

华东师范大学数据科学与工程学院实验报告

课程名称：计算机网络与编程

年级：21 级

上机实践成绩：

指导教师：张召

姓名：杨茜雅

学号：10215501435

上机实践名称：Lab14

上机实践日期：2023.6.9

上机实践编号：14

组号：

上机实践时间：2023.6.9

一、实验目的

- 快速简单了解IP协议，特别是IP数据报
- 了解IP数据报各字段的含义
- 研究 IP 数据的分片方法

二、实验任务

- 使用 Wireshark 快速了解 IP 协议

三、使用环境

- Wireshark

四、实验过程

Task 1: 任取一个有IP协议的ICMP数据报并根据该报文分析IP协议的报文格式（正确标注每一个部分），请将实验结果附在实验报告中。

IP报文格式：



启动wireshark, 使用ping指令生成IP数据包 `ping -l 3005 www.ecnu.edu.cn`
 此处可以看出, 我们指定ping包的大小为3005Byte, 从图片中可以看出默认次数为4次。

```
C:\Users\86138>ping -l 3005 www.ecnu.edu.cn

正在 Ping www.ecnu.edu.cn [202.120.92.60] 具有 3005 字节的数据:
来自 202.120.92.60 的回复: 字节=3005 时间=6ms TTL=123
来自 202.120.92.60 的回复: 字节=3005 时间=8ms TTL=123
来自 202.120.92.60 的回复: 字节=3005 时间=6ms TTL=123
来自 202.120.92.60 的回复: 字节=3005 时间=5ms TTL=123

202.120.92.60 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 4, 丢失 = 0 (0% 丢失),
    往返行程的估计时间(以毫秒为单位):
        最短 = 5ms, 最长 = 8ms, 平均 = 6ms
```

四次:

No.	Time	Source	Destination	Protocol	Length	Info
6754	33.215317	172.30.240.159	202.120.92.60	ICMP	87	Echo (ping) request id=0x0001, seq=42/10752, ttl=128 (reply in 6757)
6757	33.221000	202.120.92.60	172.30.240.159	ICMP	1514	Echo (ping) reply id=0x0001, seq=42/10752, ttl=123 (request in 6754)
6767	34.234287	172.30.240.159	202.120.92.60	ICMP	87	Echo (ping) request id=0x0001, seq=43/11008, ttl=128 (reply in 6770)
6770	34.241653	202.120.92.60	172.30.240.159	ICMP	1514	Echo (ping) reply id=0x0001, seq=43/11008, ttl=123 (request in 6767)
6781	35.247522	172.30.240.159	202.120.92.60	ICMP	87	Echo (ping) request id=0x0001, seq=44/11264, ttl=128 (reply in 6784)
6784	35.253236	202.120.92.60	172.30.240.159	ICMP	1514	Echo (ping) reply id=0x0001, seq=44/11264, ttl=123 (request in 6781)
6791	36.263328	172.30.240.159	202.120.92.60	ICMP	87	Echo (ping) request id=0x0001, seq=45/11520, ttl=128 (reply in 6794)
6794	36.268525	202.120.92.60	172.30.240.159	ICMP	1514	Echo (ping) reply id=0x0001, seq=45/11520, ttl=123 (request in 6791)

什么是ICMP? ICMP与IP的关系

网际控制报文协议; 作为IP数据包的数据, 加上首部, 组成IP数据包, 能更有效地转发IP数据包和提高交付成功机会。

```

Internet Protocol Version 4, Src: 172.30.240.159, Dst: 202.120.92.60
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    0000 00.. = Differentiated Services Codepoint: Default (0)
    .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
  Total Length: 73
  Identification: 0xc4c0 (50368)
  000. .... = Flags: 0x0
    0... .... = Reserved bit: Not set
    .0.. .... = Don't fragment: Not set
    ..0. .... = More fragments: Not set
    ...0 0001 0111 0010 = Fragment Offset: 2960
  Time to Live: 128
  Protocol: ICMP (1)
  Header Checksum: 0x0000 [validation disabled]
  [Header checksum status: Unverified]
  Source Address: 172.30.240.159
  Destination Address: 202.120.92.60
  [3 IPv4 Fragments (3013 bytes): #6752(1480), #6753(1480), #6754(53)]
    [Frame: 6752, payload: 0-1479 (1480 bytes)]
    [Frame: 6753, payload: 1480-2959 (1480 bytes)]
    [Frame: 6754, payload: 2960-3012 (53 bytes)]
    [Fragment count: 3]
    [Reassembled IPv4 length: 3013]
    [Reassembled IPv4 data: 080087cc0001002a6162636465666768696a6b6c6d6e6f707172737475767778797a7b7c7d7e7f808182838485868788898a8b8c8d8e8f90919293949596979899a0a1a2a3a4a5a6a7a8a9aaabacadaeb0b1b2b3b4b5b6b7b8b9c0c1c2c3c4c5c6c7c8c9d0d1d2d3d4d5d6d7d8d9e0e1e2e3e4e5e6e7e8e9f0f1f2f3f4f5f6f7f8f9000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f0020002100220023002400250026002700280029002a002b002c002d002e002f0030003100320033003400350036003700380039003a003b003c003d003e003f0040004100420043004400450046004700480049004a004b004c004d004e004f0050005100520053005400550056005700580059005a005b005c005d005e005f0060006100620063006400650066006700680069006a006b006c006d006e006f0070007100720073007400750076007700780079007a007b007c007d007e007f0080008100820083008400850086008700880089008a008b008c008d008e008f0090009100920093009400950096009700980099009a009b009c009d009e009f01000100020003000400050006000700080009000a000b000c000d000e000f0010001100120013001400150016001700180019001a001b001c001d001e001f002000210022002300240
```

