实验 6：ARP 实验

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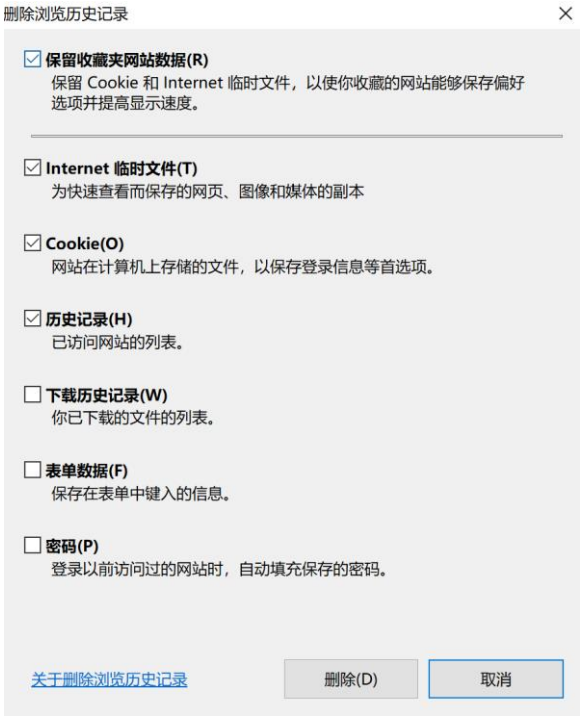
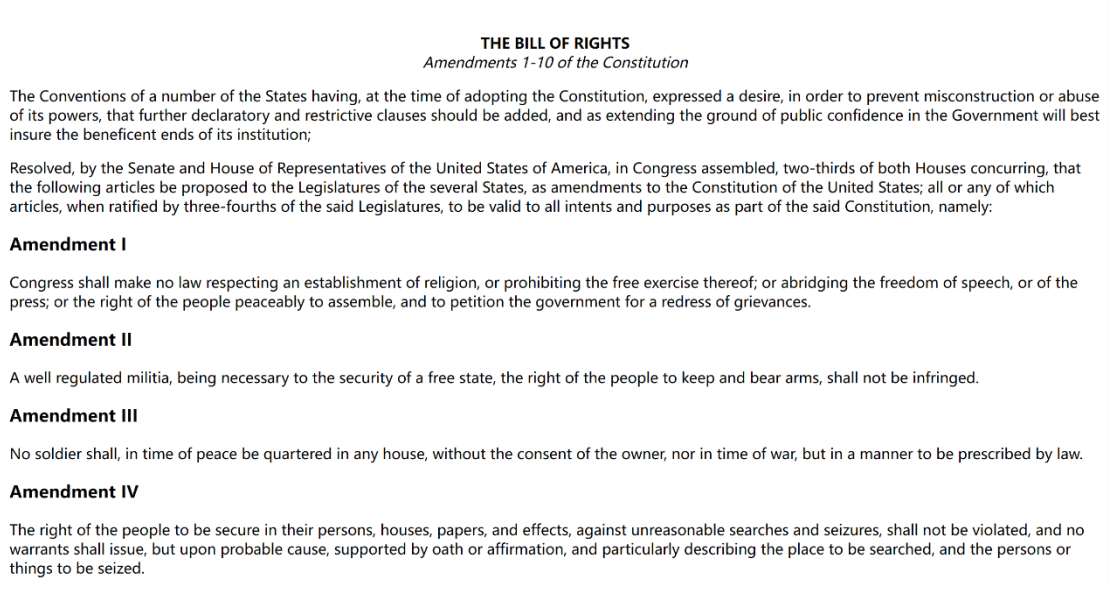
清除记录：



上指定网站：



THE BILL OF RIGHTS

Amendments 1-10 of the Constitution

The Conventions of a number of the States having, at the time of adopting the Constitution, expressed a desire, in order to prevent misconstruction or abuse of its powers, that further declaratory and restrictive clauses should be added, and as extending the ground of public confidence in the Government will best insure the beneficent ends of its institution;

Resolved, by the Senate and House of Representatives of the United States of America, in Congress assembled, two-thirds of both Houses concurring, that the following articles be proposed to the Legislatures of the several States, as amendments to the Constitution of the United States; all or any of which articles, when ratified by three-fourths of the said Legislatures, to be valid to all intents and purposes as part of the said Constitution, namely:

Amendment I

Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble, and to petition the government for a redress of grievances.

Amendment II

A well regulated militia, being necessary to the security of a free state, the right of the people to keep and bear arms, shall not be infringed.

