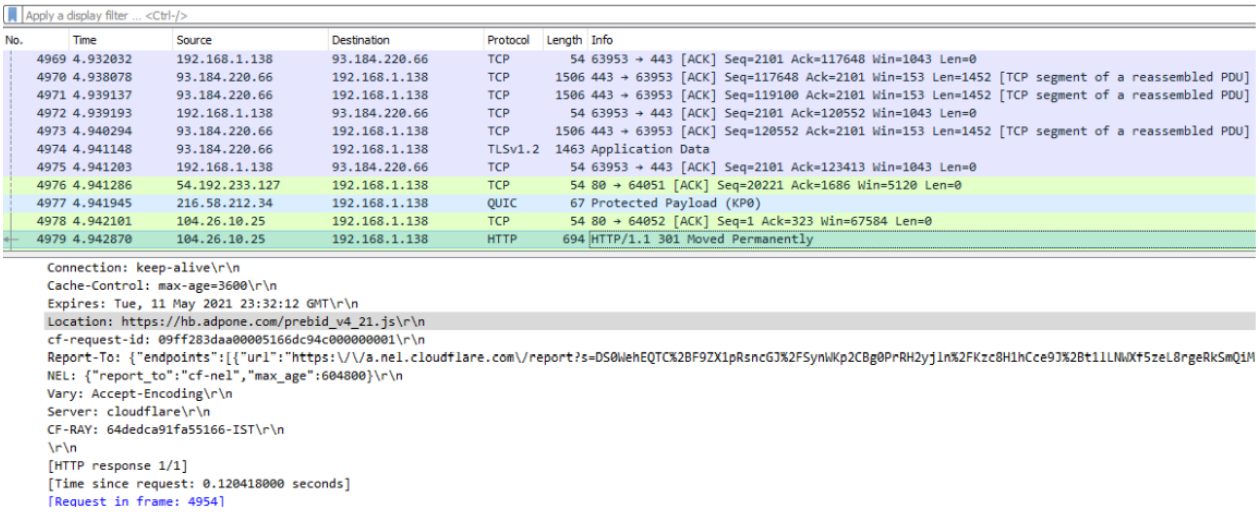


Figure 11: 301 Moved Permanently

2.9.

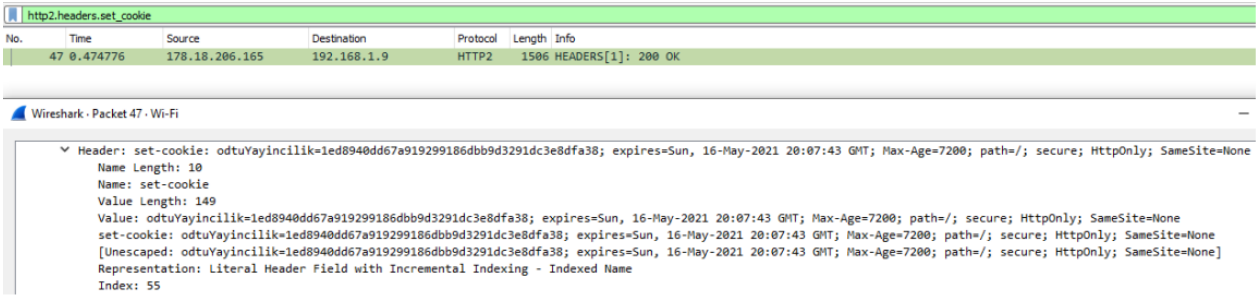


Figure 12: HTTP2 set_cookie

Figure 12 shows that the Value, set-cookie, and Unescaped fields in the Header include unique IDs for me, which are "1ed8940dd67a919299186dbb9d3291dc3e8dfa38."

Figure 12 shows two fields relating keeping the basket for me: expires = Sun, 16-May-2021 20:07:43 GMT and Max-Age=7200. I looked for it and discovered that when both are utilized, Max-Age takes precedence over Expires. So the site will keep my basket for 7200 seconds, 120 minutes, or 2 hours.

2.10.

