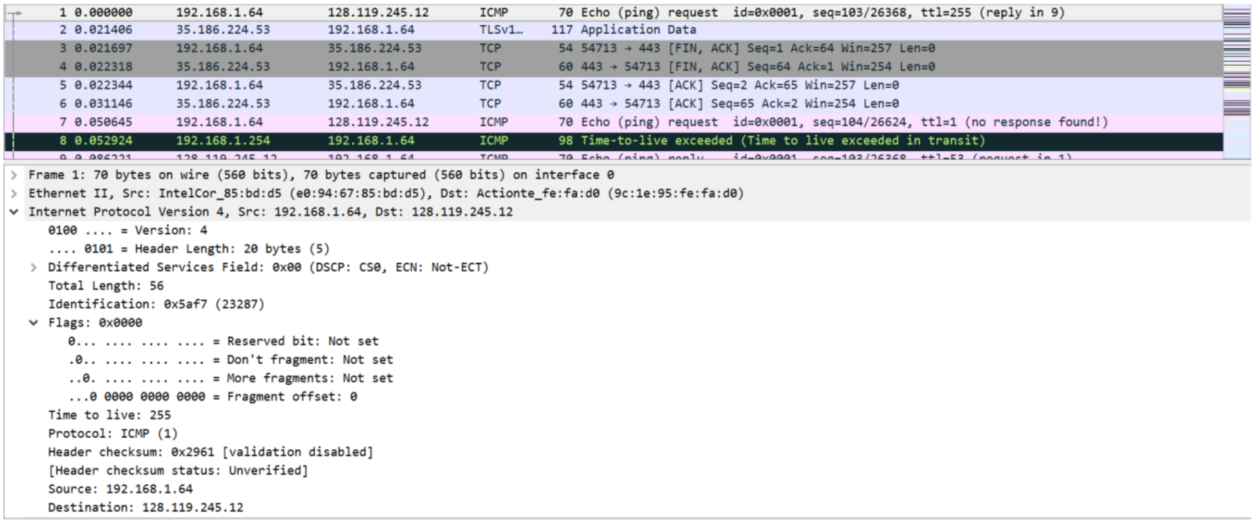
ELEC 331 Assignment 3

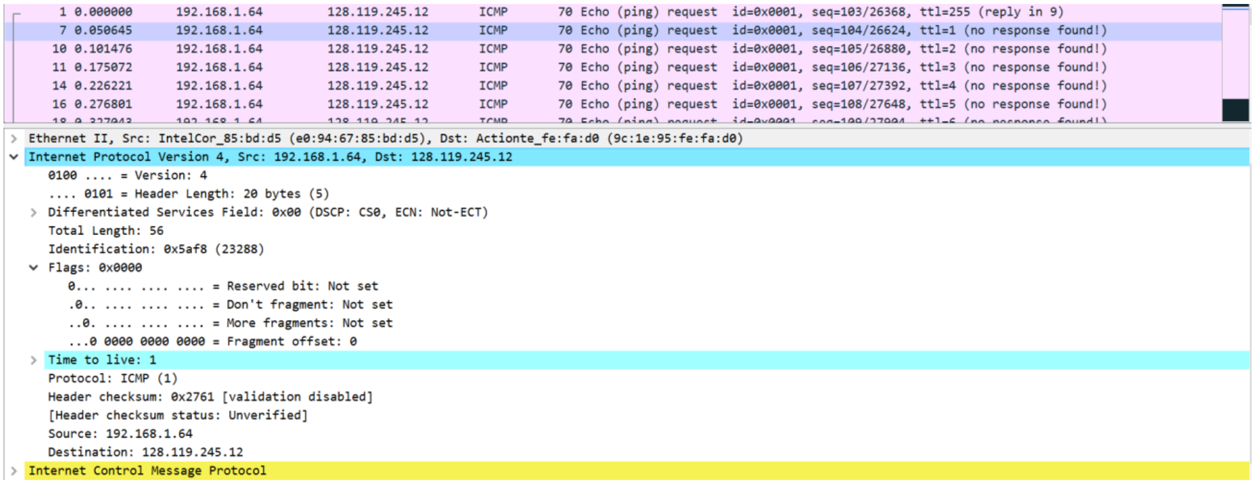
Wireshark IP



```
    1 0.000000   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=103/26368, ttl=255 (reply in 9)
    2 0.021406   35.186.224.53    192.168.1.64     TLSv1…  117 Application Data
    3 0.021697   192.168.1.64     35.186.224.53    TCP      54 54713 → 443 [FIN, ACK] Seq=1 Ack=64 Win=257 Len=0
    4 0.022318   35.186.224.53    192.168.1.64     TCP      60 443 → 54713 [FIN, ACK] Seq=64 Ack=1 Win=254 Len=0
    5 0.022344   192.168.1.64     35.186.224.53    TCP      54 54713 → 443 [ACK] Seq=2 Ack=65 Win=257 Len=0
    6 0.031146   35.186.224.53    192.168.1.64     TCP      60 443 → 54713 [ACK] Seq=65 Ack=2 Win=254 Len=0
    7 0.050645   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=104/26624, ttl=1 (no response found!)
    8 0.052924   192.168.1.254    192.168.1.64     ICMP     98 Time-to-live exceeded (Time to live exceeded in transit)
    9 0.086221   128.119.245.12   192.168.1.64     ICMP     70 Echo (ping) reply    id=0x0001, seq=103/26368, ttl=53 (request in 1)
> Frame 1: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface 0
> Ethernet II, Src: IntelCor_85:bd:d5 (e0:94:67:85:bd:d5), Dst: Actionte_fe:fa:d0 (9c:1e:95:fe:fa:d0)
v Internet Protocol Version 4, Src: 192.168.1.64, Dst: 128.119.245.12
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 56
    Identification: 0x5af7 (23287)
  v Flags: 0x0000
      0... .... .... .... = Reserved bit: Not set
      .0.. .... .... .... = Don't fragment: Not set
      ..0. .... .... .... = More fragments: Not set
      ...0 0000 0000 0000 = Fragment offset: 0
    Time to live: 255
    Protocol: ICMP (1)
    Header checksum: 0x2961 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.64
    Destination: 128.119.245.12
```

Figure #1: First ICMP Echo Request

1. The IP address of my computer is 192.168.1.64
2. The value of the upper layer protocol is ICMP (0x01)
3. The header has 20 bytes as indicated by the Header Length field. The total packet length is 56 bytes as indicated by the Total Length field, leaving 36 bytes for the payload.
4. No. This IP datagram has not been fragmented as indicated by the More Fragments bit.



```
    1 0.000000   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=103/26368, ttl=255 (reply in 9)
    7 0.050645   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=104/26624, ttl=1 (no response found!)
   10 0.101476   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=105/26880, ttl=2 (no response found!)
   11 0.175072   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=106/27136, ttl=3 (no response found!)
   14 0.226221   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=107/27392, ttl=4 (no response found!)
   16 0.276801   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=108/27648, ttl=5 (no response found!)
   18 0.327043   192.168.1.64     128.119.245.12   ICMP     70 Echo (ping) request  id=0x0001, seq=109/27904, ttl=6 (no response found!)
> Ethernet II, Src: IntelCor_85:bd:d5 (e0:94:67:85:bd:d5), Dst: Actionte_fe:fa:d0 (9c:1e:95:fe:fa:d0)
v Internet Protocol Version 4, Src: 192.168.1.64, Dst: 128.119.245.12
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 56
    Identification: 0x5af8 (23288)
  v Flags: 0x0000
      0... .... .... .... = Reserved bit: Not set
      .0.. .... .... .... = Don't fragment: Not set
      ..0. .... .... .... = More fragments: Not set
      ...0 0000 0000 0000 = Fragment offset: 0
  > Time to live: 1
    Protocol: ICMP (1)
    Header checksum: 0x2761 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.64
    Destination: 128.119.245.12
> Internet Control Message Protocol
```

Figure #2: Second ICMP Echo Request

5. The fields that always change are:
   a. ID

b. TTL

c. Header checksum

6.

a. The fields that stay constant are:

i. Version – Same version of IP (IPv4)

ii. Header Length – All packets are ICMP, so header length does not change

iii. Differentiated Services – All packets are ICMP, so same service class

iv. Source and Destination IP – Same host and same destination

v. Upper Layer Protocol – All packets are ICMP packets

b. The fields that must stay constant are:

i. Same as a).

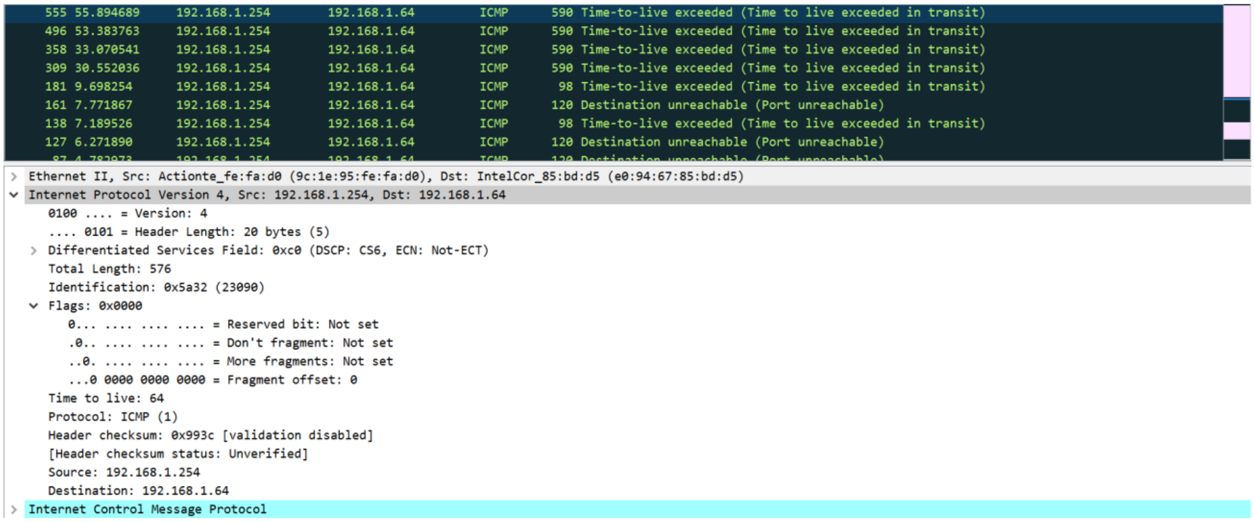
c. The fields that must change are:

i. ID – IP packets must have different ID

ii. TTL – This is incremented at every router

iii. Header checksum – Since TTL changes, the checksum must also change

7. The pattern I observe is that the value of the ID field increments after each ICMP request.



```
    555 55.894689     192.168.1.254        192.168.1.64         ICMP      590 Time-to-live exceeded (Time to live exceeded in transit)
    496 53.383763     192.168.1.254        192.168.1.64         ICMP      590 Time-to-live exceeded (Time to live exceeded in transit)
    358 33.070541     192.168.1.254        192.168.1.64         ICMP      590 Time-to-live exceeded (Time to live exceeded in transit)
    309 30.552036     192.168.1.254        192.168.1.64         ICMP      590 Time-to-live exceeded (Time to live exceeded in transit)
    181 9.698254      192.168.1.254        192.168.1.64         ICMP       98 Time-to-live exceeded (Time to live exceeded in transit)
    161 7.771867      192.168.1.254        192.168.1.64         ICMP      120 Destination unreachable (Port unreachable)
    138 7.189526      192.168.1.254        192.168.1.64         ICMP       98 Time-to-live exceeded (Time to live exceeded in transit)
    127 6.271890      192.168.1.254        192.168.1.64         ICMP      120 Destination unreachable (Port unreachable)
     87 4.782973      192.168.1.254        192.168.1.64         ICMP      120 Destination unreachable (Port unreachable)
> Ethernet II, Src: Actionte_fe:fa:d0 (9c:1e:95:fe:fa:d0), Dst: IntelCor_85:bd:d5 (e0:94:67:85:bd:d5)
v Internet Protocol Version 4, Src: 192.168.1.254, Dst: 192.168.1.64
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
    Total Length: 576
    Identification: 0x5a32 (23090)
  v Flags: 0x0000
      0... .... .... .... = Reserved bit: Not set
      .0.. .... .... .... = Don't fragment: Not set
      ..0. .... .... .... = More fragments: Not set
      ...0 0000 0000 0000 = Fragment offset: 0
    Time to live: 64
    Protocol: ICMP (1)
    Header checksum: 0x993c [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.254
    Destination: 192.168.1.64
> Internet Control Message Protocol
```

Figure #3: First ICMP Echo Response – TTL Expired

8. The value of the ID field is 23090 and the value of the TTL field is 64.

9. The value of the ID field changes as it gets incremented. The value of the TTL field does not change however because this is all for the "first-hop router."