Amendment III

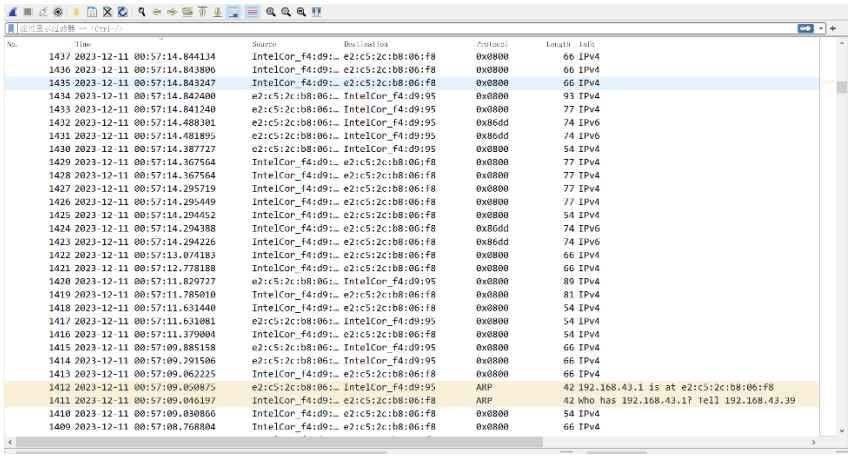
No soldier shall, in time of peace be quartered in any house, without the consent of the owner, nor in time of war, but in a manner to be prescribed by law.

Amendment IV

The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

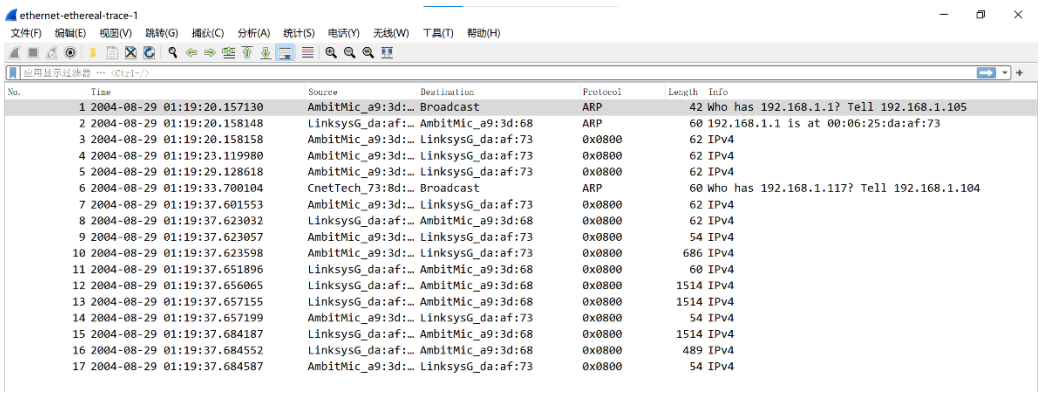
修改捕获数据包的协议类型，仅显示 IP 以下协议信息：

☐ IPv4	Internet Protocol Version 4
☑ IPv4 Address Acknowledge...	MIPv6 Option - IPv4 Address Acknowledgement
☑ IPv4 Care-of Address	MIPv6 Option - IPv4 Care-of Address
☑ IPv4 Default Router Address	IPv4 Default Router Address
☑ IPv4 Default-Router Address	MIPv6 Option - IPv4 Default-Router Address
☑ IPv4 DHCP Support Mode	MIPv6 Option - IPv4 DHCP Support Mode
☑ IPv4 Home Address	MIPv6 Option - IPv4 Home Address
☑ IPv4 Home Address Reply	MIPv6 Option - IPv4 Home Address Reply
☑ IPv4 Home Address Request	MIPv6 Option - IPv4 Home Address Request
☐ IPv6	Internet Protocol Version 6
☑ IPv6 compression	IPv6 compression
☑ IPv6 Destination	Destination Options for IPv6
☑ IPv6 Fragment	Fragment Header for IPv6