A DNS header is 12 bytes long and contains the following fields: identification, flags, number of questions, number of answers, number of authoritative resource records (RRs), and number of further RRs. Each field is 2 bytes long and occurs in this sequence.

https://www.ece.cmu.edu/ Transaction Id is 0x83e3, as seen in Figure 13.

Transaction id of https://www.ece.cmu.edu.tr/ is 0xf567, as seen in Figure 14.

The first flag bit indicates whether the DNS message is a query or a response. A "0" represents a question, while a "1" indicates an answer. Figure 13 depicts a question, whereas Figure 14 depicts a response.

The difference in the replies for the given addresses is that the website name https://www.ece.cmu.edu/ is found, but not https://www.ece.cmu.edu.tr/.

As a result, it received the message "No such name," as seen in Figure 14.

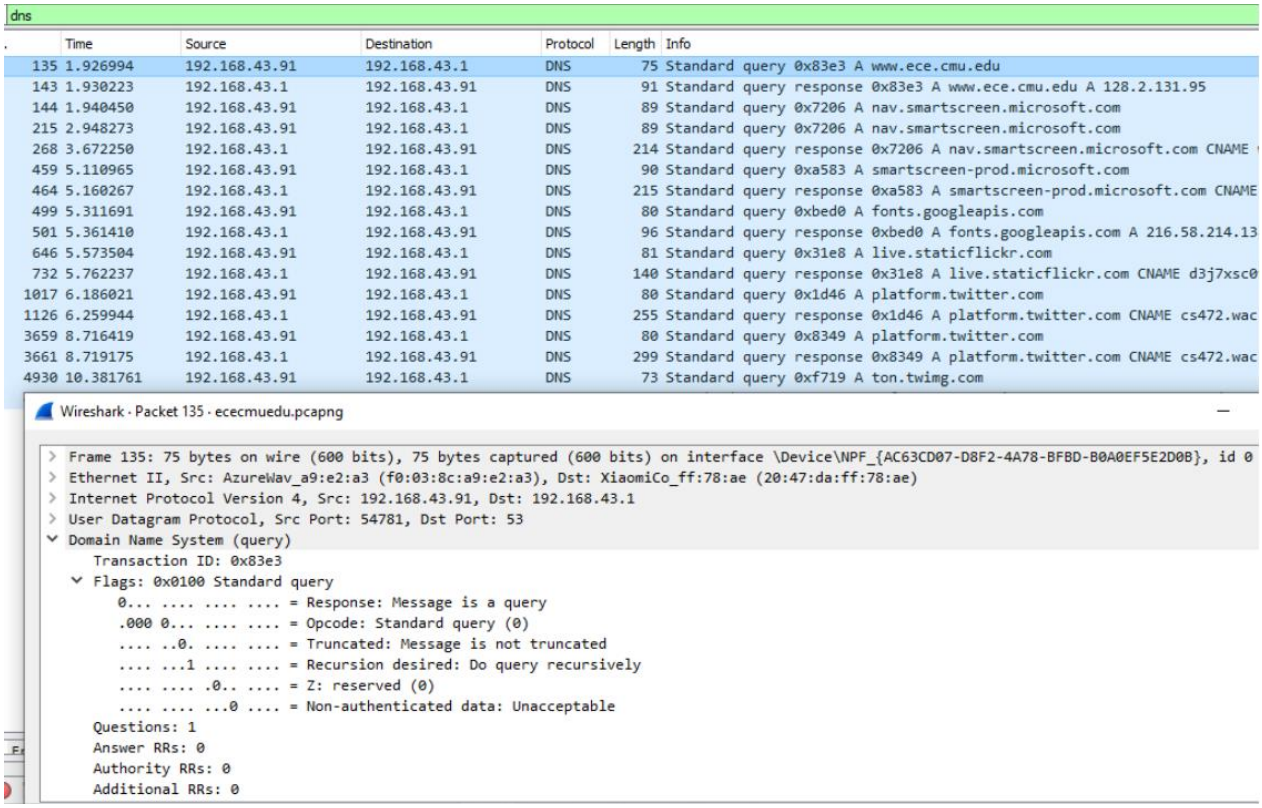


Figure 13: https://www.ece.cmu.edu/

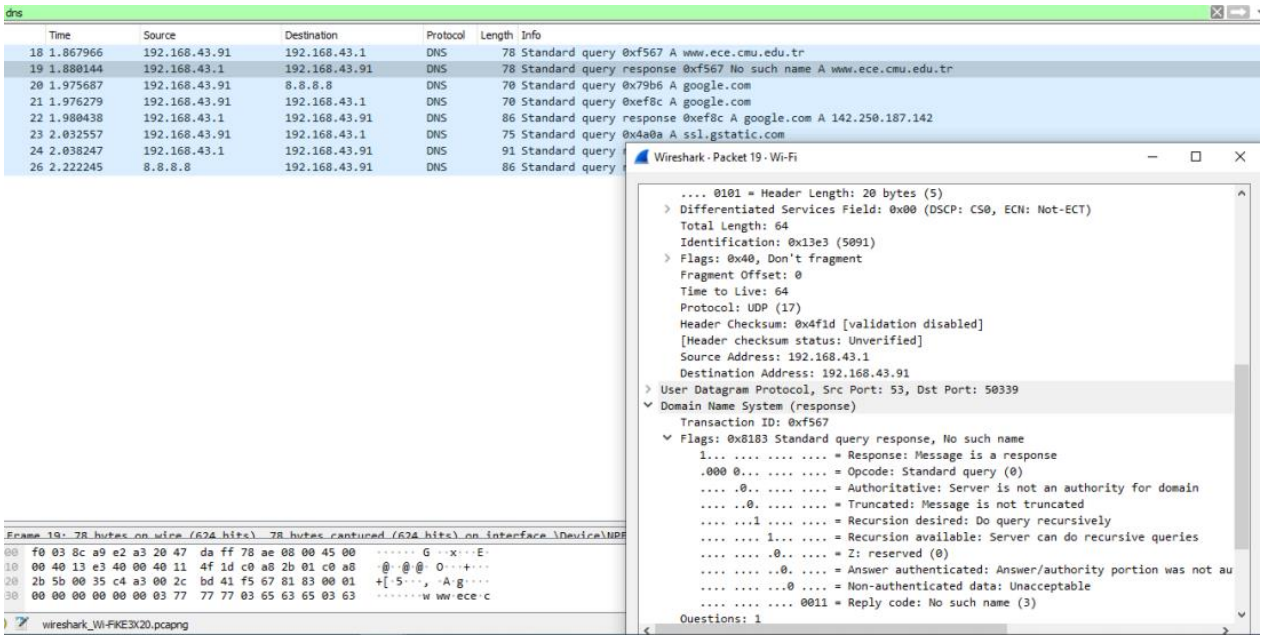


Figure 14: https://www.ece.cmu.edu.tr/

Part 3 – ICMP

3.1.

```
Pinging 208.67.222.222 with 1000 bytes of data:
Reply from 208.67.222.222: bytes=1000 time=38ms TTL=52
Reply from 208.67.222.222: bytes=1000 time=30ms TTL=52
Reply from 208.67.222.222: bytes=1000 time=31ms TTL=52
Reply from 208.67.222.222: bytes=1000 time=31ms TTL=52

Ping statistics for 208.67.222.222:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 30ms, Maximum = 38ms, Average = 32ms

C:\Users\Casper> ping -l 2000 208.67.222.222

Pinging 208.67.222.222 with 2000 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 208.67.222.222:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\Casper> ping -l 9001 208.67.222.222