可以看到各个字段的值：

版本号 (Version) : 4, 说明是IPv4, ip报文中, 版本占了4位, 用来表示该协议采用的是那一个版本的ip, 相同版本的ip才能进行通信。

首部长度的 (Header Length) : 20 bytes

区分服务 (Differentiated Services Field) : 0x00 (DSCP:CS0, ECN Not-ECT)

数据报长度 (Total Length) : 73 bytes

标识 (Identification) : 0xc4c0 (50368)

R位 (Reserved bit) : Not set

DF位 (Don't Fragment) : Not set, 表示该数据报不会再分片

MF位 (More Fragment) : Not set, 表示该数据报是大数据报的最后一个分片

片偏移 (Fragment offset) : 2960, 该字段指出较长的分组在分片后某片在原分组中的相对位置

生存时间 (Time to live) : 128, 记为 TTL (Time To Live)数据报在网络中可通过的路由器数的最大值。

协议 (Protocol) : ICMP, 该字段指出此数据报携带的数据使用何种协议以便目的主机的 IP 层将数据部分上交给哪个处理过程。

首部校验和 (Header Checksum) : 0x0000, 该字段只检验数据报的首部不检验数据部分。

源IP地址: 172.30.240.159

目的IP地址: 202.120.92.60

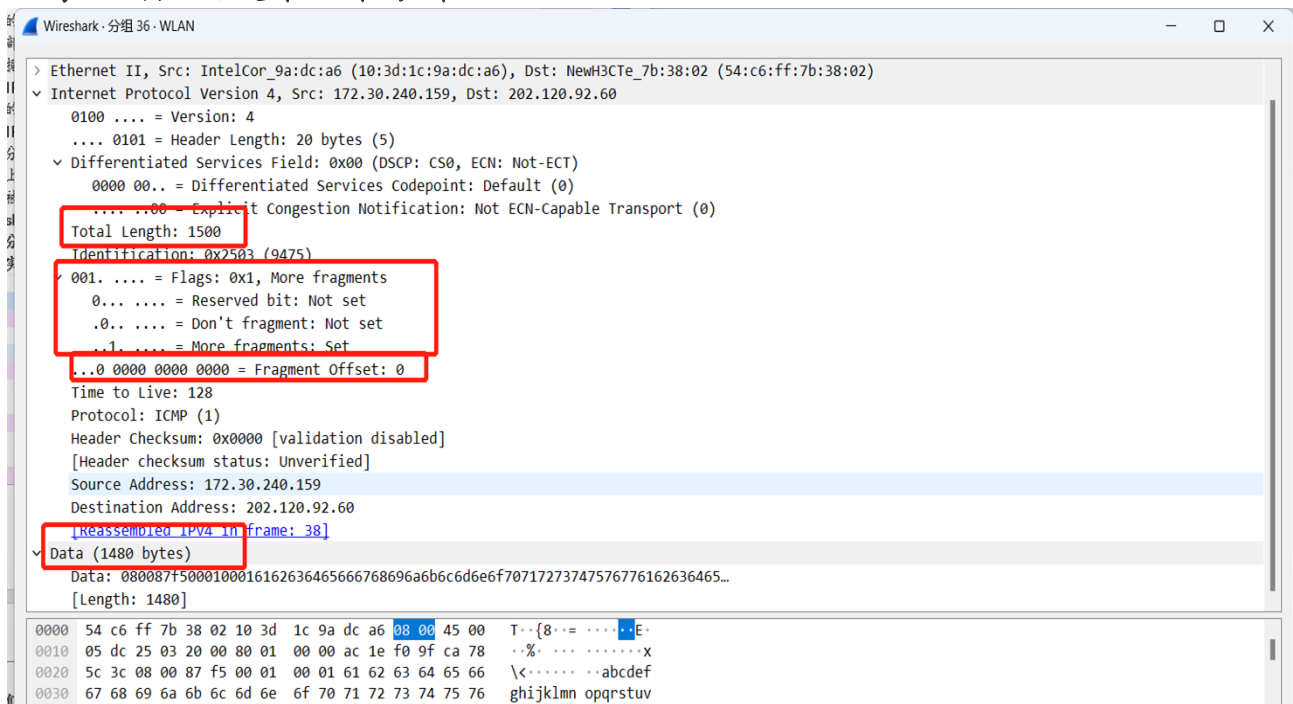
在IP数据报后面还给出了具体分片情况, 和数据报给出的信息相吻合 (如第三个分片长53字节, 数据报长度长73字节, 刚好是加上头部20字节的长度)