No.	Time	Source	Destination	Protocol	Length	Info
1437	2023-12-11 00:57:14.844134	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	66	IPv4
1436	2023-12-11 00:57:14.843806	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	66	IPv4
1435	2023-12-11 00:57:14.843247	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	66	IPv4
1434	2023-12-11 00:57:14.842400	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x0800	93	IPv4
1433	2023-12-11 00:57:14.841240	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x0800	77	IPv4
1432	2023-12-11 00:57:14.488301	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x86dd	74	IPv6
1431	2023-12-11 00:57:14.481895	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x86dd	74	IPv6
1430	2023-12-11 00:57:14.387727	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x0800	54	IPv4
1429	2023-12-11 00:57:14.367564	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	77	IPv4
1428	2023-12-11 00:57:14.367564	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	77	IPv4
1427	2023-12-11 00:57:14.295719	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	77	IPv4
1426	2023-12-11 00:57:14.295449	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	77	IPv4
1425	2023-12-11 00:57:14.294452	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	54	IPv4
1424	2023-12-11 00:57:14.294388	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x86dd	74	IPv6
1423	2023-12-11 00:57:14.294226	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x86dd	74	IPv6
1422	2023-12-11 00:57:13.074183	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	66	IPv4
1421	2023-12-11 00:57:12.778188	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	66	IPv4
1420	2023-12-11 00:57:11.829727	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x0800	89	IPv4
1419	2023-12-11 00:57:11.785010	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	81	IPv4
1418	2023-12-11 00:57:11.631440	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	54	IPv4
1417	2023-12-11 00:57:11.631081	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x0800	54	IPv4
1416	2023-12-11 00:57:11.379004	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	54	IPv4
1415	2023-12-11 00:57:09.885158	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x0800	66	IPv4
1414	2023-12-11 00:57:09.291506	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	0x0800	66	IPv4
1413	2023-12-11 00:57:09.062225	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	66	IPv4
1412	2023-12-11 00:57:09.050875	e2:c5:2c:b8:06:…	IntelCor_f4:d9:95	ARP	42	192.168.43.1 is at e2:c5:2c:b8:06:f8
1411	2023-12-11 00:57:09.046197	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	ARP	42	Who has 192.168.43.1? Tell 192.168.43.39
1410	2023-12-11 00:57:09.030866	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	54	IPv4
1409	2023-12-11 00:57:08.768804	IntelCor_f4:d9:…	e2:c5:2c:b8:06:f8	0x0800	66	IPv4

由于抓包干扰较多，采取文档提供的包：



ethernet-ethereal-trace-1

文件(F) 编辑(E) 视图(V) 跳转(G) 捕获(C) 分析(A) 统计(S) 电话(Y) 无线(W) 工具(T) 帮助(H)

No.	Time	Source	Destination	Protocol	Length	Info
1	2004-08-29 01:19:20.157130	AmbitMic_a9:3d:…	Broadcast	ARP	42	Who has 192.168.1.1? Tell 192.168.1.105
2	2004-08-29 01:19:20.158148	LinksysG_da:af:…	AmbitMic_a9:3d:68	ARP	60	192.168.1.1 is at 00:06:25:da:af:73
3	2004-08-29 01:19:20.158158	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	62	IPv4
4	2004-08-29 01:19:23.119980	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	62	IPv4
5	2004-08-29 01:19:29.128618	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	62	IPv4
6	2004-08-29 01:19:33.700104	CnetTech_73:8d:…	Broadcast	ARP	60	Who has 192.168.1.117? Tell 192.168.1.104
7	2004-08-29 01:19:37.601553	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	62	IPv4
8	2004-08-29 01:19:37.623032	LinksysG_da:af:…	AmbitMic_a9:3d:68	0x0800	62	IPv4
9	2004-08-29 01:19:37.623057	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	54	IPv4
10	2004-08-29 01:19:37.623598	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	686	IPv4
11	2004-08-29 01:19:37.651896	LinksysG_da:af:…	AmbitMic_a9:3d:68	0x0800	60	IPv4
12	2004-08-29 01:19:37.656065	LinksysG_da:af:…	AmbitMic_a9:3d:68	0x0800	1514	IPv4
13	2004-08-29 01:19:37.657155	LinksysG_da:af:…	AmbitMic_a9:3d:68	0x0800	1514	IPv4
14	2004-08-29 01:19:37.657199	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	54	IPv4
15	2004-08-29 01:19:37.684187	LinksysG_da:af:…	AmbitMic_a9:3d:68	0x0800	1514	IPv4
16	2004-08-29 01:19:37.684552	LinksysG_da:af:…	AmbitMic_a9:3d:68	0x0800	489	IPv4
17	2004-08-29 01:19:37.684587	AmbitMic_a9:3d:…	LinksysG_da:af:73	0x0800	54	IPv4