Pinging 208.67.222.222 with 9001 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 208.67.222.222:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figure 15: Ping Instructions

In ping instructions, the -l command specifies the size, and the address specifies where to pinge, in this example 208.67.222.222. As shown in Figure 15, the size of the "ping –l 1000 208.67.222.222" command is 1000 bytes; the size of the "ping –l 2000 208.67.222.222" command is 2000 bytes; and the size of the "ping –l 9001 208.67.222.222" command is 9001 bytes.

The average RTT in the first instruction is 32 ms. It is believed that if it is less than 50 ms, it is OK, and the TTL for all packets is 52. In this situation, no packets are lost. Request timed out error is taken in the second and third commands. This message shows that no Echo Reply messages were received within the

1 second time limit. This can be caused by a variety of factors, the most common of which being network congestion, ARP request failure, packet filtering, routing error, or a quiet discard.

Jumbo frames are Ethernet frames containing more than 1500 bytes of payload, as defined by the IEEE 802.3 standard. Jumbo frames can typically store up to 9000 bytes of payload, however smaller and bigger versions occur, therefore the word should be used with caution.

As a result, the request for 2000 bytes has timed out on my machine, but it cannot be on another computer on another network. However, 9001 bytes is beyond the limit, and the request was supposed to time out.

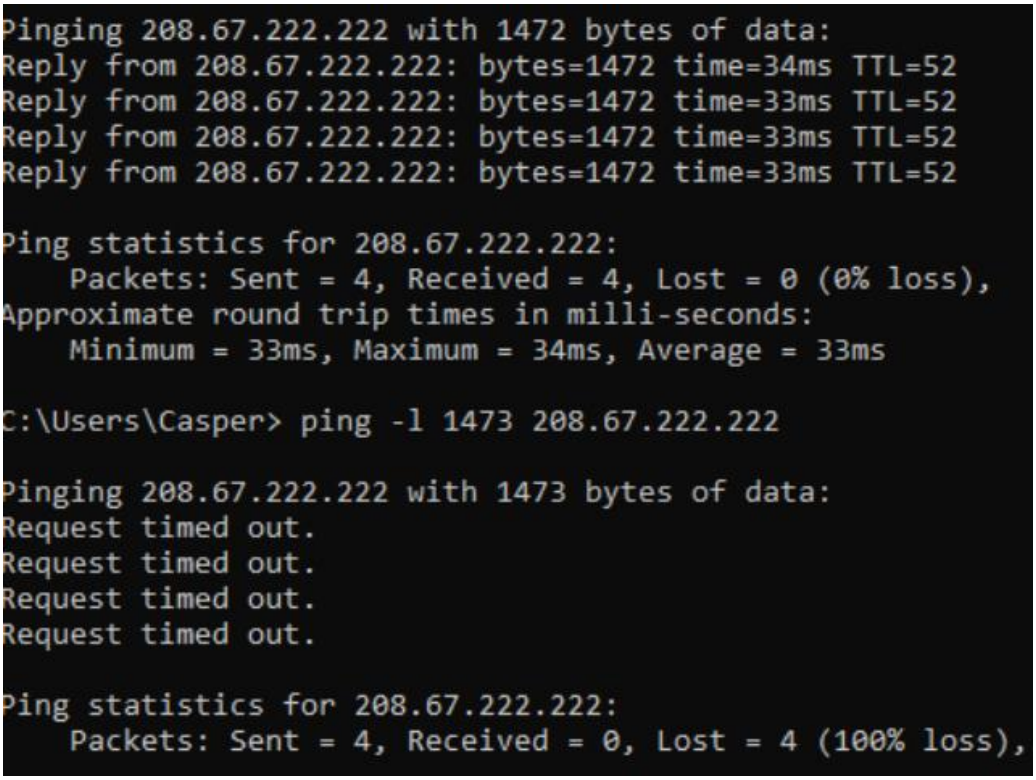


Figure 16: My Trials to find the limit

When I tried what is the limit on my computer, I saw that the limit was 1472 bytes, as seen in Figure 16.

```
Pinging 0.0.0.0 with 32 bytes of data:
PING: transmit failed. General failure.
PING: transmit failed. General failure.
PING: transmit failed. General failure.
PING: transmit failed. General failure.

Ping statistics for 0.0.0.0:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\Casper> ping 127.0.0.0

Pinging 127.0.0.0 with 32 bytes of data:
General failure.
General failure.
General failure.
General failure.

Ping statistics for 127.0.0.0:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\Casper> ping 255.255.255.255
Ping request could not find host 255.255.255.255. Please check the name and try again.
```

Figure 17: Ping Commands

Figure 17 shows that I received General Failure errors and that packets were lost. It is because the router is not in the same subnet as the "pinging" server. In this case, 0.0.0.0 represents this network device while 127.0.0.1 represents the local host. As a result, they are not on the same subnet as 208.67.222.222.

As shown in Figure 17, when the command "ping 255.255.255.255" is sent, the message "Ping request could not discover host 255.255.255.255." Please double-check the name and try again." In this case, 255.255.255.255 is a broadcast address, and I am sending a ping to every device on my local network, expecting a response from each device. This did not work since not all of the devices responded to my message.