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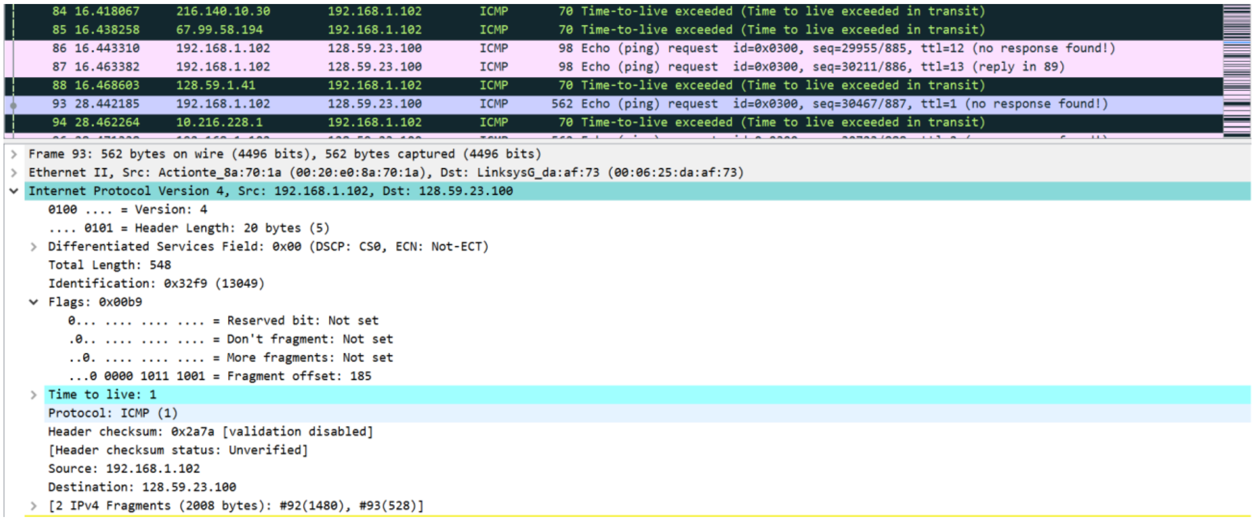
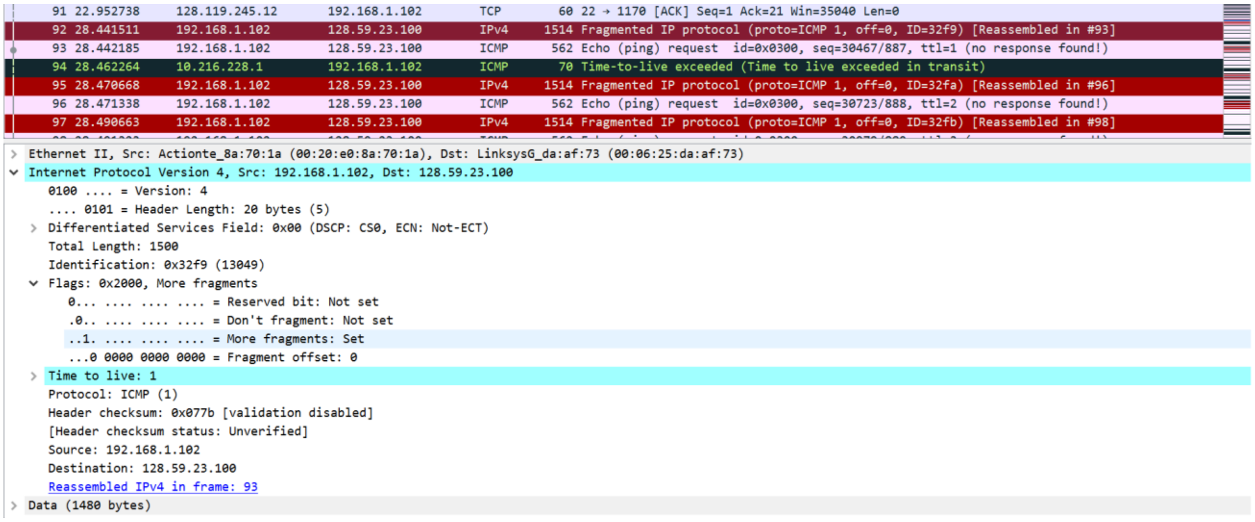


```
  84 16.418067    216.140.10.30     192.168.1.102     ICMP      70 Time-to-live exceeded (Time to live exceeded in transit)
  85 16.438258    67.99.58.194      192.168.1.102     ICMP      70 Time-to-live exceeded (Time to live exceeded in transit)
  86 16.443310    192.168.1.102     128.59.23.100     ICMP      98 Echo (ping) request  id=0x0300, seq=29955/885, ttl=12 (no response found!)
  87 16.463382    192.168.1.102     128.59.23.100     ICMP      98 Echo (ping) request  id=0x0300, seq=30211/886, ttl=13 (reply in 89)
  88 16.468603    128.59.1.41       192.168.1.102     ICMP      70 Time-to-live exceeded (Time to live exceeded in transit)
  93 28.442185    192.168.1.102     128.59.23.100     ICMP     562 Echo (ping) request  id=0x0300, seq=30467/887, ttl=1 (no response found!)
  94 28.462264    10.216.228.1      192.168.1.102     ICMP      70 Time-to-live exceeded (Time to live exceeded in transit)
```

```
> Frame 93: 562 bytes on wire (4496 bits), 562 bytes captured (4496 bits)
> Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
v Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.59.23.100
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 548
    Identification: 0x32f9 (13049)
  v Flags: 0x00b9
      0... .... .... .... = Reserved bit: Not set
      .0.. .... .... .... = Don't fragment: Not set
      ..0. .... .... .... = More fragments: Not set
      ...0 0000 1011 1001 = Fragment offset: 185
  > Time to live: 1
    Protocol: ICMP (1)
    Header checksum: 0x2a7a [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.102
    Destination: 128.59.23.100
  > [2 IPv4 Fragments (2008 bytes): #92(1480), #93(528)]
```

Figure #4: Fragmented ICMP Request

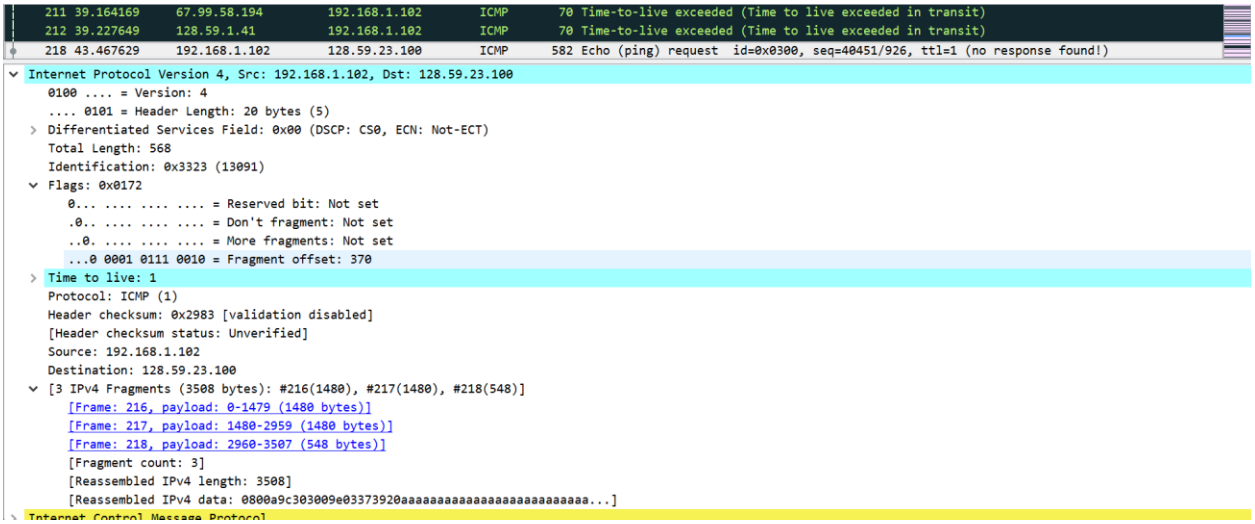


```
  91 22.952738    128.119.245.12    192.168.1.102     TCP       60 22 → 1170 [ACK] Seq=1 Ack=21 Win=35040 Len=0
  92 28.441511    192.168.1.102     128.59.23.100     IPv4    1514 Fragmented IP protocol (proto=ICMP 1, off=0, ID=32f9) [Reassembled in #93]
  93 28.442185    192.168.1.102     128.59.23.100     ICMP     562 Echo (ping) request  id=0x0300, seq=30467/887, ttl=1 (no response found!)
  94 28.462264    10.216.228.1      192.168.1.102     ICMP      70 Time-to-live exceeded (Time to live exceeded in transit)
  95 28.470668    192.168.1.102     128.59.23.100     IPv4    1514 Fragmented IP protocol (proto=ICMP 1, off=0, ID=32fa) [Reassembled in #96]
  96 28.471338    192.168.1.102     128.59.23.100     ICMP     562 Echo (ping) request  id=0x0300, seq=30723/888, ttl=2 (no response found!)
  97 28.490663    192.168.1.102     128.59.23.100     IPv4    1514 Fragmented IP protocol (proto=ICMP 1, off=0, ID=32fb) [Reassembled in #98]
```

```
> Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
v Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.59.23.100
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 1500
    Identification: 0x32f9 (13049)
  v Flags: 0x2000, More fragments
      0... .... .... .... = Reserved bit: Not set
      .0.. .... .... .... = Don't fragment: Not set
      ..1. .... .... .... = More fragments: Set
      ...0 0000 0000 0000 = Fragment offset: 0
  > Time to live: 1
    Protocol: ICMP (1)
    Header checksum: 0x077b [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.102
    Destination: 128.59.23.100
    Reassembled IPv4 in frame: 93
> Data (1480 bytes)
```

Figure #5: First fragment of the Fragmented Datagram (2000 Bytes)

10. I will be using the provided trace for these questions. Here, the packet was fragmented into 2 IPv4 fragments totalling up to 2000 bytes. (Fig 4)
11. The header has the "More fragments" flag set to 1, meaning it has been fragmented. Looking at the fragment offset field, we see that it is 0, meaning that it is the first fragment. (Fig 5)
12. The "More fragments" flag was not set and we see the offset has been correctly set. Not only that, it mentions that the first fragment is #92 (Fig 5) and second fragment is #93 (Fig 4).
13. Between the two fragments, the total length, flags (more fragments and fragment offset), and checksum have changed.



```
211 39.164169    67.99.58.194     192.168.1.102    ICMP     70 Time-to-live exceeded (Time to live exceeded in transit)
212 39.227649    128.59.1.41      192.168.1.102    ICMP     70 Time-to-live exceeded (Time to live exceeded in transit)
218 43.467629    192.168.1.102    128.59.23.100    ICMP    582 Echo (ping) request  id=0x0300, seq=40451/926, ttl=1 (no response found!)
```

```
v Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.59.23.100
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 568
    Identification: 0x3323 (13091)
  v Flags: 0x0172
      0... .... .... .... = Reserved bit: Not set
      .0.. .... .... .... = Don't fragment: Not set
      ..0. .... .... .... = More fragments: Not set
      ...0 0001 0111 0010 = Fragment offset: 370
  > Time to live: 1
    Protocol: ICMP (1)
    Header checksum: 0x2983 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.102
    Destination: 128.59.23.100
  v [3 IPv4 Fragments (3508 bytes): #216(1480), #217(1480), #218(548)]
      [Frame: 216, payload: 0-1479 (1480 bytes)]
      [Frame: 217, payload: 1480-2959 (1480 bytes)]
      [Frame: 218, payload: 2960-3507 (548 bytes)]
      [Fragment count: 3]
      [Reassembled IPv4 length: 3508]
      [Reassembled IPv4 data: 0800a9c303009e03373920aaaaaaaaaaaaaaaaaaaaaaaaa...]
> Internet Control Message Protocol
```

Figure #6: First fragment of the Fragmented Datagram (3500 Bytes)

14. 3 fragments were created.
15. The fields that change among the fragments are:
    a. More fragments
    b. Fragment offset
    c. Checksum
    d. Length (last packet only has 568 while the other have 1500)