1. What is the 48-bit Ethernet address of your computer?

AmbitMic_a9:3d:68 LinksysG_da:af:73 0x0800 62 IPv4

AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)

Ethernet address: AmbitMic_a9:3d:68(00:d0:59:a9:3d:68)

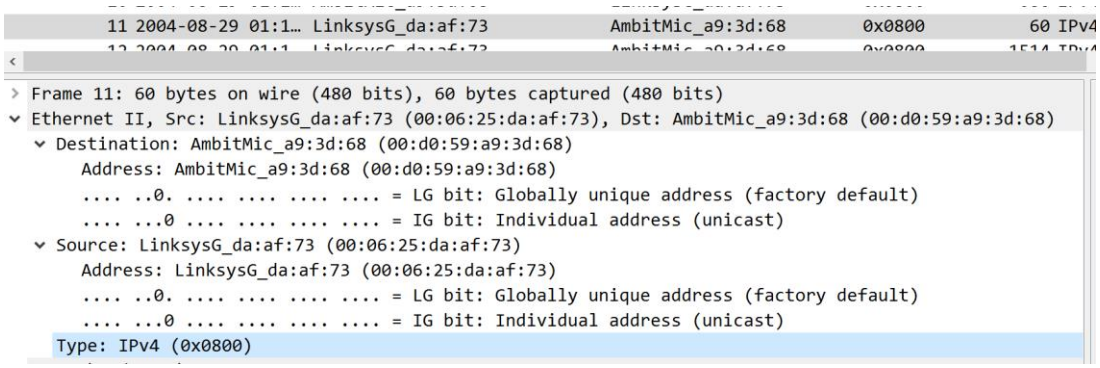
2. What is the 48-bit destination address in the Ethernet frame? Is this the Ethernet address of gaia.cs.umass.edu? (Hint: the answer is no). What device has this as its Ethernet address? [Note: this is an important question, and one that students sometimes get wrong. Re-read pages 468-469 in the text and make sure

you understand the answer here.]

Destination: LinksysG_da:af:73 (00:06:25:da:af:73)

不是 gaia.cs.umass.edu 的 Ethernet address，该地址有可能是连接该子网的路由器。

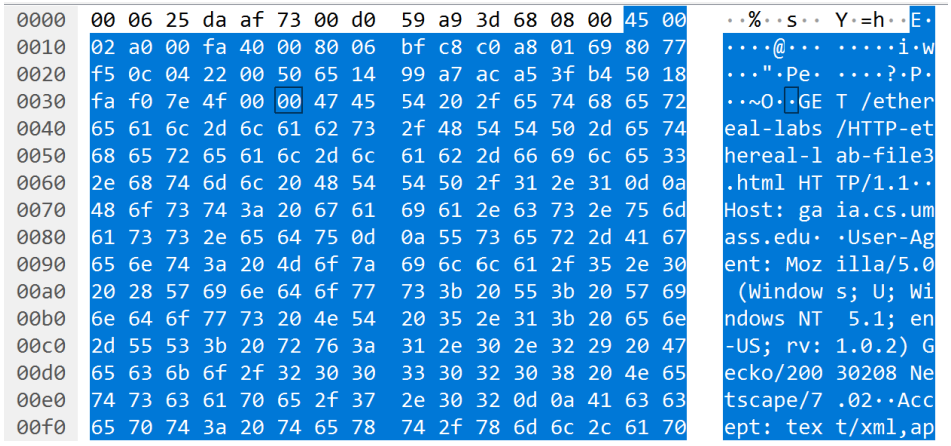
3. Give the hexadecimal value for the two-byte Frame type field. What upper layer protocol does this correspond to?



hexadecimal value：0x0800

协议：IPv4

4. How many bytes from the very start of the Ethernet frame does the ASCII "G" in "GET" appear in the Ethernet frame?



由图，前面有三行，所以是 48 个，G 之前的第四行有 6 个，所以 G 之前有 54 字节（不包括 G，如果包括则为 55）。

5. What is the value of the Ethernet source address? Is this the address of your computer, or of gaia.cs.umass.edu (Hint: the answer is no). What device has this as its Ethernet address?