```
C:\Users\Casper>tracert twitter.com

Tracing route to twitter.com [104.244.42.1]
over a maximum of 30 hops:

  1     1 ms     1 ms     1 ms  router.asus.com [192.168.1.1]
  2     5 ms     8 ms     5 ms  172.17.1.135
  3     5 ms     *        *     85.118.223.31.srv.turk.net [31.223.118.85]
  4    21 ms     6 ms     5 ms  86.118.223.31.srv.turk.net [31.223.118.86]
  5    13 ms     7 ms     7 ms  81.118.223.31.srv.turk.net [31.223.118.81]
  6     *        *        *     Request timed out.
  7     *       21 ms     *     22.100.146.159.srv.turk.net [159.146.100.22]
  8    68 ms    55 ms    55 ms  be2549.ccr31.sof02.atlas.cogentco.com [154.54.36.137]
  9   155 ms    56 ms    58 ms  be3421.ccr51.beg03.atlas.cogentco.com [130.117.0.94]
 10   155 ms    56 ms    62 ms  be3422.ccr31.bud01.atlas.cogentco.com [130.117.0.125]
 11   155 ms    75 ms   155 ms  be3261.ccr21.bts01.atlas.cogentco.com [130.117.3.137]
 12    55 ms    55 ms    57 ms  be2988.ccr51.vie01.atlas.cogentco.com [154.54.59.86]
 13    54 ms    49 ms    48 ms  130.117.14.182
 14    50 ms    50 ms    50 ms  win-bb4-link.ip.twelve99.net [62.115.114.182]
 15    50 ms    51 ms    47 ms  ffm-bb2-link.ip.twelve99.net [62.115.138.22]
 16     *       49 ms     *     ffm-b11-link.ip.twelve99.net [62.115.124.119]
 17   168 ms    56 ms    54 ms  twitter-ic322866-ffm-b11.ip.twelve99-cust.net [62.115.49.187]
 18   155 ms    55 ms   159 ms  104.244.42.1

Trace complete.
```

Figure 18: Trace Route Command

The trace route command tracks the path followed by a packet on an IP network from a source to a destination in real time, revealing the IP addresses of all routers pinged in between and the time spent for each hop. Figure 18 shows that the twitter.com website is opened in 18 hops, with 18 distinct IP addresses.

```
Tracing route to www.google.com.tr [216.58.205.195]
over a maximum of 30 hops:

  1     1 ms     4 ms     1 ms  router.asus.com [192.168.1.1]
  2     5 ms     6 ms     5 ms  172.17.1.135
  3     *        5 ms     *     85.118.223.31.srv.turk.net [31.223.118.85]
  4     5 ms     5 ms    59 ms  86.118.223.31.srv.turk.net [31.223.118.86]
  5     6 ms     6 ms     6 ms  81.118.223.31.srv.turk.net [31.223.118.81]
  6     *       22 ms     *     186.100.146.159.srv.turk.net [159.146.100.186]
  7    63 ms   124 ms     *     22.100.146.159.srv.turk.net [159.146.100.22]
  8   236 ms   457 ms   337 ms  195.175.51.209.static.turktelekom.com.tr [195.175.51.209]
  9    15 ms    16 ms    23 ms  00-gayrettepe-xrs-t2-2---00-gayrettepe-t3-9.statik.turktelekom.com.tr [212.156.121.138]
 10     *       14 ms    13 ms  00-ebgp-gayrettepe-k---00-gayrettepe-xrs-t2-2.statik.turktelekom.com.tr [81.212.202.19]
 11    23 ms    23 ms    23 ms  307-sof-col-2---00-ebgp-gayrettepe-k.statik.turktelekom.com.tr [212.156.104.156]
 12    51 ms    51 ms    51 ms  72.14.204.10
 13    54 ms    52 ms    52 ms  216.239.59.239
 14    54 ms    51 ms    51 ms  108.170.250.162
 15    52 ms    52 ms    52 ms  142.250.213.228
 16    52 ms    54 ms    51 ms  172.253.66.215
 17    51 ms    61 ms    51 ms  216.239.46.102
 18    52 ms    53 ms    52 ms  74.125.244.225
 19    53 ms    52 ms    53 ms  142.250.46.97
 20    51 ms    51 ms    54 ms  mil04s29-in-f3.1e100.net [216.58.205.195]