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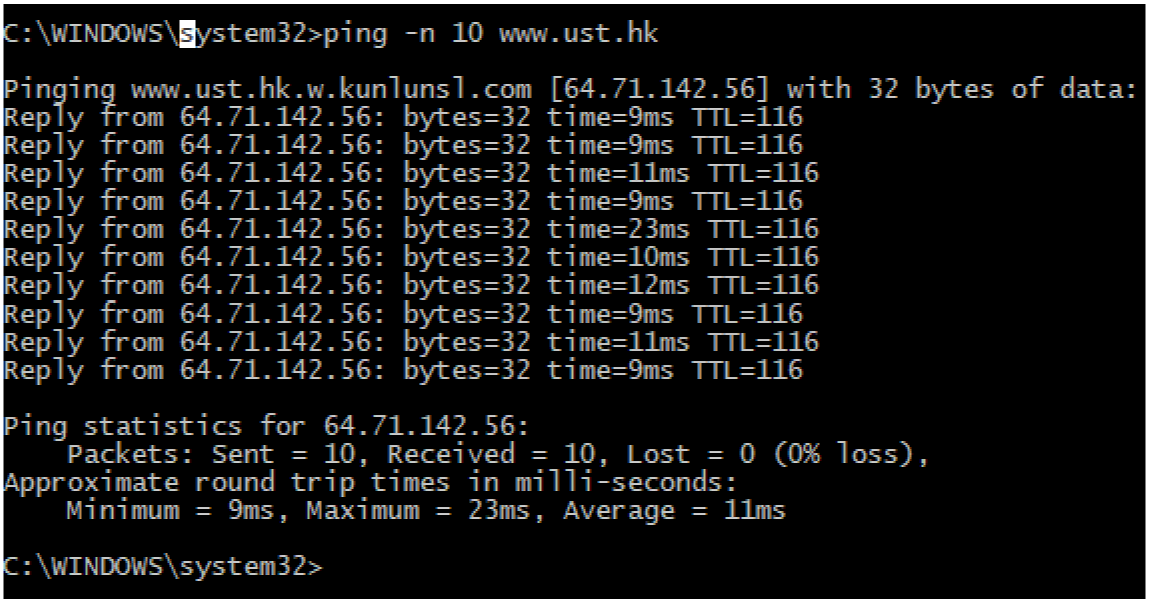
Wireshark ICMP



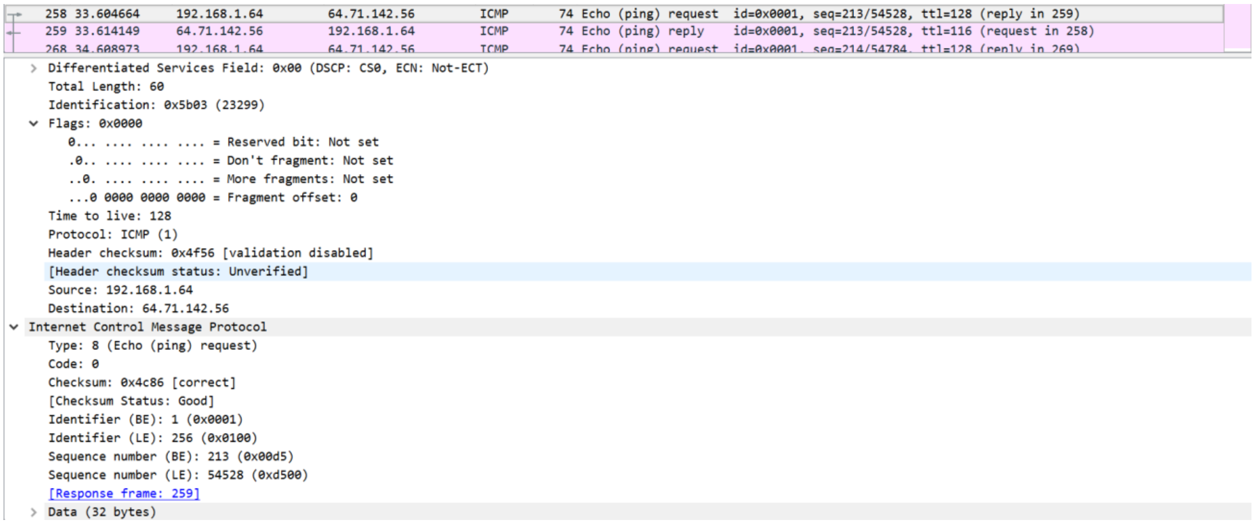
```
C:\WINDOWS\system32>ping -n 10 www.ust.hk

Pinging www.ust.hk.w.kunlunsl.com [64.71.142.56] with 32 bytes of data:
Reply from 64.71.142.56: bytes=32 time=9ms TTL=116
Reply from 64.71.142.56: bytes=32 time=9ms TTL=116
Reply from 64.71.142.56: bytes=32 time=11ms TTL=116
Reply from 64.71.142.56: bytes=32 time=9ms TTL=116
Reply from 64.71.142.56: bytes=32 time=23ms TTL=116
Reply from 64.71.142.56: bytes=32 time=10ms TTL=116
Reply from 64.71.142.56: bytes=32 time=12ms TTL=116
Reply from 64.71.142.56: bytes=32 time=9ms TTL=116
Reply from 64.71.142.56: bytes=32 time=11ms TTL=116
Reply from 64.71.142.56: bytes=32 time=9ms TTL=116

Ping statistics for 64.71.142.56:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 23ms, Average = 11ms

C:\WINDOWS\system32>
```

Figure #7: Ping results



```
  258 33.604664    192.168.1.64     64.71.142.56     ICMP     74 Echo (ping) request  id=0x0001, seq=213/54528, ttl=128 (reply in 259)
  259 33.614149    64.71.142.56     192.168.1.64     ICMP     74 Echo (ping) reply    id=0x0001, seq=213/54528, ttl=116 (request in 258)
  268 34.608973    192.168.1.64     64.71.142.56     ICMP     74 Echo (ping) request  id=0x0001, seq=214/54784, ttl=128 (reply in 269)
   > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
     Total Length: 60
     Identification: 0x5b03 (23299)
   v Flags: 0x0000
        0... .... .... .... = Reserved bit: Not set
        .0.. .... .... .... = Don't fragment: Not set
        ..0. .... .... .... = More fragments: Not set
        ...0 0000 0000 0000 = Fragment offset: 0
     Time to live: 128
     Protocol: ICMP (1)
     Header checksum: 0x4f56 [validation disabled]
     [Header checksum status: Unverified]
     Source: 192.168.1.64
     Destination: 64.71.142.56
 v Internet Control Message Protocol
     Type: 8 (Echo (ping) request)
     Code: 0
     Checksum: 0x4c86 [correct]
     [Checksum Status: Good]
     Identifier (BE): 1 (0x0001)
     Identifier (LE): 256 (0x0100)
     Sequence number (BE): 213 (0x00d5)
     Sequence number (LE): 54528 (0xd500)
     [Response frame: 259]
   > Data (32 bytes)
```

Figure #8: ICMP PING request

1. As before, the IP address of my host is 192.168.1.64 and the IP address of the destination host is 64.71.142.56.
2. An ICMP packet does not have source and destination ports because ICMP is part of the network layer with IP instead of the transport layer with TCP / UDP. As it is an integral part of the network layer, it was designed to communicate network layer information between hosts and routers and not between application layer processes.

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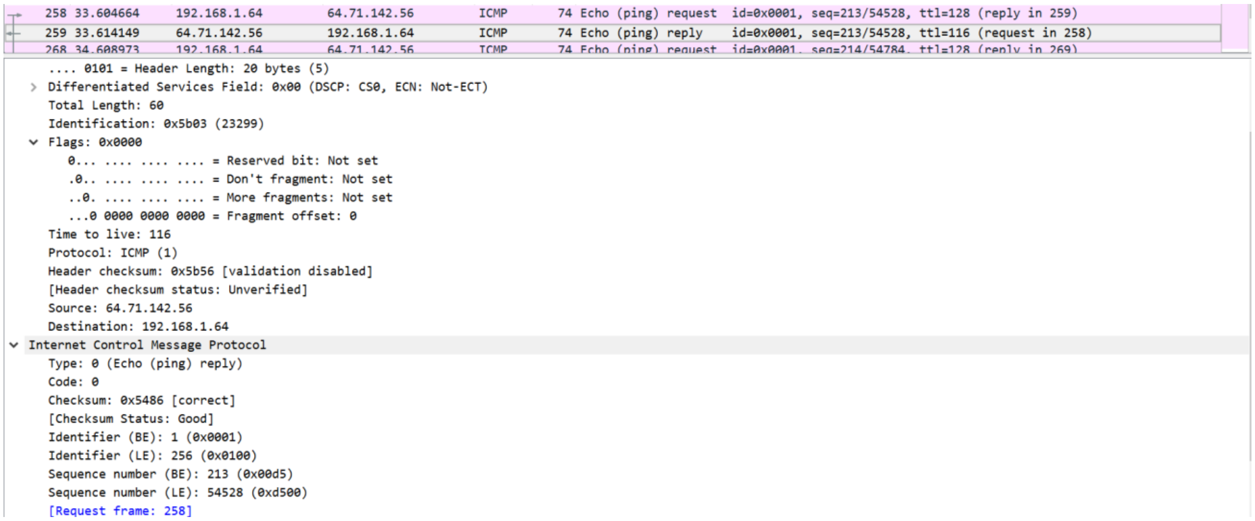
3. Referring to Fig 8, we see that the Type is 8 for Echo (ping) request and Code is 0. It has a few other fields, namely checksum, identifier, sequence number, and data fields.

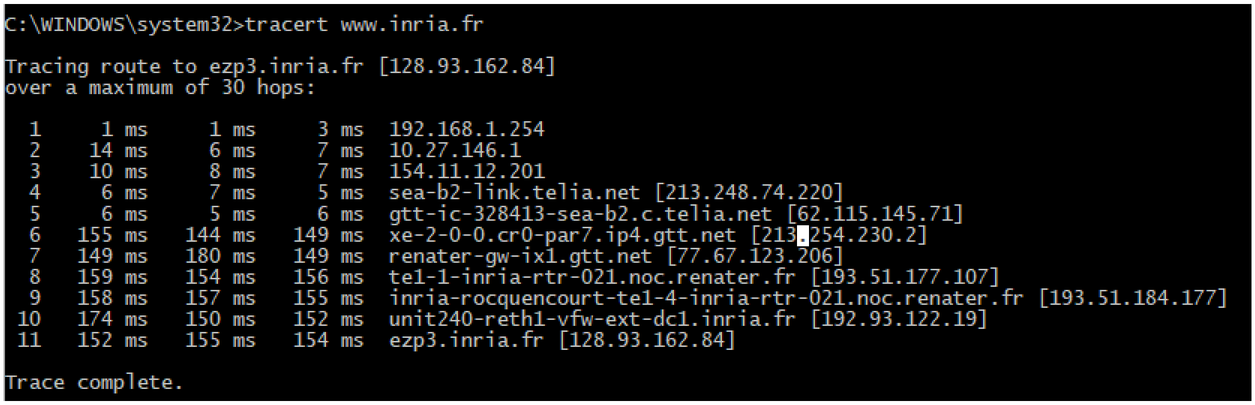
   The checksum, sequence number, and identifier fields are all 2 bytes each.



```
258 33.604664   192.168.1.64    64.71.142.56    ICMP   74 Echo (ping) request  id=0x0001, seq=213/54528, ttl=128 (reply in 259)
259 33.614149   64.71.142.56    192.168.1.64    ICMP   74 Echo (ping) reply    id=0x0001, seq=213/54528, ttl=116 (request in 258)
268 34.608973   192.168.1.64    64.71.142.56    ICMP   74 Echo (ping) request  id=0x0001, seq=214/54784, ttl=128 (reply in 269)

    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 60
    Identification: 0x5b03 (23299)
  v Flags: 0x0000
      0... .... .... .... = Reserved bit: Not set
      .0.. .... .... .... = Don't fragment: Not set
      ..0. .... .... .... = More fragments: Not set
      ...0 0000 0000 0000 = Fragment offset: 0
    Time to live: 116
    Protocol: ICMP (1)
    Header checksum: 0x5b56 [validation disabled]
    [Header checksum status: Unverified]
    Source: 64.71.142.56
    Destination: 192.168.1.64
v Internet Control Message Protocol
    Type: 0 (Echo (ping) reply)
    Code: 0
    Checksum: 0x5486 [correct]
    [Checksum Status: Good]
    Identifier (BE): 1 (0x0001)
    Identifier (LE): 256 (0x0100)
    Sequence number (BE): 213 (0x00d5)
    Sequence number (LE): 54528 (0xd500)
    [Request frame: 258]
```

Figure #9: ICMP PING reply

4. For the reply, Type is 0 for Echo (ping) reply and Code is 0. It has the same fields as the request above, namely checksum, identifier, sequence number, and data. In addition, the checksum, sequence number, and identifier fields are all 2 bytes each.

