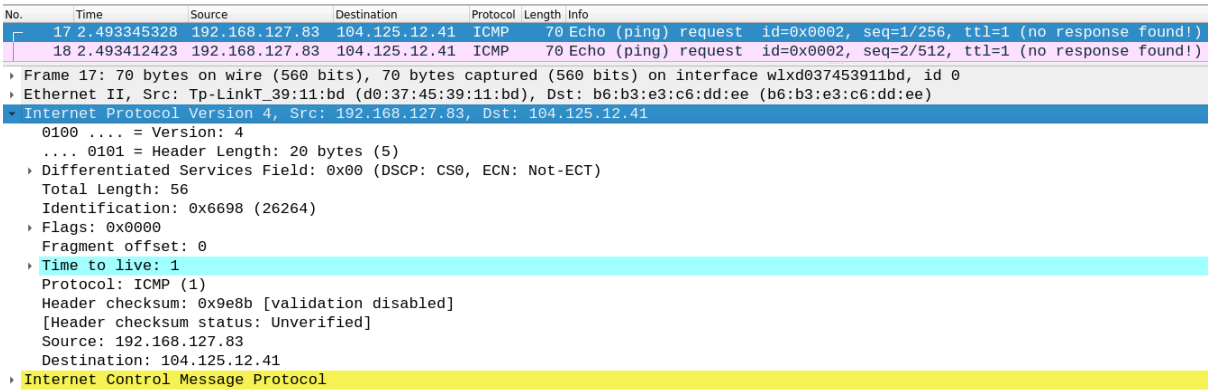
1. Wireshark. IP

1)

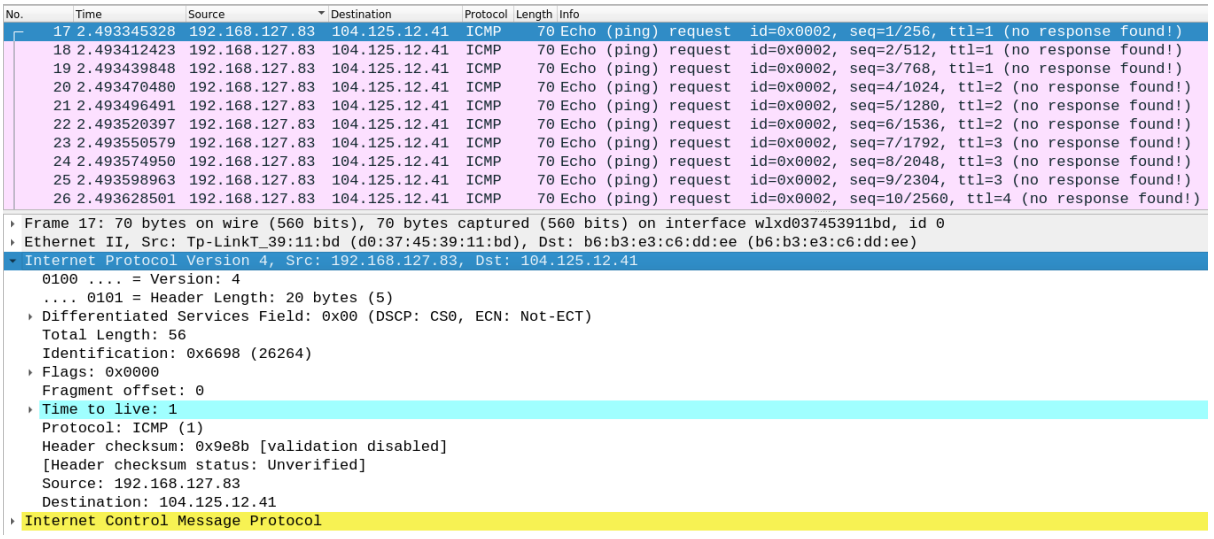


IP-адрес моего компьютера - 192.168.127.83.