Trace complete.
```

Figure 19: Route Trace of google.com

3.2.

Figure 20 shows the name ICMP in the upper layer protocol field of the IP packet header (1). The IP header has 20 bytes. The payload of the IP datagram has 92 bytes, for a total of 72 bytes in the payload. To calculate the amount of payload bytes, subtract the IP header size (20 bytes) from the entire length (92 bytes), and the remaining is the payload size in bytes.

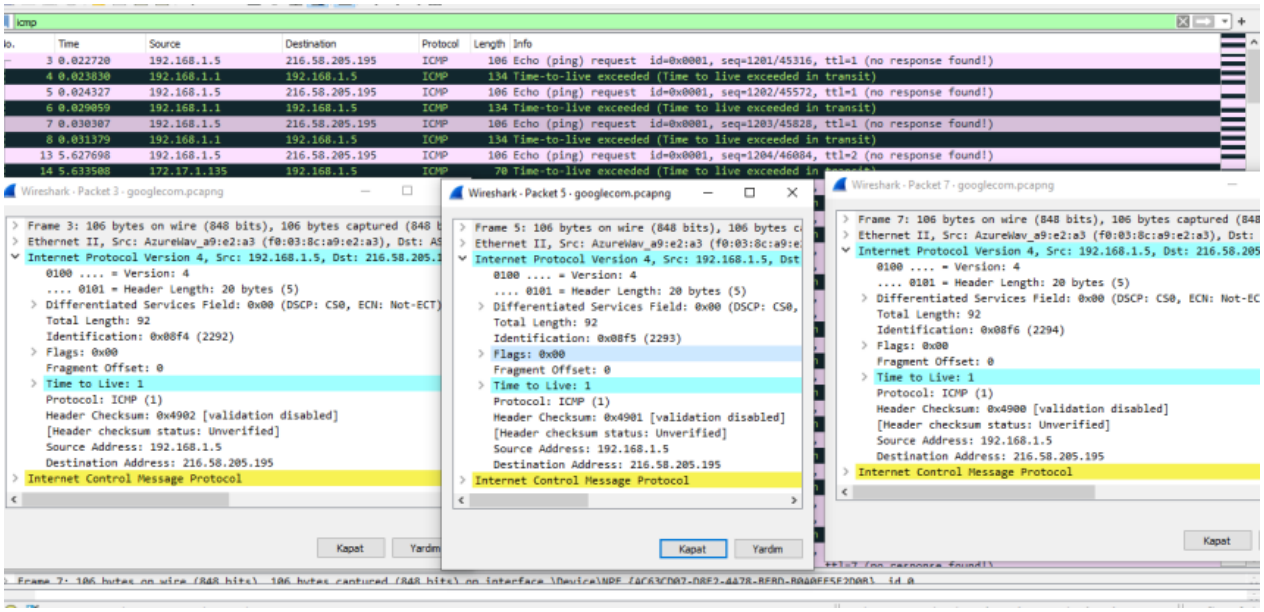


Figure 20: ICMP Echo Request Messages

3.3.

The IP datagram's Time to Live, Identification, and Header checksum fields are continually changing from one to the next. Because each packet's identifier is a unique number, it must always change. As a result, the Header checksum and Time to Live will both alter.

Version (because I'm using IPv4 for all packets), Header Length (because these are ICMP packets), Source IP (because I'm sending from the same source), Destination IP (because I'm sending to the same destination), Differentiated Services (because all packets are ICMP, they use the same Type of Service class), and Upper Layer Protocol must all remain constant (since these are ICMP packets).

3.4.

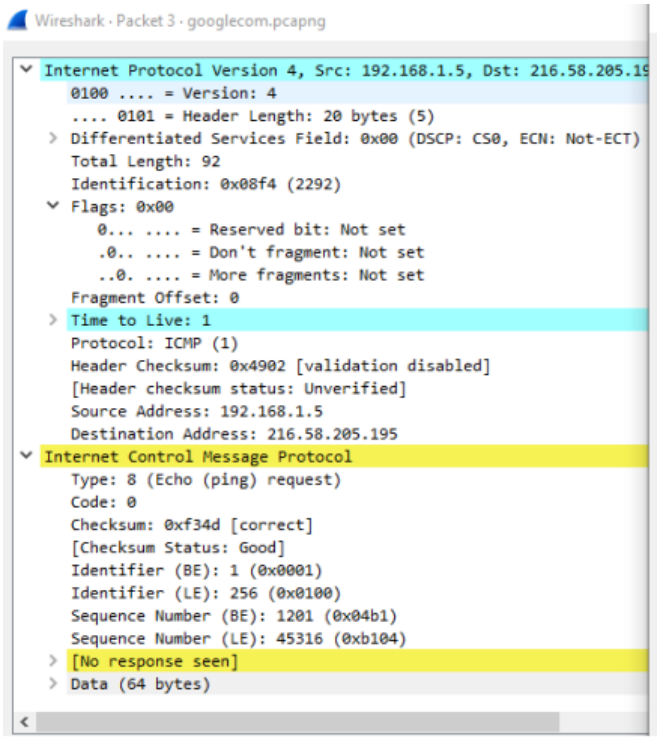
Three packets with the same TTL are sent.