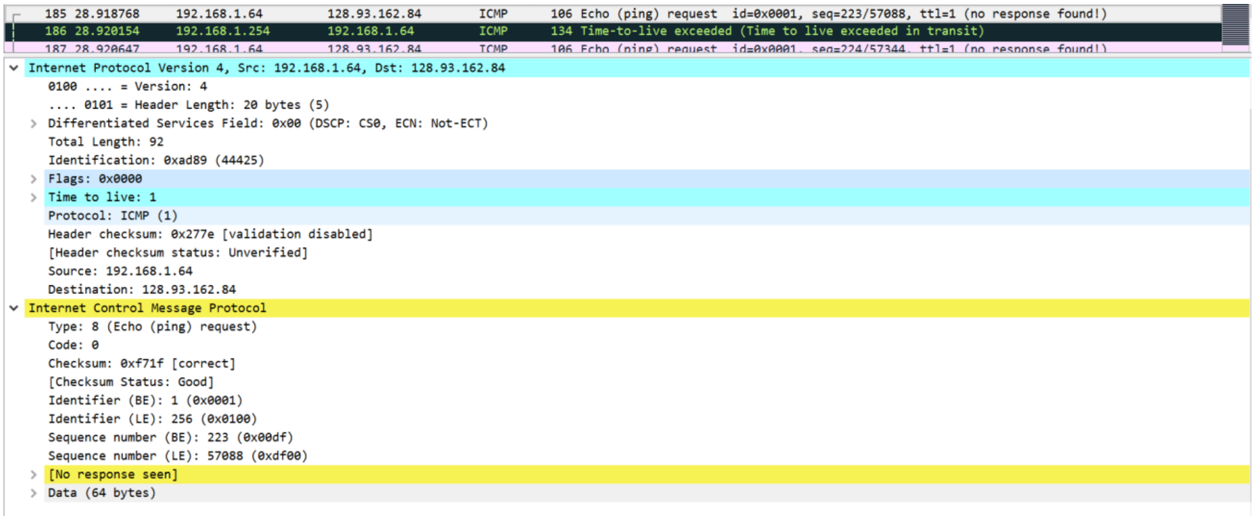


```
C:\WINDOWS\system32>tracert www.inria.fr

Tracing route to ezp3.inria.fr [128.93.162.84]
over a maximum of 30 hops:

  1     1 ms     1 ms     3 ms  192.168.1.254
  2    14 ms     6 ms     7 ms  10.27.146.1
  3    10 ms     8 ms     7 ms  154.11.12.201
  4     6 ms     7 ms     5 ms  sea-b2-link.telia.net [213.248.74.220]
  5     6 ms     5 ms     6 ms  gtt-ic-328413-sea-b2.c.telia.net [62.115.145.71]
  6   155 ms   144 ms   149 ms  xe-2-0-0.cr0-par7.ip4.gtt.net [213.254.230.2]
  7   149 ms   180 ms   149 ms  renater-gw-ix1.gtt.net [77.67.123.206]
  8   159 ms   154 ms   156 ms  te1-1-inria-rtr-021.noc.renater.fr [193.51.177.107]
  9   158 ms   157 ms   155 ms  inria-rocquencourt-te1-4-inria-rtr-021.noc.renater.fr [193.51.184.177]
 10   174 ms   150 ms   152 ms  unit240-reth1-vfw-ext-dc1.inria.fr [192.93.122.19]
 11   152 ms   155 ms   154 ms  ezp3.inria.fr [128.93.162.84]

Trace complete.
```

Figure #10: Tracert results

5. As before, the IP address of my host is 192.168.1.64 and the IP address of the destination host is 128.93.162.84.

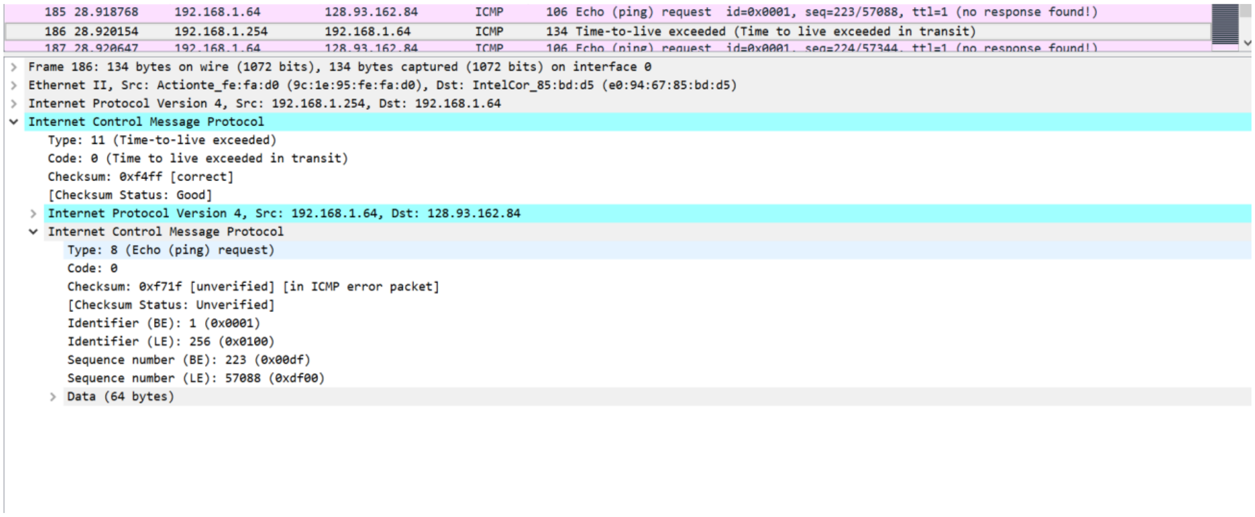
6. No, if ICMP sent UDP packets instead, the protocol field in the IP header should be 0x11 for UDP (17).



```
  185 28.918768     192.168.1.64        128.93.162.84       ICMP      106 Echo (ping) request  id=0x0001, seq=223/57088, ttl=1 (no response found!)
  186 28.920154     192.168.1.254       192.168.1.64        ICMP      134 Time-to-live exceeded (Time to live exceeded in transit)
  187 28.920647     192.168.1.64        128.93.162.84       ICMP      106 Echo (ping) request  id=0x0001, seq=224/57344, ttl=1 (no response found!)
v Internet Protocol Version 4, Src: 192.168.1.64, Dst: 128.93.162.84
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 92
    Identification: 0xad89 (44425)
  > Flags: 0x0000
  > Time to live: 1
    Protocol: ICMP (1)
    Header checksum: 0x277e [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.64
    Destination: 128.93.162.84
v Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0xf71f [correct]
    [Checksum Status: Good]
    Identifier (BE): 1 (0x0001)
    Identifier (LE): 256 (0x0100)
    Sequence number (BE): 223 (0x00df)
    Sequence number (LE): 57088 (0xdf00)
  > [No response seen]
  > Data (64 bytes)
```

Figure #11: Tracert Request

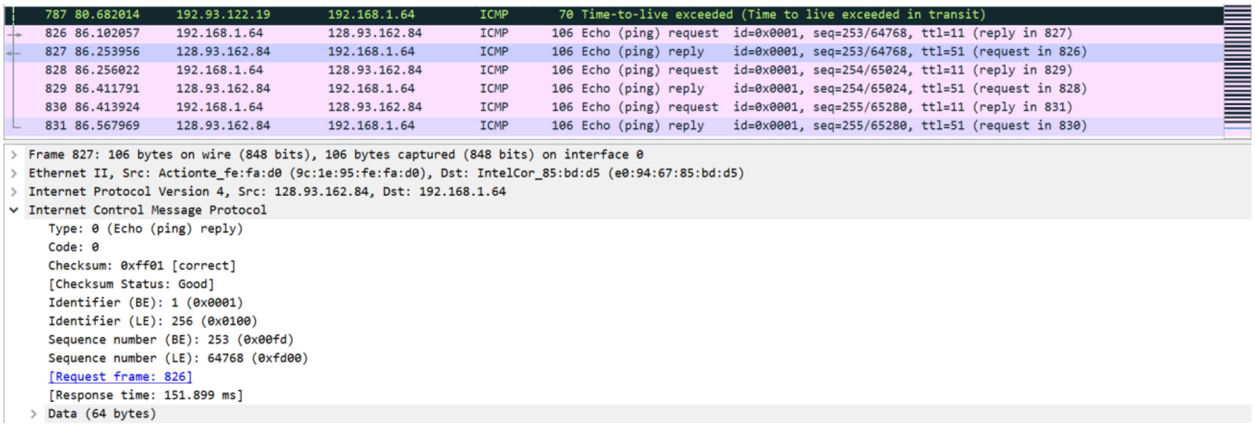
7. The ICMP echo packet seems to have the same fields as the ping query packets from above.



```
  185 28.918768     192.168.1.64        128.93.162.84       ICMP      106 Echo (ping) request  id=0x0001, seq=223/57088, ttl=1 (no response found!)
  186 28.920154     192.168.1.254       192.168.1.64        ICMP      134 Time-to-live exceeded (Time to live exceeded in transit)
  187 28.920647     192.168.1.64        128.93.162.84       ICMP      106 Echo (ping) request  id=0x0001, seq=224/57344, ttl=1 (no response found!)
> Frame 186: 134 bytes on wire (1072 bits), 134 bytes captured (1072 bits) on interface 0
> Ethernet II, Src: Actionte_fe:fa:d0 (9c:1e:95:fe:fa:d0), Dst: IntelCor_85:bd:d5 (e0:94:67:85:bd:d5)
> Internet Protocol Version 4, Src: 192.168.1.254, Dst: 192.168.1.64
v Internet Control Message Protocol
    Type: 11 (Time-to-live exceeded)
    Code: 0 (Time to live exceeded in transit)
    Checksum: 0xf4ff [correct]
    [Checksum Status: Good]
  > Internet Protocol Version 4, Src: 192.168.1.64, Dst: 128.93.162.84
  v Internet Control Message Protocol
      Type: 8 (Echo (ping) request)
      Code: 0
      Checksum: 0xf71f [unverified] [in ICMP error packet]
      [Checksum Status: Unverified]
      Identifier (BE): 1 (0x0001)
      Identifier (LE): 256 (0x0100)
      Sequence number (BE): 223 (0x00df)
      Sequence number (LE): 57088 (0xdf00)
    > Data (64 bytes)
```

Figure #12: Tracert Error (TTL expired)

8. There are a few extra fields in the ICMP error packet – it includes the IP header and the first 8 bytes of the ICMP request the error packet corresponds to.