综上可知: 我们抓到的这个包是某个原始数据包的最后一个分片, 该原始数据报被分成3个片

Task 2: 对截获的报文进行分析, 将属于同一个ICMP请求报文的分片找出来, 并分析其字节长度特点 (如, 每个分片的大小, 片偏移等), 请将实验结果附在实验报告中。

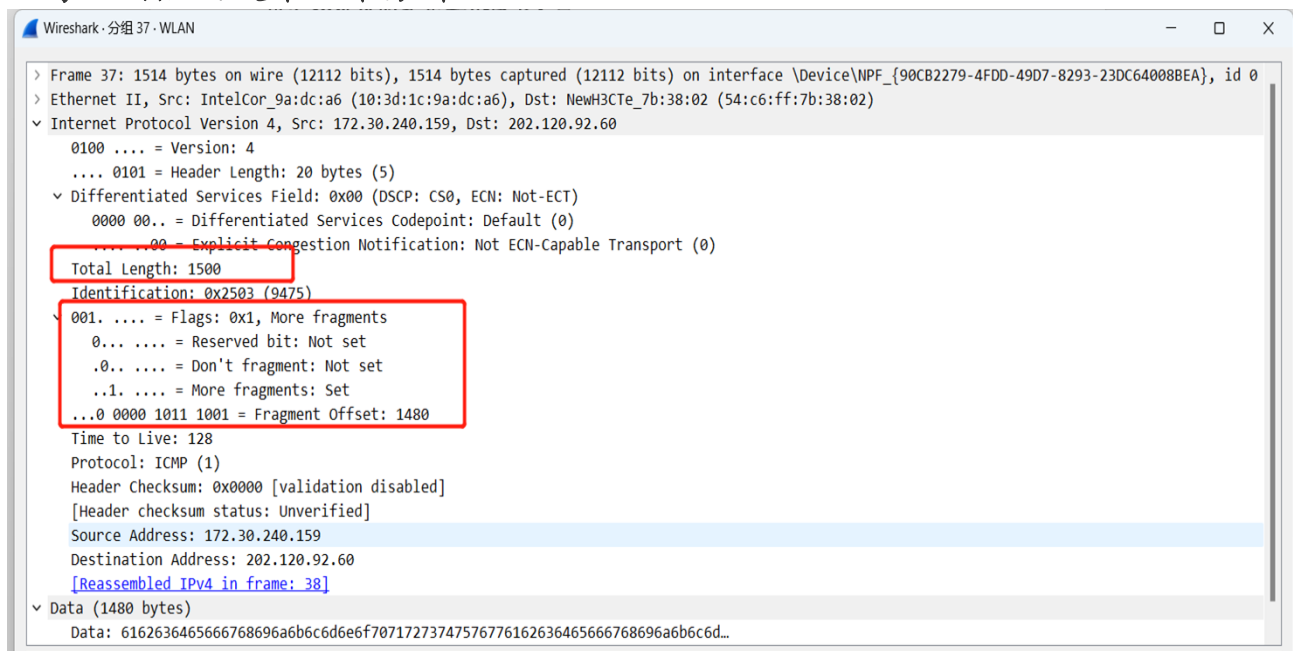
36	3.953390	172.30.240.159	202.120.92.60	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=2503) [Reassembled in #38]
37	3.953390	172.30.240.159	202.120.92.60	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=1480, ID=2503) [Reassembled in #38]
38	3.953390	172.30.240.159	202.120.92.60	ICMP	87	Echo (ping) request id=0x0001, seq=1/256, ttl=128 (reply in 41)
39	3.957644	202.120.92.60	172.30.240.159	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=cfbf) [Reassembled in #41]
40	3.958415	202.120.92.60	172.30.240.159	IPv4	87	Fragmented IP protocol (proto=ICMP 1, off=2960, ID=cfbf) [Reassembled in #41]
41	3.958415	202.120.92.60	172.30.240.159	ICMP	1514	Echo (ping) reply id=0x0001, seq=1/256, ttl=123 (request in 38)
42	4.968688	172.30.240.159	202.120.92.60	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=2504) [Reassembled in #44]
43	4.968688	172.30.240.159	202.120.92.60	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=1480, ID=2504) [Reassembled in #44]
44	4.968688	172.30.240.159	202.120.92.60	ICMP	87	Echo (ping) request id=0x0001, seq=2/512, ttl=128 (reply in 47)
45	4.972730	202.120.92.60	172.30.240.159	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=d168) [Reassembled in #47]
46	4.972730	202.120.92.60	172.30.240.159	IPv4	87	Fragmented IP protocol (proto=ICMP 1, off=2960, ID=d168) [Reassembled in #47]
47	4.972730	202.120.92.60	172.30.240.159	ICMP	1514	Echo (ping) reply id=0x0001, seq=2/512, ttl=123 (request in 44)