Source: LinksysG_da:af:73 (00:06:25:da:af:73)

LinksysG_da:af:73 (00:06:25:da:af:73)

不是 address of my computer 或者 gaia.cs.umass.edu，是连接子网的路由器地址。

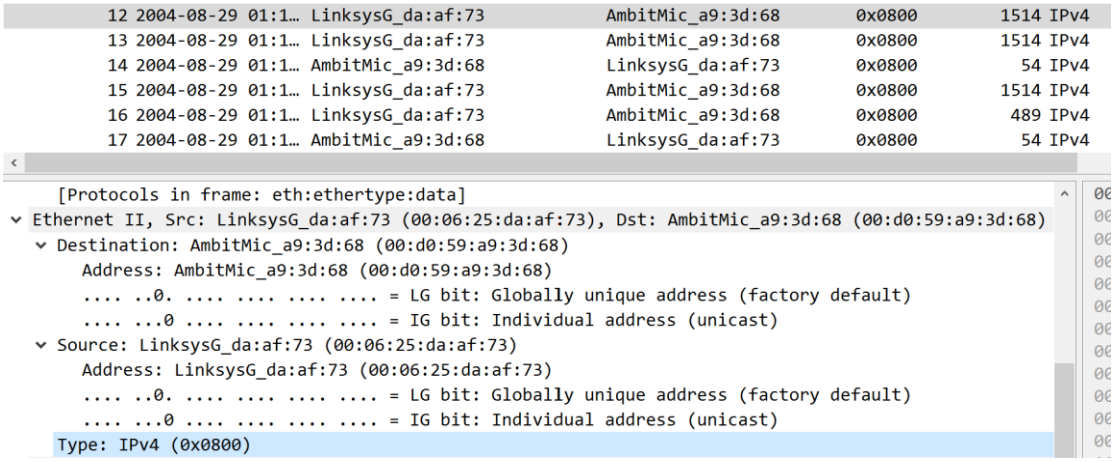
6. What is the destination address in the Ethernet frame? Is this the Ethernet address of your computer?

```
Destination: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
   Address: AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)
```

AmbitMic_a9:3d:68(00:d0:59:a9:3d:68)

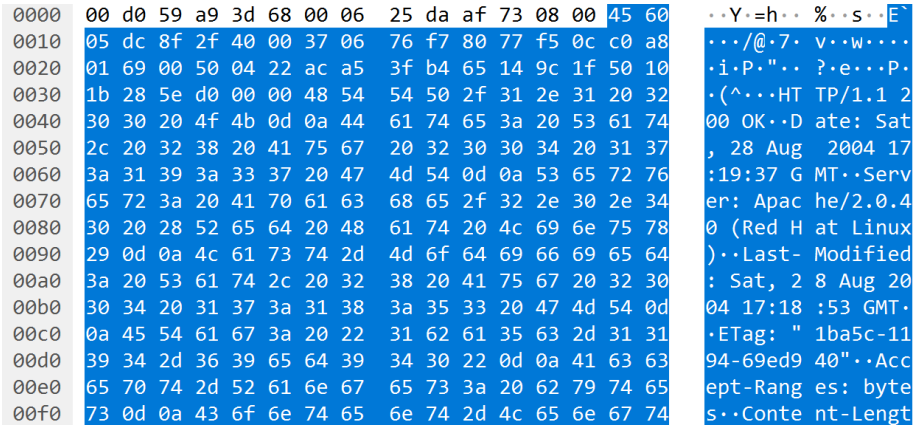
是 the Ethernet address of my computer

7. Give the hexadecimal value for the two-byte Frame type field. What upper layer protocol does this correspond to?



答案：0x0800，IPv4

8. How many bytes from the very start of the Ethernet frame does the ASCII “0” in “OK” (i.e., the HTTP response code) appear in the Ethernet frame?



4*16 + 3 =67 （不包括“0”，包括“0”则为 68）

9. Write down the contents of your computer’s ARP cache. What is the meaning of each column value?

```
C:\Users\86181>arp -a

接口: 192.168.43.39 --- 0xa
  Internet 地址         物理地址              类型
  192.168.43.1          e2-c5-2c-b8-06-f8     动态
  192.168.43.255        ff-ff-ff-ff-ff-ff     静态
  224.0.0.22            01-00-5e-00-00-16     静态
  224.0.0.251           01-00-5e-00-00-fb     静态
  224.0.0.252           01-00-5e-00-00-fc     静态
  239.255.255.250       01-00-5e-7f-ff-fa     静态
  255.255.255.255       ff-ff-ff-ff-ff-ff     静态

接口: 192.168.137.1 --- 0xe
  Internet 地址         物理地址              类型
  192.168.137.255       ff-ff-ff-ff-ff-ff     静态
  224.0.0.22            01-00-5e-00-00-16     静态
  224.0.0.251           01-00-5e-00-00-fb     静态
  224.0.0.252           01-00-5e-00-00-fc     静态
  239.255.255.250       01-00-5e-7f-ff-fa     静态
  255.255.255.255       ff-ff-ff-ff-ff-ff     静态
```