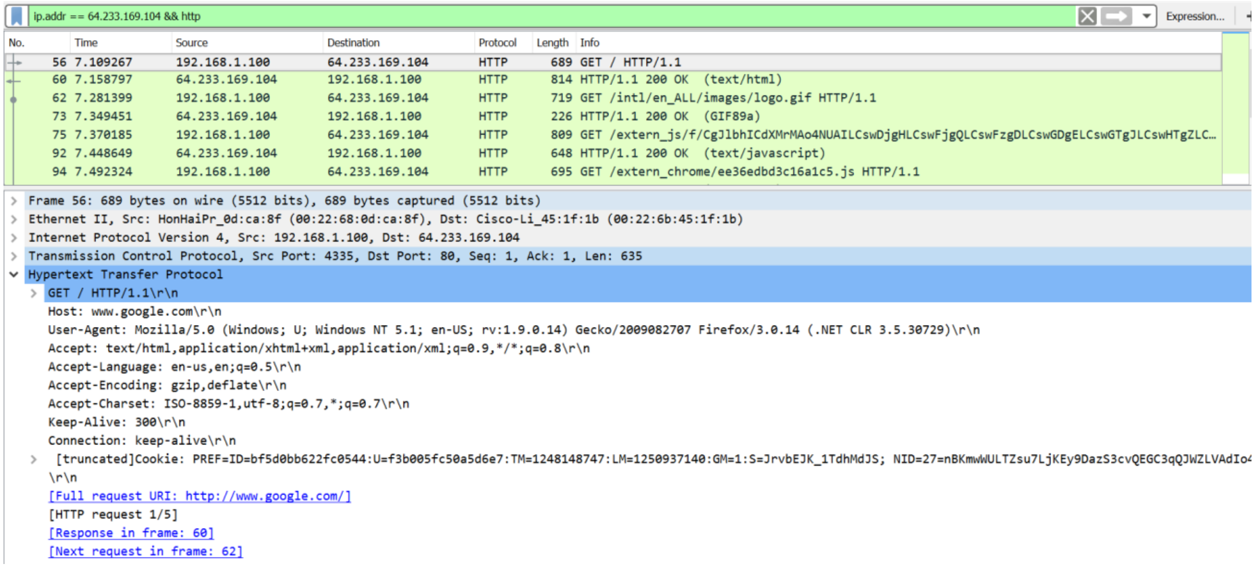
```
   787 80.682014    192.93.122.19     192.168.1.64      ICMP      70 Time-to-live exceeded (Time to live exceeded in transit)
   826 86.102057    192.168.1.64      128.93.162.84     ICMP     106 Echo (ping) request  id=0x0001, seq=253/64768, ttl=11 (reply in 827)
   827 86.253956    128.93.162.84     192.168.1.64      ICMP     106 Echo (ping) reply    id=0x0001, seq=253/64768, ttl=51 (request in 826)
   828 86.256022    192.168.1.64      128.93.162.84     ICMP     106 Echo (ping) request  id=0x0001, seq=254/65024, ttl=11 (reply in 829)
   829 86.411791    128.93.162.84     192.168.1.64      ICMP     106 Echo (ping) reply    id=0x0001, seq=254/65024, ttl=51 (request in 828)
   830 86.413924    192.168.1.64      128.93.162.84     ICMP     106 Echo (ping) request  id=0x0001, seq=255/65280, ttl=11 (reply in 831)
   831 86.567969    128.93.162.84     192.168.1.64      ICMP     106 Echo (ping) reply    id=0x0001, seq=255/65280, ttl=51 (request in 830)

> Frame 827: 106 bytes on wire (848 bits), 106 bytes captured (848 bits) on interface 0
> Ethernet II, Src: Actionte_fe:fa:d0 (9c:1e:95:fe:fa:d0), Dst: IntelCor_85:bd:d5 (e0:94:67:85:bd:d5)
> Internet Protocol Version 4, Src: 128.93.162.84, Dst: 192.168.1.64
v Internet Control Message Protocol
    Type: 0 (Echo (ping) reply)
    Code: 0
    Checksum: 0xff01 [correct]
    [Checksum Status: Good]
    Identifier (BE): 1 (0x0001)
    Identifier (LE): 256 (0x0100)
    Sequence number (BE): 253 (0x00fd)
    Sequence number (LE): 64768 (0xfd00)
    [Request frame: 826]
    [Response time: 151.899 ms]
  > Data (64 bytes)
```

Figure #13: Last three ICMP packets

9. The last three ICMP packets are different as they have Type 0 for Echo (ping) reply instead of 11 for TTL expiration. They are different from the ICMP error packets because these datagrams have reached the destination before the TTL expired.
10. Yes. Referring to Fig 10, we see that between steps 6 and 7, there is a sudden increase in RTT. Based on the router name, I would assume that par7 is referring to Paris as the website is a French website (.fr).

ELEC 331 Assignment 3

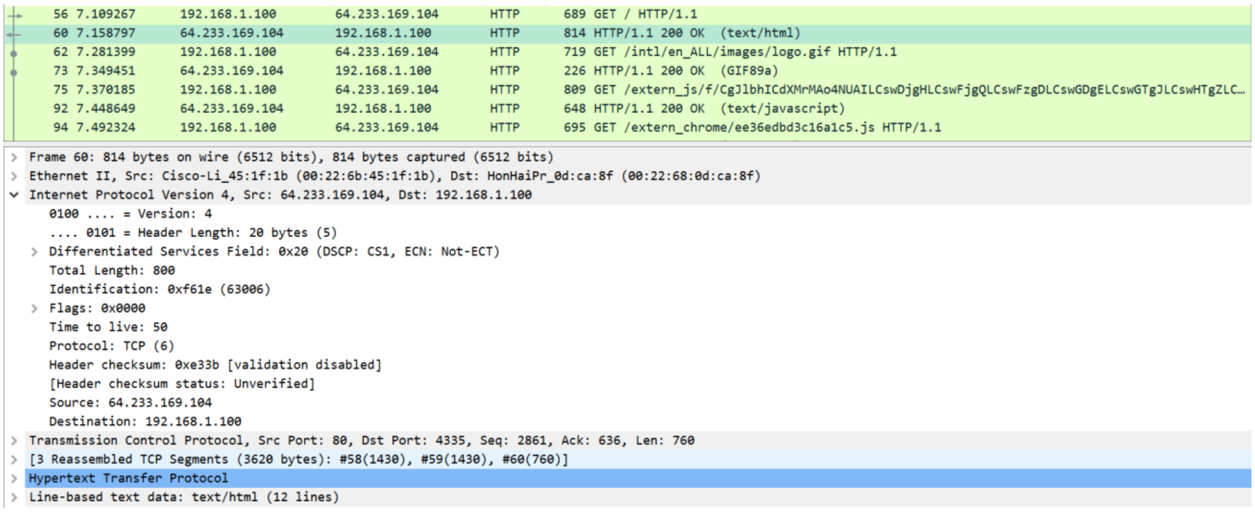
Wireshark NAT



```
ip.addr == 64.233.169.104 && http

No.    Time       Source            Destination       Protocol  Length  Info
   56  7.109267   192.168.1.100     64.233.169.104    HTTP      689 GET / HTTP/1.1
   60  7.158797   64.233.169.104    192.168.1.100     HTTP      814 HTTP/1.1 200 OK  (text/html)
   62  7.281399   192.168.1.100     64.233.169.104    HTTP      719 GET /intl/en_ALL/images/logo.gif HTTP/1.1
   73  7.349451   64.233.169.104    192.168.1.100     HTTP      226 HTTP/1.1 200 OK  (GIF89a)
   75  7.370185   192.168.1.100     64.233.169.104    HTTP      809 GET /extern_js/f/CgJlbhICdXMrMAo4NUAILCswDjgHLCswFjgQLCswFzgDLCswGDgELCswGTgJLCswHTgZLC…
   92  7.448649   64.233.169.104    192.168.1.100     HTTP      648 HTTP/1.1 200 OK  (text/javascript)
   94  7.492324   192.168.1.100     64.233.169.104    HTTP      695 GET /extern_chrome/ee36edbd3c16a1c5.js HTTP/1.1

> Frame 56: 689 bytes on wire (5512 bits), 689 bytes captured (5512 bits)
> Ethernet II, Src: HonHaiPr_0d:ca:8f (00:22:68:0d:ca:8f), Dst: Cisco-Li_45:1f:1b (00:22:6b:45:1f:1b)
> Internet Protocol Version 4, Src: 192.168.1.100, Dst: 64.233.169.104
> Transmission Control Protocol, Src Port: 4335, Dst Port: 80, Seq: 1, Ack: 1, Len: 635
v Hypertext Transfer Protocol
  > GET / HTTP/1.1\r\n
    Host: www.google.com\r\n
    User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; en-US; rv:1.9.0.14) Gecko/2009082707 Firefox/3.0.14 (.NET CLR 3.5.30729)\r\n
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8\r\n
    Accept-Language: en-us,en;q=0.5\r\n
    Accept-Encoding: gzip,deflate\r\n
    Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7\r\n
    Keep-Alive: 300\r\n
    Connection: keep-alive\r\n
  >  [truncated]Cookie: PREF=ID=bf5d0bb622fc0544:U=f3b005fc50a5d6e7:TM=1248148747:LM=1250937140:GM=1:S=JrvbEJK_1TdhMdJS; NID=27=nBKmwWULTZsu7LjKEy9DazS3cvQEGC3qQJWZLVAdIo4
    \r\n
    [Full request URI: http://www.google.com/]
    [HTTP request 1/5]
    [Response in frame: 60]
    [Next request in frame: 62]
```

Figure #14: HTTP Request and Filter

1. The IP address of the client is 192.168.1.100
2. Filtering above (Fig 14)
3. Source: 192.168.1.100, 4335 and Destination: 64.233.169.104, 80 (A.B.C.D, Port Number)

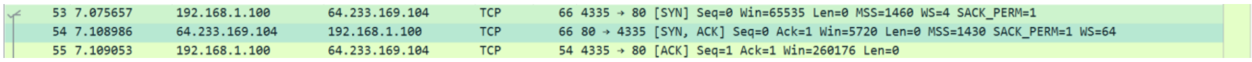


```
   56  7.109267   192.168.1.100     64.233.169.104    HTTP      689 GET / HTTP/1.1
   60  7.158797   64.233.169.104    192.168.1.100     HTTP      814 HTTP/1.1 200 OK  (text/html)
   62  7.281399   192.168.1.100     64.233.169.104    HTTP      719 GET /intl/en_ALL/images/logo.gif HTTP/1.1
   73  7.349451   64.233.169.104    192.168.1.100     HTTP      226 HTTP/1.1 200 OK  (GIF89a)
   75  7.370185   192.168.1.100     64.233.169.104    HTTP      809 GET /extern_js/f/CgJlbhICdXMrMAo4NUAILCswDjgHLCswFjgQLCswFzgDLCswGDgELCswGTgJLCswHTgZLC…
   92  7.448649   64.233.169.104    192.168.1.100     HTTP      648 HTTP/1.1 200 OK  (text/javascript)
   94  7.492324   192.168.1.100     64.233.169.104    HTTP      695 GET /extern_chrome/ee36edbd3c16a1c5.js HTTP/1.1

> Frame 60: 814 bytes on wire (6512 bits), 814 bytes captured (6512 bits)
> Ethernet II, Src: Cisco-Li_45:1f:1b (00:22:6b:45:1f:1b), Dst: HonHaiPr_0d:ca:8f (00:22:68:0d:ca:8f)
v Internet Protocol Version 4, Src: 64.233.169.104, Dst: 192.168.1.100
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x20 (DSCP: CS1, ECN: Not-ECT)
    Total Length: 800
    Identification: 0xf61e (63006)
  > Flags: 0x0000
    Time to live: 50
    Protocol: TCP (6)
    Header checksum: 0xe33b [validation disabled]
    [Header checksum status: Unverified]
    Source: 64.233.169.104
    Destination: 192.168.1.100
> Transmission Control Protocol, Src Port: 80, Dst Port: 4335, Seq: 2861, Ack: 636, Len: 760
> [3 Reassembled TCP Segments (3620 bytes): #58(1430), #59(1430), #60(760)]
> Hypertext Transfer Protocol
> Line-based text data: text/html (12 lines)
```

Figure #15: HTTP 200 Response

4. The 200 OK HTTP message was received at time t = 7.158797.
   Source: 64.233.169.104, 80 and Destination: 192.168.1.100, 4335 -> reverse of 3.

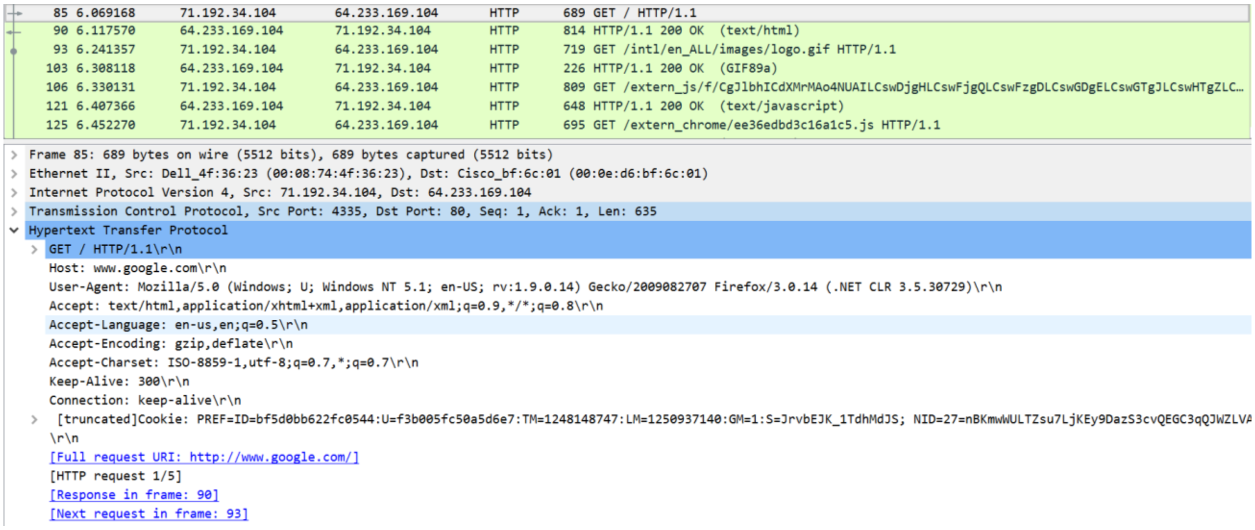
ELEC 331 Assignment 3



```
53 7.075657   192.168.1.100    64.233.169.104   TCP   66 4335 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=4 SACK_PERM=1
54 7.108986   64.233.169.104   192.168.1.100    TCP   66 80 → 4335 [SYN, ACK] Seq=0 Ack=1 Win=5720 Len=0 MSS=1430 SACK_PERM=1 WS=64
55 7.109053   192.168.1.100    64.233.169.104   TCP   54 4335 → 80 [ACK] Seq=1 Ack=1 Win=260176 Len=0
```