2) В поле протокола верхнего уровня заголовка IP-пакета указано значение ICMP (0x01).

3) В IP-заголовке 20 байт, а, так как размер пакета был задан равным 56 байт, на полезную нагрузку IP-дейтаграммы приходится 36 байт.

4)



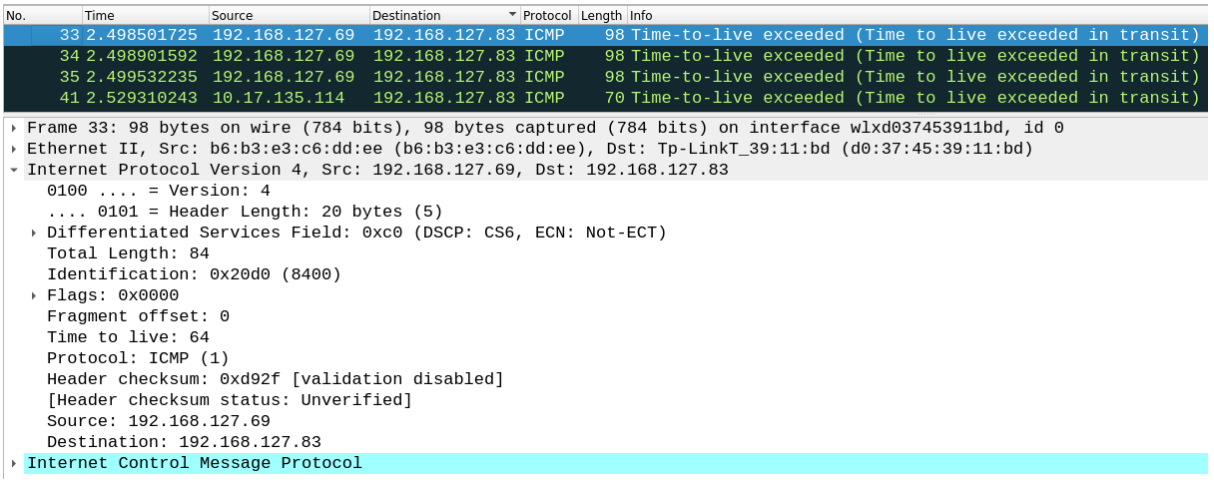
a) Всегда от одной дейтаграммы к следующей изменяются поля Identification и Header checksum, также от одной последовательности дейтаграмм к следующей изменяется поле Time to live.

b) Не изменяются поля Version, Header Length, Differentiated Services Field, Total Length, Flags, Fragment offset, Protocol, Source, Destination. Эти же поля должны оставаться неизменными. Изменяться должны поля Identification (так как все пакеты должны иметь разные идентификаторы), Header checksum (так как изменяется Identification) и Time to live (так как его увеличивает traceroute).

c) Значение поля Identification с каждым последующим эхо-запросом увеличивается на 1.

5) Identification: 0x6698 (26264), TTL: 1.

6)