网卡：192.168.43.39

路由 IP：

```
192.168.43.1          e2-c5-2c-b8-06-f8     动态
```

组播地址：

```
255.255.255.255       ff-ff-ff-ff-ff-ff     静态
```

MAC 地址：

```
192.168.43.255        ff-ff-ff-ff-ff-ff     静态
```

广播地址：

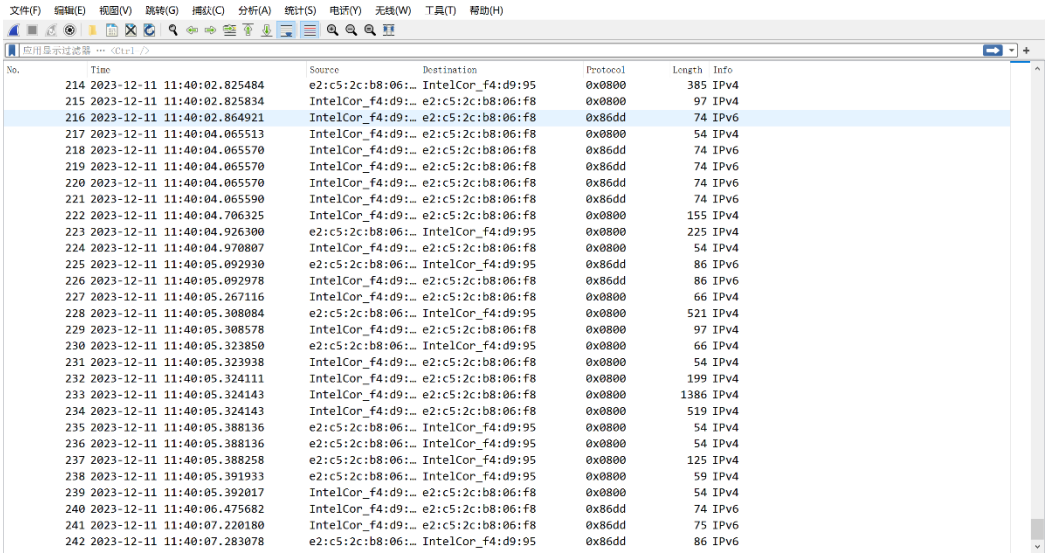
```
224.0.0.22            01-00-5e-00-00-16     静态
224.0.0.251           01-00-5e-00-00-fb     静态
224.0.0.252           01-00-5e-00-00-fc     静态
239.255.255.250       01-00-5e-7f-ff-fa     静态
```

进行如下操作：

1. clear arp 缓存：

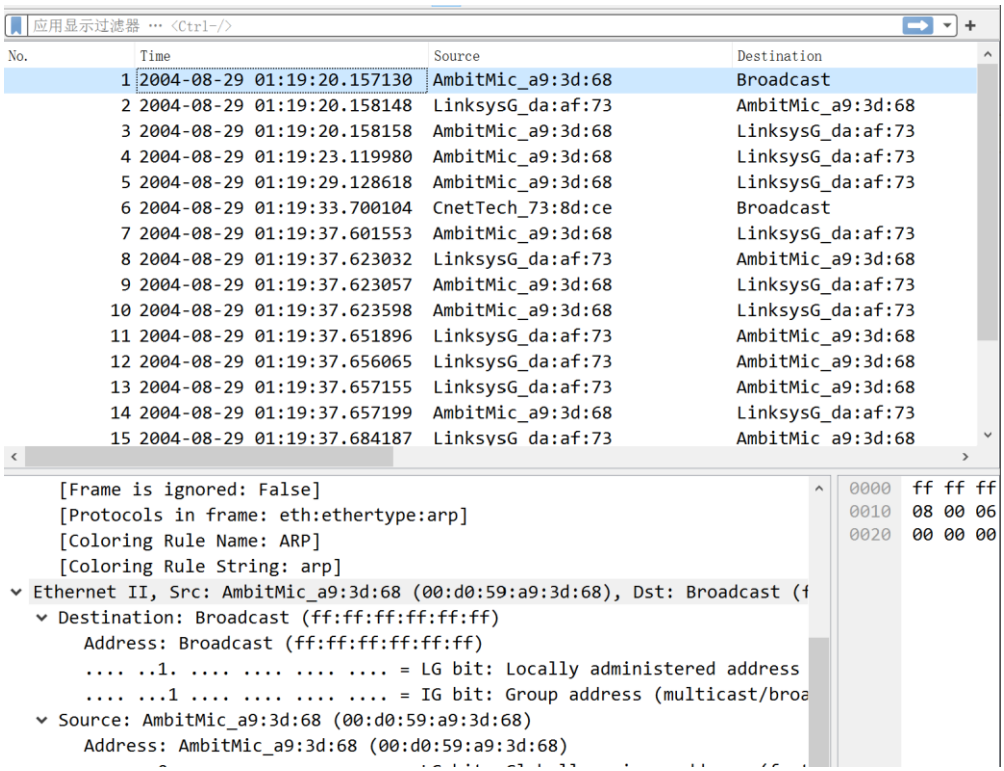
```
C:\Windows\system32>arp -d

C:\Windows\system32>
```