Figure #16: TCP SYN/ACK segments

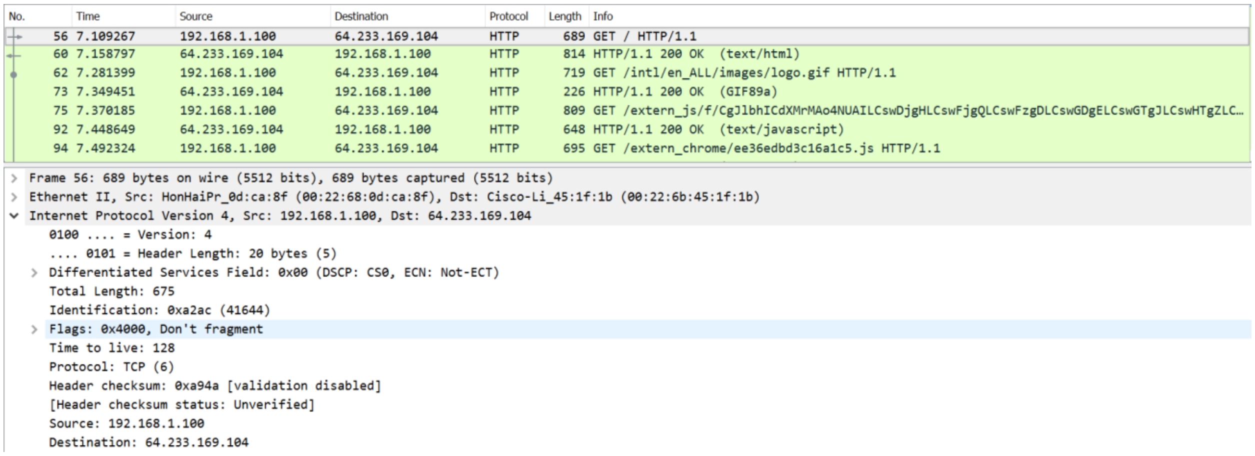
5. The TCP SYN segment was sent at t = 7.075657. The TCP ACK was received at t = 7.108986.
   a. TCP SYN segment:
      i. Source: 192.168.1.100, 4335 and Destination: 64.233.169.104, 80
   b. TCP ACK response:
      i. Source: 64.233.169.104, 80 and Destination: 192.168.1.100, 4335



```
 85 6.069168   71.192.34.104    64.233.169.104   HTTP   689 GET / HTTP/1.1
 90 6.117570   64.233.169.104   71.192.34.104    HTTP   814 HTTP/1.1 200 OK  (text/html)
 93 6.241357   71.192.34.104    64.233.169.104   HTTP   719 GET /intl/en_ALL/images/logo.gif HTTP/1.1
103 6.308118   64.233.169.104   71.192.34.104    HTTP   226 HTTP/1.1 200 OK  (GIF89a)
106 6.330131   71.192.34.104    64.233.169.104   HTTP   809 GET /extern_js/f/CgJlbhICdXMrMAo4NUAILCswDjgHLCswFjgQLCswFzgDLCswGDgELCswGTgJLCswHTgZLC…
121 6.407366   64.233.169.104   71.192.34.104    HTTP   648 HTTP/1.1 200 OK  (text/javascript)
125 6.452270   71.192.34.104    64.233.169.104   HTTP   695 GET /extern_chrome/ee36edbd3c16a1c5.js HTTP/1.1

> Frame 85: 689 bytes on wire (5512 bits), 689 bytes captured (5512 bits)
> Ethernet II, Src: Dell_4f:36:23 (00:08:74:4f:36:23), Dst: Cisco_bf:6c:01 (00:0e:d6:bf:6c:01)
> Internet Protocol Version 4, Src: 71.192.34.104, Dst: 64.233.169.104
> Transmission Control Protocol, Src Port: 4335, Dst Port: 80, Seq: 1, Ack: 1, Len: 635
v Hypertext Transfer Protocol
  > GET / HTTP/1.1\r\n
    Host: www.google.com\r\n
    User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; en-US; rv:1.9.0.14) Gecko/2009082707 Firefox/3.0.14 (.NET CLR 3.5.30729)\r\n
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8\r\n
    Accept-Language: en-us,en;q=0.5\r\n
    Accept-Encoding: gzip,deflate\r\n
    Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7\r\n
    Keep-Alive: 300\r\n
    Connection: keep-alive\r\n
  >  [truncated]Cookie: PREF=ID=bf5d0bb622fc0544:U=f3b005fc50a5d6e7:TM=1248148747:LM=1250937140:GM=1:S=JrvbEJK_1TdhMdJS; NID=27=nBKmwWULTZsu7LjKEy9DazS3cvQEGC3qQJWZLVA
    \r\n
    [Full request URI: http://www.google.com/]
    [HTTP request 1/5]
    [Response in frame: 90]
    [Next request in frame: 93]
```

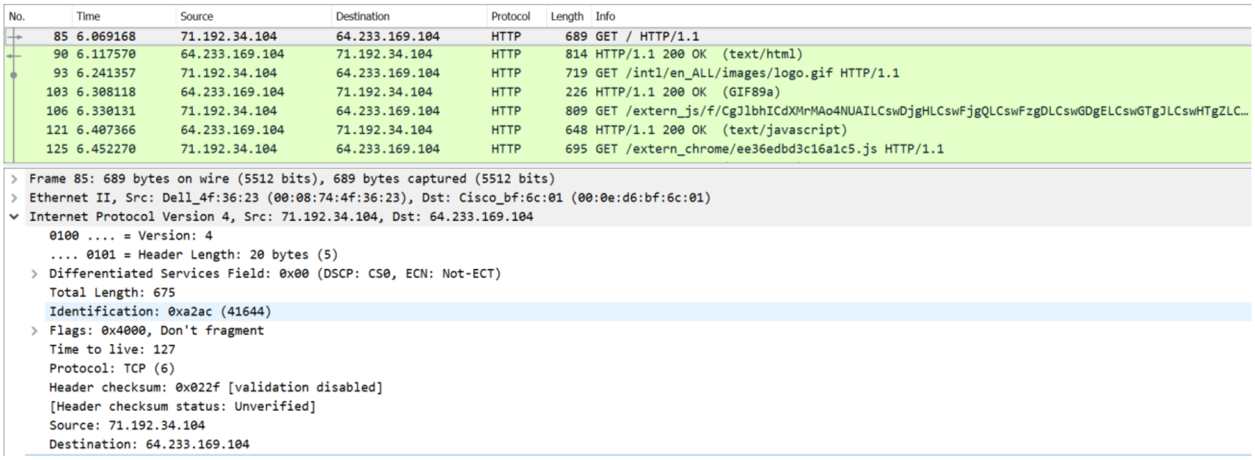
Figure #17: NAT ISP Side of the GET request

6. The request appears on the ISP side at t = 6.069168. For this request, the destination IP and Port and source Port are the same, only the source IP has changed.
   a. Source: 71.192.34.104, 4335 and Destination: 64.233.169.104, 80



```
No.    Time         Source           Destination      Protocol  Length  Info
   56 7.109267     192.168.1.100    64.233.169.104   HTTP        689 GET / HTTP/1.1
   60 7.158797     64.233.169.104   192.168.1.100    HTTP        814 HTTP/1.1 200 OK  (text/html)
   62 7.281399     192.168.1.100    64.233.169.104   HTTP        719 GET /intl/en_ALL/images/logo.gif HTTP/1.1
   73 7.349451     64.233.169.104   192.168.1.100    HTTP        226 HTTP/1.1 200 OK  (GIF89a)
   75 7.370185     192.168.1.100    64.233.169.104   HTTP        809 GET /extern_js/f/CgJlbhICdXMrMAo4NUAILCswDjgHLCswFjgQLCswFzgDLCswGDgELCswGTgJLCswHTgZLC…
   92 7.448649     64.233.169.104   192.168.1.100    HTTP        648 HTTP/1.1 200 OK  (text/javascript)
   94 7.492324     192.168.1.100    64.233.169.104   HTTP        695 GET /extern_chrome/ee36edbd3c16a1c5.js HTTP/1.1

> Frame 56: 689 bytes on wire (5512 bits), 689 bytes captured (5512 bits)
> Ethernet II, Src: HonHaiPr_0d:ca:8f (00:22:68:0d:ca:8f), Dst: Cisco-Li_45:1f:1b (00:22:6b:45:1f:1b)
v Internet Protocol Version 4, Src: 192.168.1.100, Dst: 64.233.169.104
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 675
    Identification: 0xa2ac (41644)
  > Flags: 0x4000, Don't fragment
    Time to live: 128
    Protocol: TCP (6)
    Header checksum: 0xa94a [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.100
    Destination: 64.233.169.104
```

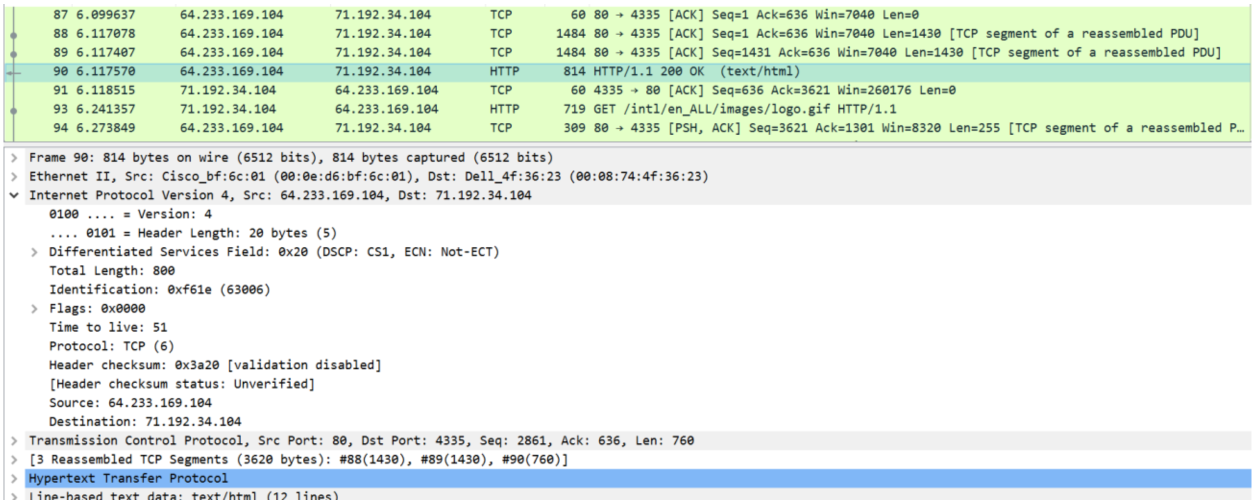
Figure #18: NAT Home GET Request IP Datagram



```
No.    Time         Source           Destination      Protocol  Length  Info
   85 6.069168     71.192.34.104    64.233.169.104   HTTP        689 GET / HTTP/1.1
   90 6.117570     64.233.169.104   71.192.34.104    HTTP        814 HTTP/1.1 200 OK  (text/html)
   93 6.241357     71.192.34.104    64.233.169.104   HTTP        719 GET /intl/en_ALL/images/logo.gif HTTP/1.1
  103 6.308118     64.233.169.104   71.192.34.104    HTTP        226 HTTP/1.1 200 OK  (GIF89a)
  106 6.330131     71.192.34.104    64.233.169.104   HTTP        809 GET /extern_js/f/CgJlbhICdXMrMAo4NUAILCswDjgHLCswFjgQLCswFzgDLCswGDgELCswGTgJLCswHTgZLC…
  121 6.407366     64.233.169.104   71.192.34.104    HTTP        648 HTTP/1.1 200 OK  (text/javascript)
  125 6.452270     71.192.34.104    64.233.169.104   HTTP        695 GET /extern_chrome/ee36edbd3c16a1c5.js HTTP/1.1

> Frame 85: 689 bytes on wire (5512 bits), 689 bytes captured (5512 bits)
> Ethernet II, Src: Dell_4f:36:23 (00:08:74:4f:36:23), Dst: Cisco_bf:6c:01 (00:0e:d6:bf:6c:01)
v Internet Protocol Version 4, Src: 71.192.34.104, Dst: 64.233.169.104
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 675
    Identification: 0xa2ac (41644)
  > Flags: 0x4000, Don't fragment
    Time to live: 127
    Protocol: TCP (6)
    Header checksum: 0x022f [validation disabled]
    [Header checksum status: Unverified]
    Source: 71.192.34.104
    Destination: 64.233.169.104
```