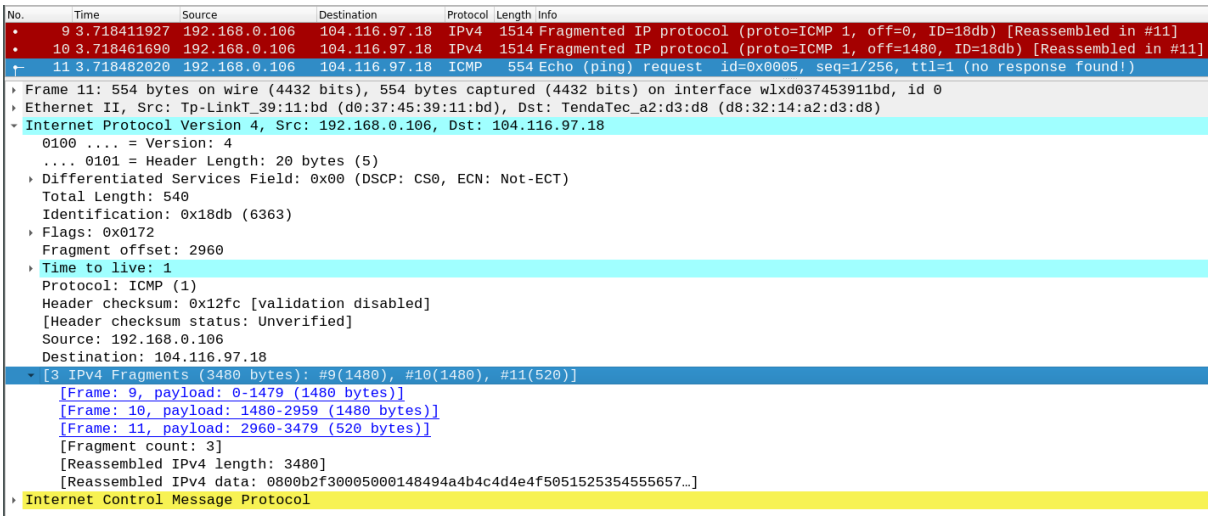
No.	Time	Source	Destination	Protocol	Length	Info
33	2.498501725	192.168.127.69	192.168.127.83	ICMP	98	Time-to-live exceeded (Time to live exceeded in transit)
34	2.498901592	192.168.127.69	192.168.127.83	ICMP	98	Time-to-live exceeded (Time to live exceeded in transit)
35	2.499532235	192.168.127.69	192.168.127.83	ICMP	98	Time-to-live exceeded (Time to live exceeded in transit)
41	2.529310243	10.17.135.114	192.168.127.83	ICMP	70	Time-to-live exceeded (Time to live exceeded in transit)

```
▸ Frame 33: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface wlxd037453911bd, id 0
▸ Ethernet II, Src: b6:b3:e3:c6:dd:ee (b6:b3:e3:c6:dd:ee), Dst: Tp-LinkT_39:11:bd (d0:37:45:39:11:bd)
▾ Internet Protocol Version 4, Src: 192.168.127.69, Dst: 192.168.127.83
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  ▸ Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
    Total Length: 84
    Identification: 0x20d0 (8400)
  ▸ Flags: 0x0000
    Fragment offset: 0
    Time to live: 64
    Protocol: ICMP (1)
    Header checksum: 0xd92f [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.127.69
    Destination: 192.168.127.83
▸ Internet Control Message Protocol
```

В сообщениях об истечении предписанного времени жизни, поступивших с ближайшего маршрутизатора, изменяется Identification (увеличивается на 1), не изменяется TTL.

7) Identification: 0x20d0 (8400), TTL: 64.

8)



No.	Time	Source	Destination	Protocol	Length	Info
9	3.718411927	192.168.0.106	104.116.97.18	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=18db) [Reassembled in #11]
10	3.718461690	192.168.0.106	104.116.97.18	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=1480, ID=18db) [Reassembled in #11]
11	3.718482020	192.168.0.106	104.116.97.18	ICMP	554	Echo (ping) request id=0x0005, seq=1/256, ttl=1 (no response found!)

```
▸ Frame 11: 554 bytes on wire (4432 bits), 554 bytes captured (4432 bits) on interface wlxd037453911bd, id 0
▸ Ethernet II, Src: Tp-LinkT_39:11:bd (d0:37:45:39:11:bd), Dst: TendaTec_a2:d3:d8 (d8:32:14:a2:d3:d8)
▾ Internet Protocol Version 4, Src: 192.168.0.106, Dst: 104.116.97.18
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  ▸ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 540
    Identification: 0x18db (6363)
  ▸ Flags: 0x0172
    Fragment offset: 2960
  ▸ Time to live: 1
    Protocol: ICMP (1)
    Header checksum: 0x12fc [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.0.106
    Destination: 104.116.97.18
  ▾ [3 IPv4 Fragments (3480 bytes): #9(1480), #10(1480), #11(520)]
      [Frame: 9, payload: 0-1479 (1480 bytes)]
      [Frame: 10, payload: 1480-2959 (1480 bytes)]
      [Frame: 11, payload: 2960-3479 (520 bytes)]
      [Fragment count: 3]
      [Reassembled IPv4 length: 3480]
      [Reassembled IPv4 data: 0800b2f30005000148494a4b4c4d4e4f5051525354555657…]
▸ Internet Control Message Protocol
```