2. 清空浏览器缓存
3. wireshark 抓包
4. 打开停止抓包
5. 抓包界面如下（只有比 IP 低层的协议）



使用作者的包进行回答问题。

10. What are the hexadecimal values for the source and destination addresses in the Ethernet frame containing the ARP request message?



destination : Broadcast (ff:ff:ff:ff:ff:ff)

source : AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)

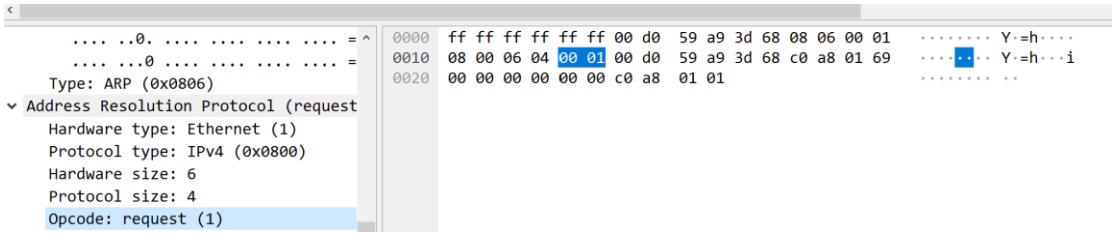
11. Give the hexadecimal value for the two-byte Ethernet Frame type field. What upper layer protocol does this correspond to?

```
▾ Destination: Broadcast (ff:ff:ff:ff:ff:ff)
    Address: Broadcast (ff:ff:ff:ff:ff:ff)
    .... ..1. .... .... .... .... = LG bit: Locally administered address
    .... ...1 .... .... .... .... = IG bit: Group address (multicast/broa
▾ Source: 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 (fact
    .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  Type: ARP (0x0806)
```

ARP(0x0806)

12. Download the ARP specification from ftp://ftp.rfc-editor.org/in-notes/std/std37.txt. A readable, detailed discussion of ARP is also at http://www.erg.abdn.ac.uk/users/gorry/course/inet-pages/arp.html.

a) How many bytes from the very beginning of the Ethernet frame does the ARP opcode field begin?



20bytes(如果包括 opcode 的开头就是 21)

b) What is the value of the opcode field within the ARP-payload part of the Ethernet frame in which an ARP request is made?

如上图 0x0001

c) Does the ARP message contain the IP address of the sender?

```
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
```