Because trace-route delivers a message three times, the source really sends 3*N packets to the destination. The goal is to capture the source of each ICMP TTL exceeded message in order to give a trail of the path the packet followed to reach its destination. The differences in hop durations in Figure 19 can be attributed to a variety of factors such as network congestion, routing errors, and so on.

3.5.

When using the same router, the TTL will remain constant. Because it is allocated to a unique value, the identification field for every ICMP TTL-exceeded answers will vary. When two or more IP datagrams have the same identification value, it implies that they are fragments of a larger IP datagram, which is not the case here. Header Verification The number of messages sent from the same network varies as well. It is the same time to live. As seen in Figure 20, the remainder is similarly as predicted.

Header Checksum and Identification, as in the case of the same router, were the IP header fields that changed when the source router changed. In this instance, Time to Live is also shifting. Others refuse to change. Figure 21 shows an example of a comparison between two messages arriving from separate routers.



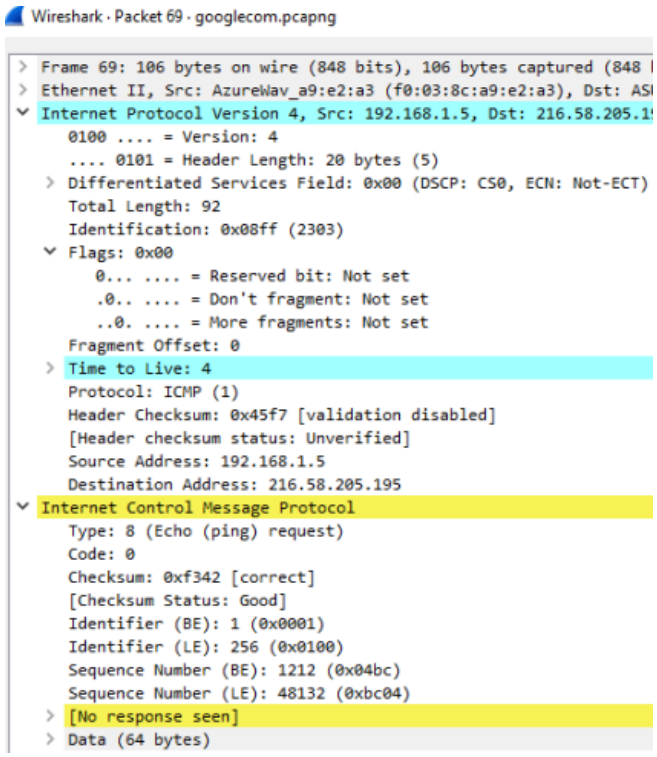


Figure 21: Messages Coming from Two Different Routers

Appendix

Total time spent on report writing: 9 hours