a) Сообщение было фрагментированно, было создано 3 фрагмента.

b) В разных фрагментах изменяются поля Total Length, Flags, Fragment offset, Header checksum.

2. Программирование.

1. Эхо запросы через ICMP

```
eartser@eartser:~/Learning/comp-networks/lab10$ sudo python3 ping.py 127.0.0.1
PING 127.0.0.1 (127.0.0.1)
Received ICMP echo reply from 127.0.0.1: icmp_seq=1 time=0.029 ms
Received ICMP echo reply from 127.0.0.1: icmp_seq=2 time=0.15 ms
Received ICMP echo reply from 127.0.0.1: icmp_seq=3 time=0.148 ms
Received ICMP echo reply from 127.0.0.1: icmp_seq=4 time=0.144 ms
Received ICMP echo reply from 127.0.0.1: icmp_seq=5 time=0.147 ms
Received ICMP echo reply from 127.0.0.1: icmp_seq=6 time=0.143 ms
Received ICMP echo reply from 127.0.0.1: icmp_seq=7 time=0.166 ms
^C
7 packets transmitted, 7 packets received, 0% packet loss, time 6498ms
rtt min/avg/max/mdev = 0.029/0.132/0.166/0.043 ms
eartser@eartser:~/Learning/comp-networks/lab10$ sudo python3 ping.py vk.com
PING vk.com (87.240.190.72)
Received ICMP echo reply from 87.240.190.72: icmp_seq=1 time=2.687 ms
Received ICMP echo reply from 87.240.190.72: icmp_seq=2 time=5.236 ms
Received ICMP echo reply from 87.240.190.72: icmp_seq=3 time=5.425 ms
Received ICMP echo reply from 87.240.190.72: icmp_seq=4 time=8.986 ms
Received ICMP echo reply from 87.240.190.72: icmp_seq=5 time=2.696 ms
Received ICMP echo reply from 87.240.190.72: icmp_seq=6 time=2.657 ms
Received ICMP echo reply from 87.240.190.72: icmp_seq=7 time=3.073 ms
^C
7 packets transmitted, 7 packets received, 0% packet loss, time 6375ms
rtt min/avg/max/mdev = 2.657/4.394/8.986/2.185 ms
eartser@eartser:~/Learning/comp-networks/lab10$ sudo python3 ping.py akamai.com
PING akamai.com (104.82.181.162)
Received ICMP echo reply from 104.82.181.162: icmp_seq=1 time=43.912 ms
Received ICMP echo reply from 104.82.181.162: icmp_seq=2 time=41.269 ms
Received ICMP echo reply from 104.82.181.162: icmp_seq=3 time=46.266 ms
Received ICMP echo reply from 104.82.181.162: icmp_seq=4 time=47.073 ms
Received ICMP echo reply from 104.82.181.162: icmp_seq=5 time=41.605 ms
Received ICMP echo reply from 104.82.181.162: icmp_seq=6 time=41.154 ms
Received ICMP echo reply from 104.82.181.162: icmp_seq=7 time=41.001 ms
^C
7 packets transmitted, 7 packets received, 0% packet loss, time 6560ms
rtt min/avg/max/mdev = 41.001/43.183/47.073/2.396 ms
eartser@eartser:~/Learning/comp-networks/lab10$
```