Figure #19: NAT ISP GET Request IP Datagram

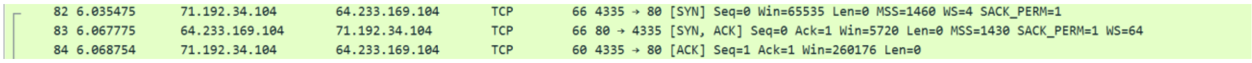
7. No, nothing in the HTTP GET message was changed. This can be confirmed by referring to Figures 14 and 17. Regarding the IP datagram carrying the HTTP GET, the Version, Header Length, and Flags were not changed. The only thing that was changed was checksum as both IP address and TTL changed.



```
87 6.099637   64.233.169.104   71.192.34.104    TCP    60 80 → 4335 [ACK] Seq=1 Ack=636 Win=7040 Len=0
88 6.117078   64.233.169.104   71.192.34.104    TCP  1484 80 → 4335 [ACK] Seq=1 Ack=636 Win=7040 Len=1430 [TCP segment of a reassembled PDU]
89 6.117407   64.233.169.104   71.192.34.104    TCP  1484 80 → 4335 [ACK] Seq=1431 Ack=636 Win=7040 Len=1430 [TCP segment of a reassembled PDU]
90 6.117570   64.233.169.104   71.192.34.104    HTTP  814 HTTP/1.1 200 OK  (text/html)
91 6.118515   71.192.34.104    64.233.169.104   TCP    60 4335 → 80 [ACK] Seq=636 Ack=3621 Win=260176 Len=0
93 6.241357   71.192.34.104    64.233.169.104   HTTP  719 GET /intl/en_ALL/images/logo.gif HTTP/1.1
94 6.273849   64.233.169.104   71.192.34.104    TCP   309 80 → 4335 [PSH, ACK] Seq=3621 Ack=1301 Win=8320 Len=255 [TCP segment of a reassembled P…

> Frame 90: 814 bytes on wire (6512 bits), 814 bytes captured (6512 bits)
> Ethernet II, Src: Cisco_bf:6c:01 (00:0e:d6:bf:6c:01), Dst: Dell_4f:36:23 (00:08:74:4f:36:23)
v Internet Protocol Version 4, Src: 64.233.169.104, Dst: 71.192.34.104
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x20 (DSCP: CS1, ECN: Not-ECT)
    Total Length: 800
    Identification: 0xf61e (63006)
  > Flags: 0x0000
    Time to live: 51
    Protocol: TCP (6)
    Header checksum: 0x3a20 [validation disabled]
    [Header checksum status: Unverified]
    Source: 64.233.169.104
    Destination: 71.192.34.104
> Transmission Control Protocol, Src Port: 80, Dst Port: 4335, Seq: 2861, Ack: 636, Len: 760
> [3 Reassembled TCP Segments (3620 bytes): #88(1430), #89(1430), #90(760)]
> Hypertext Transfer Protocol
> Line-based text data: text/html (12 lines)
```

Figure #20: NAT ISP 200 OK IP Datagram

8. The first 200 OK HTTP message came arrived at t = 6.117570. Comparing Figures 15 and 20, it looks like the only things that are different are the Destination IP address, TTL, and checksum.
    a. Source: 64.233.169.104, 80 and Destination: 71.192.34.104, 4335



```
82 6.035475   71.192.34.104    64.233.169.104   TCP   66 4335 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=4 SACK_PERM=1
83 6.067775   64.233.169.104   71.192.34.104    TCP   66 80 → 4335 [SYN, ACK] Seq=0 Ack=1 Win=5720 Len=0 MSS=1430 SACK_PERM=1 WS=64
84 6.068754   71.192.34.104    64.233.169.104   TCP   60 4335 → 80 [ACK] Seq=1 Ack=1 Win=260176 Len=0
```

Figure #21: TCP SYN/ACK Segments

9. The TCP SYN segment was captured at t = 6.035475 and the TCP ACK segment was captured at t = 6.067775.
    a. TCP SYN:
        i. Source IP changed
    b. TCP ACK:
        i. Destination IP changed

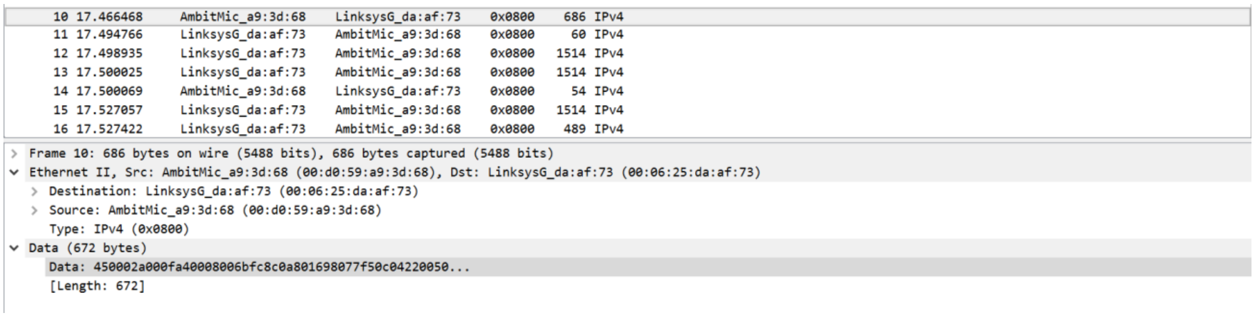
10. NAT Table

NAT translation table	
WAN side addr	LAN side addr
71.192.34.104, 4335	192.168.1.100, 4335

ELEC 331 Assignment 3

Wireshark Ethernet and ARP

Note: I will be using the provided ethereal trace for this part of the assignment.

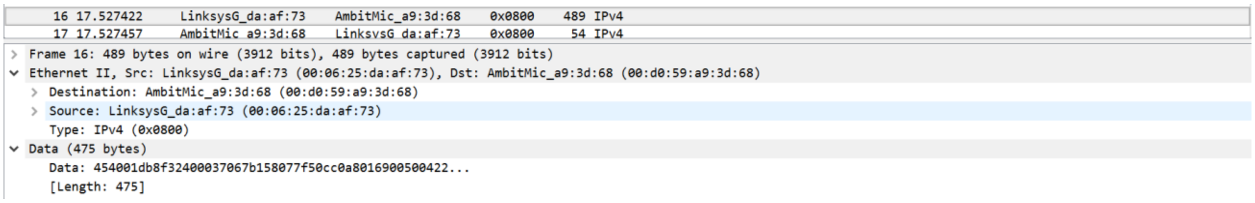


```
     10 17.466468     AmbitMic_a9:3d:68    LinksysG_da:af:73    0x0800    686 IPv4
     11 17.494766     LinksysG_da:af:73    AmbitMic_a9:3d:68    0x0800     60 IPv4
     12 17.498935     LinksysG_da:af:73    AmbitMic_a9:3d:68    0x0800   1514 IPv4
     13 17.500025     LinksysG_da:af:73    AmbitMic_a9:3d:68    0x0800   1514 IPv4
     14 17.500069     AmbitMic_a9:3d:68    LinksysG_da:af:73    0x0800     54 IPv4
     15 17.527057     LinksysG_da:af:73    AmbitMic_a9:3d:68    0x0800   1514 IPv4
     16 17.527422     LinksysG_da:af:73    AmbitMic_a9:3d:68    0x0800    489 IPv4
> Frame 10: 686 bytes on wire (5488 bits), 686 bytes captured (5488 bits)
v Ethernet II, Src: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
  > Destination: LinksysG_da:af:73 (00:06:25:da:af:73)
  > Source: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
    Type: IPv4 (0x0800)
v Data (672 bytes)
    Data: 450002a000fa40008006bfc8c0a801698077f50c04220050...
    [Length: 672]
```

Figure #22: Ethernet Frame for HTTP GET Request

1. The 48-bit Ethernet address of my computer is 00:d0:59:a9:3d:68.
2. The 48-bit destination Ethernet address is 00:06:25:da:af:73. This corresponds to the Linksys router that is used to get off the local subnet.
3. The hexadecimal value for the Frame Type is 0x0800, corresponding to the IPv4 protocol.
4. As the ASCII G is the first thing in the payload, it would appear 54 bytes from the very start of the Ethernet frame.

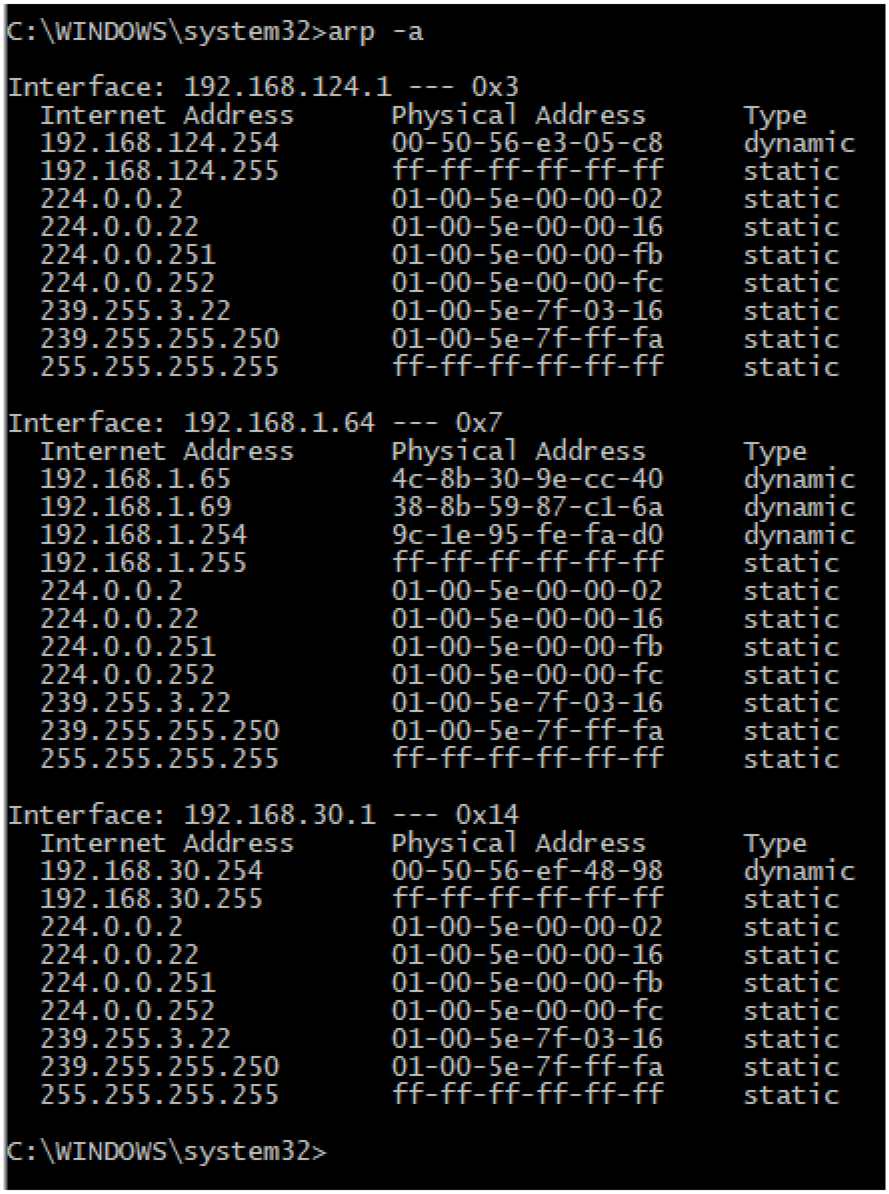
   This is because the HTTP GET message is carried inside of a TCP segment, which is carried inside an IP datagram, which is finally carried inside the Ethernet frame. Thus, we must consider 20 bytes of header from the TCP segment, 20 bytes from the IP datagram, and finally 14 bytes for Ethernet frame's type and source and destination address.



```
     16 17.527422     LinksysG_da:af:73    AmbitMic_a9:3d:68    0x0800    489 IPv4
     17 17.527457     AmbitMic_a9:3d:68    LinksysG_da:af:73    0x0800     54 IPv4
> Frame 16: 489 bytes on wire (3912 bits), 489 bytes captured (3912 bits)
v Ethernet II, Src: LinksysG_da:af:73 (00:06:25:da:af:73), Dst: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
  > Destination: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
  > Source: LinksysG_da:af:73 (00:06:25:da:af:73)
    Type: IPv4 (0x0800)
v Data (475 bytes)
    Data: 454001db8f32400037067b158077f50cc0a8016900500422...
    [Length: 475]
```