我们分析第一个请求报文的三个分片，组号分别是36、37、38
组号36对应的是第一个分片：



第一个分片长1480字节，加上头部20字节的长度就是数据报的Total Length: 1500，片偏移Fragment Offset为0, More fragment: Set, Flags被置为1说明还有别的分片。

组号37对应的是第二个分片：



第二个分片长1480字节，加上头部20字节的长度就是数据报的Total Length: 1500，片偏移Fragment Offset为1480，其实就是第一个分片的长度，More fragment: Set, Flags被置为1说明还有别的分片。

组号38对应的是第三个分片：

```

> Frame 38: 87 bytes on wire (696 bits), 87 bytes captured (696 bits) on interface \Device\NPF_{90CB2279-4FDD-49D7-8293-23DC64008BEA}, id 0
> Ethernet II, Src: IntelCor_9a:dc:a6 (10:3d:1c:9a:dc:a6), Dst: NewH3CTe_7b:38:02 (54:c6:ff:7b:38:02)
v Internet Protocol Version 4, Src: 172.30.240.159, Dst: 202.120.92.60
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
v Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    0000 00.. = Differentiated Services Codepoint: Default (0)
    .... 00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
    Total Length: 73
    Identification: 0x2503 (9475)
v 000. .... = Flags: 0x0
    0... .... = Reserved bit: Not set
    .0.. .... = Don't fragment: Not set
    ..0. .... = More fragments: Not set
    ...0 0001 0111 0010 = Fragment Offset: 2960
    Time to Live: 128
    Protocol: ICMP (1)
    Header Checksum: 0x0000 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 172.30.240.159
    Destination Address: 202.120.92.60
v [3 IPv4 Fragments (3013 bytes): #36(1480), #37(1480), #38(53)]
    [Frame: 36, payload: 0-1479 (1480 bytes)]
    [Frame: 37, payload: 1480-2959 (1480 bytes)]
    [Frame: 38, payload: 2960-3012 (53 bytes)]
    [Fragment count: 3]
    [Reassembled IPv4 length: 3013]
    [Reassembled IPv4 data: 080087f5000100016162636465666768696a6b6c6d6e6f70717273747576776162636465...]
v Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0x87f5 [correct]
    [Checksum Status: Good]
    Identifier (BE): 1 (0x0001)
    Identifier (LE): 256 (0x0100)
    Sequence Number (BE): 1 (0x0001)
    Sequence Number (LE): 256 (0x0100)
    [Response frame: 41]
v Data (3005 bytes)
    Data: 6162636465666768696a6b6c6d6e6f70717273747576776162636465666768696a6b6c6d...
    [Length: 3005]

```

第三个分片长53字节，加上头部20字节的长度就是数据报的Total Length: 73
片偏移Fragment Offset为2960，其实就是第一个分片和第二个分片长度的总和，More fragment: Not Set，Flags被置为0说明没有别的分片了，该分片是最后一个。

还可以看出属于同一个ICMP请求报文的分片Frame分别是36、37、38，Fragment count为3，总体长度是1480+1480+53=3013，该请求报文的reply为Frame 41。

五、总结

本次实验我了解了IP协议相关的知识，尤其是IP数据报，学会动手抓取IP报文并且分析该报文中各个字段的含义。研究了IP数据的分片方法并且抓取了属于同一个ICMP请求报文的分片进行分析。