Figure #23: Ethernet Frame for HTTP GET Response

5. The Ethernet source address is 00:06:25:da:af:73, which is the Ethernet address of the Linksys router as mentioned in Question 2.
6. The Ethernet destination address is 00:d0:59:a9:3d:68, the address of my computer.
7. The hexadecimal value for the Frame Type is 0x0800, corresponding to the IPv4 protocol.
8. Similar to Question 4, as the O in OK is the first character, it will be 54 bytes away from the very start of the Ethernet frame. The calculations are the exact as Question 4.



```
C:\WINDOWS\system32>arp -a

Interface: 192.168.124.1 --- 0x3
  Internet Address      Physical Address      Type
  192.168.124.254       00-50-56-e3-05-c8     dynamic
  192.168.124.255       ff-ff-ff-ff-ff-ff     static
  224.0.0.2             01-00-5e-00-00-02     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.3.22          01-00-5e-7f-03-16     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static

Interface: 192.168.1.64 --- 0x7
  Internet Address      Physical Address      Type
  192.168.1.65          4c-8b-30-9e-cc-40     dynamic
  192.168.1.69          38-8b-59-87-c1-6a     dynamic
  192.168.1.254         9c-1e-95-fe-fa-d0     dynamic
  192.168.1.255         ff-ff-ff-ff-ff-ff     static
  224.0.0.2             01-00-5e-00-00-02     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.3.22          01-00-5e-7f-03-16     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static

Interface: 192.168.30.1 --- 0x14
  Internet Address      Physical Address      Type
  192.168.30.254        00-50-56-ef-48-98     dynamic
  192.168.30.255        ff-ff-ff-ff-ff-ff     static
  224.0.0.2             01-00-5e-00-00-02     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.3.22          01-00-5e-7f-03-16     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static

C:\WINDOWS\system32>
```

Figure #24: ARP Table

9.

Internet Address	IP Address
Physical Address	MAC Address
Type	Protocol Type

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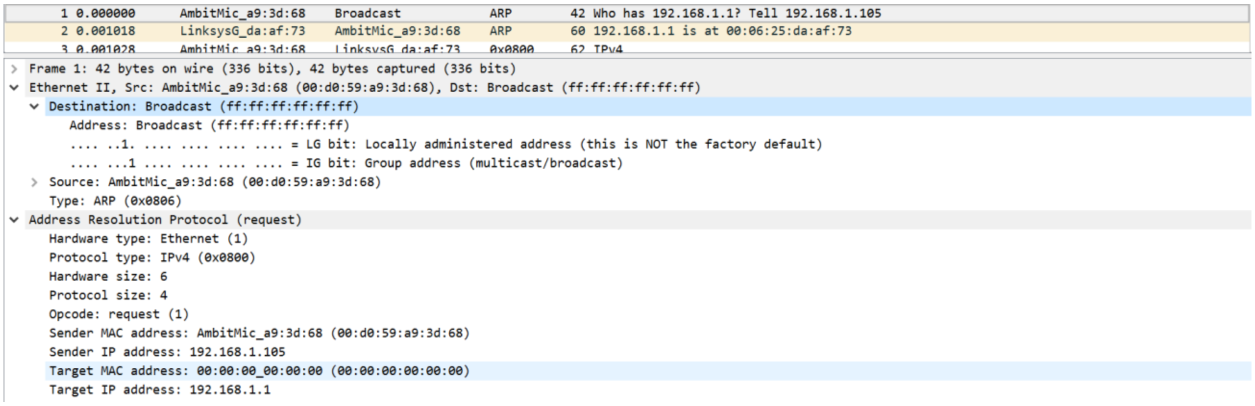


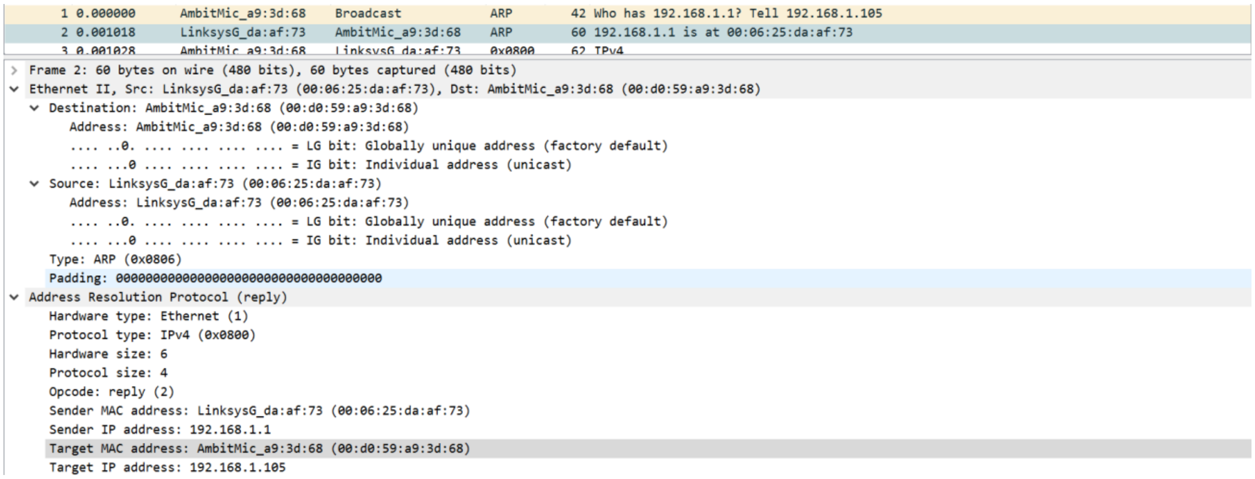
```
      1 0.000000      AmbitMic_a9:3d:68    Broadcast            ARP        42 Who has 192.168.1.1? Tell 192.168.1.105
      2 0.001018      LinksysG_da:af:73    AmbitMic_a9:3d:68    ARP        60 192.168.1.1 is at 00:06:25:da:af:73
      3 0.001028      AmbitMic_a9:3d:68    LinksysG_da:af:73    0x0800     62 IPv4
> Frame 1: 42 bytes on wire (336 bits), 42 bytes captured (336 bits)
v Ethernet II, Src: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  v Destination: Broadcast (ff:ff:ff:ff:ff:ff)
      Address: Broadcast (ff:ff:ff:ff:ff:ff)
      .... ..1. .... .... .... .... = LG bit: Locally administered address (this is NOT the factory default)
      .... ...1 .... .... .... .... = IG bit: Group address (multicast/broadcast)
  > Source: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
    Type: ARP (0x0806)
v Address Resolution Protocol (request)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (1)
    Sender MAC address: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
    Sender IP address: 192.168.1.105
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 192.168.1.1
```

Figure #25: ARP Request Message

10.
   a. Source: 00:d0:59:a9:3d:68.
   b. Destination: ff:ff:ff:ff:ff:ff, for broadcast.

11. The hexadecimal value for the Frame Type is 0x806, corresponding to the ARP protocol.

12.
   a. The ARP opcode field begins 20 bytes from the very beginning of the Ethernet frame.
   b. Referring to fig 25, we see that the opcode is 1 (0x0001) for request.
   c. Yes, the ARP message contains the “Sender IP address” field.
   d. In the ARP message, the Target IP address field corresponds to the IP address being queried, and thus the Target MAC address field is set to 00:00:00:00:00:00 to “question” the machine whose IP is the value of the Target IP address field.



```
      1 0.000000      AmbitMic_a9:3d:68    Broadcast            ARP        42 Who has 192.168.1.1? Tell 192.168.1.105
      2 0.001018      LinksysG_da:af:73    AmbitMic_a9:3d:68    ARP        60 192.168.1.1 is at 00:06:25:da:af:73
      3 0.001028      AmbitMic_a9:3d:68    LinksysG_da:af:73    0x0800     62 IPv4
> Frame 2: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
v Ethernet II, Src: LinksysG_da:af:73 (00:06:25:da:af:73), Dst: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
  v Destination: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
      Address: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  v Source: LinksysG_da:af:73 (00:06:25:da:af:73)
      Address: LinksysG_da:af:73 (00:06:25:da:af:73)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: ARP (0x0806)
    Padding: 000000000000000000000000000000000000
v Address Resolution Protocol (reply)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: reply (2)
    Sender MAC address: LinksysG_da:af:73 (00:06:25:da:af:73)
    Sender IP address: 192.168.1.1
    Target MAC address: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
    Target IP address: 192.168.1.105
```

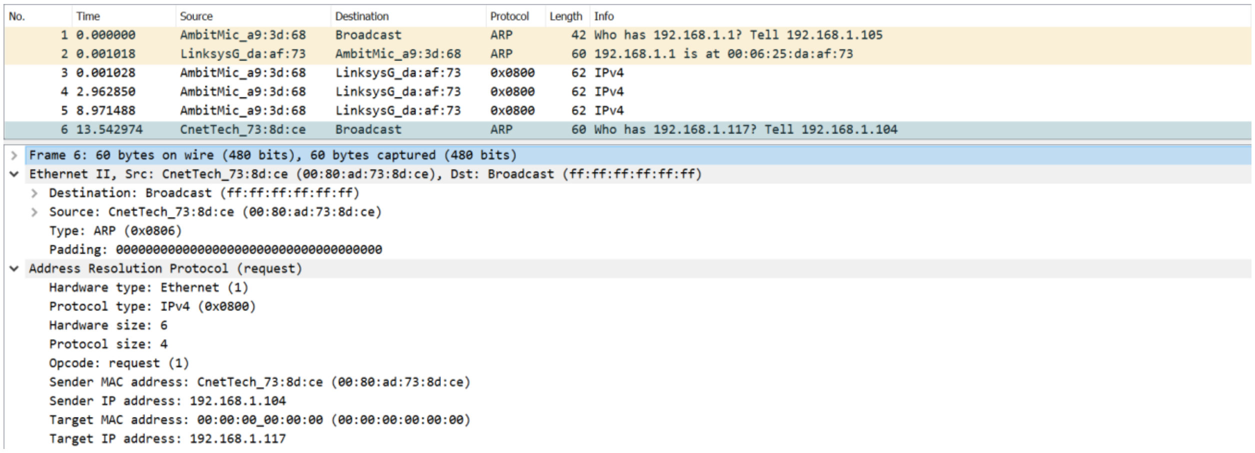
Figure #26: ARP Response Message

13.

a. Same answer as question 12 a) -> 20 bytes from the very beginning.
b. Referring to fig 25, we see that the opcode is 2 (0x0002) for reply
c. The “answer” to the previous query appears in the “Sender MAC address” field.

14.

a. Source: 00:06:25:da:af:73
b. Destination: 00:d0:59:a9:3d:68



```
No.     Time        Source              Destination         Protocol  Length  Info
      1 0.000000    AmbitMic_a9:3d:68   Broadcast           ARP           42  Who has 192.168.1.1? Tell 192.168.1.105
      2 0.001018    LinksysG_da:af:73   AmbitMic_a9:3d:68   ARP           60  192.168.1.1 is at 00:06:25:da:af:73
      3 0.001028    AmbitMic_a9:3d:68   LinksysG_da:af:73   0x0800        62  IPv4
      4 2.962850    AmbitMic_a9:3d:68   LinksysG_da:af:73   0x0800        62  IPv4
      5 8.971488    AmbitMic_a9:3d:68   LinksysG_da:af:73   0x0800        62  IPv4
      6 13.542974   CnetTech_73:8d:ce   Broadcast           ARP           60  Who has 192.168.1.117? Tell 192.168.1.104

> Frame 6: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
v Ethernet II, Src: CnetTech_73:8d:ce (00:80:ad:73:8d:ce), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  > Destination: Broadcast (ff:ff:ff:ff:ff:ff)
  > Source: CnetTech_73:8d:ce (00:80:ad:73:8d:ce)
    Type: ARP (0x0806)
    Padding: 000000000000000000000000000000000000
v Address Resolution Protocol (request)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (1)
    Sender MAC address: CnetTech_73:8d:ce (00:80:ad:73:8d:ce)
    Sender IP address: 192.168.1.104
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 192.168.1.117
```

Figure #26: Unreplied ARP Request Message

15. There is no reply on our trace because while the ARP request is similar to the DHCP request in that they are both broadcasts, the ARP reply is a unicast reply. As the ARP request was not made by us (different source IP and MAC address), we are unable to capture the ARP reply packet.