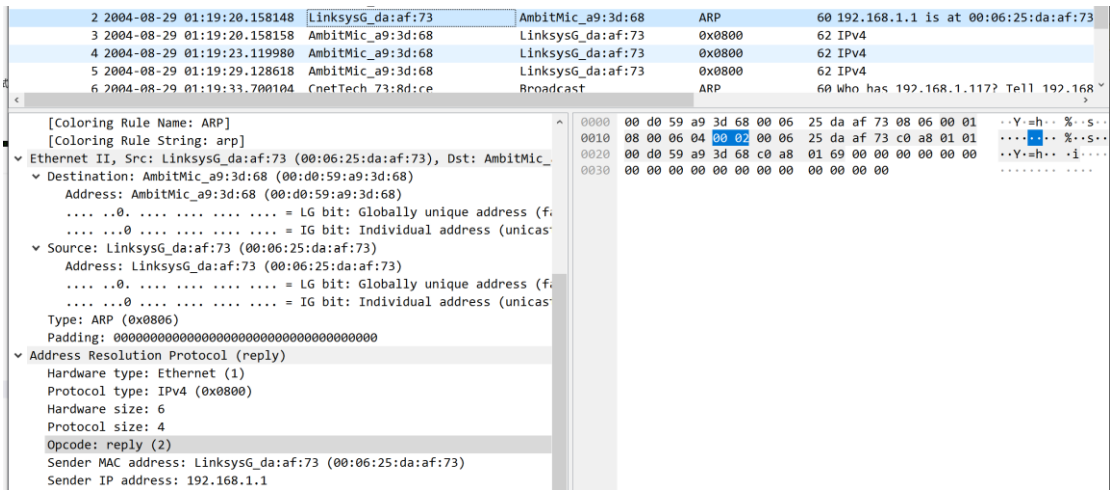
包含 the IP address of the sender

d) Where in the ARP request does the "question" appear - the Ethernet address of the machine whose corresponding IP address is being queried?

Opcode 告诉我们是 request

13. Now find the ARP reply that was sent in response to the ARP request.

a) How many bytes from the very beginning of the Ethernet frame does the ARP opcode field begin?



20bytes(如果包括 opcode 的开头就是 21)

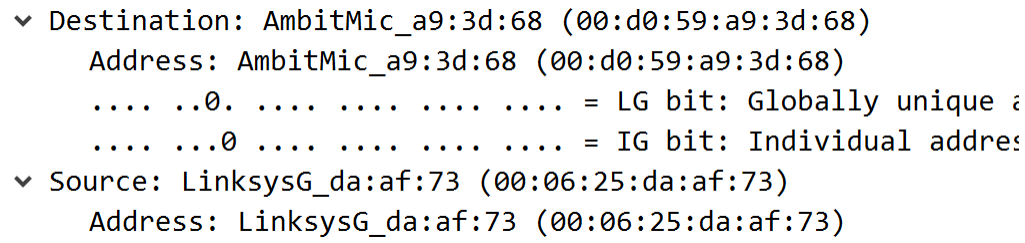
b) What is the value of the opcode field within the ARP-payload part of the Ethernet frame in which an ARP response is made?

值为 0x0002

c) Where in the ARP message does the "answer" to the earlier ARP request appear - the IP address of the machine having the Ethernet address whose corresponding IP address is being queried?

Opcode: reply(2)，是 reply

14. What are the hexadecimal values for the source and destination addresses in the Ethernet frame containing the ARP reply message?



destination : AmbitMic_a9:3d:68 (00:d0:59:a9:3d:68)

source : LinksysG_da:af:73 (00:06:25:da:af:73)

15. Open the ethernet-ethereal-trace-1 trace file in http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.Wireshark, and the ARP reply sent to the computer running Wireshark by the computer with the ARP-requested Ethernet address. But there is yet another computer on this network, as indicated by packet 6 - another ARP request. Why is there no ARP reply (sent in response to the ARP request in packet 6) in the packet trace?

ARP 查询报文通过广播帧传播，而响应 ARP 通过一个标准帧发送，所以响应 ARP 只有请求 ARP 的结点才可以接受，

Extra Credit

EX-1. The arp command: arp -s InetAddr EtherAddr allows you to manually add an entry to the ARP cache that resolves the IP address InetAddr to the physical address EtherAddr. What would happen if, when you manually added an entry, you entered the correct IP address, but the wrong Ethernet address for that remote interface?

如果输入了正确的 IP 地址，但输入了与该远程接口不匹配的错误的以太网地址，会导致通信失败：系统将尝试使用该错误的以太网地址与远程接口进行通信，但是由于以太网地址不匹配，通信将会失败。将无法与具有正确 IP 地址的远程主机建立连接。

EX-2. What is the default amount of time that an entry remains in your ARP cache before being removed. You can determine this empirically (by monitoring the cache contents) or by looking this up in your operation system documentation. Indicate how/where you determined this value.

```
C:\Windows\system32>netsh interface ipv4 show interfaces

Idx     Met         MTU          状态                名称
---  ----------  ----------  ------------  ---------------------------
  1          75  4294967295  connected     Loopback Pseudo-Interface 1
 10          55        1500  connected     WLAN
  3          25        1500  disconnected  本地连接* 1
 14          25        1500  connected     本地连接* 2
```

Idx=10 对应 WLAN：

```
C:\Windows\system32>netsh interface ipv4 show interface 10

接口 WLAN 参数
------------------------------------------
IfLuid                             : wireless_32768
IfIndex                            : 10
状态                               : connected
跃点数                             : 55
链接 MTU                           : 1500 字节
可访问时间                         : 33500 毫秒
基本可访问时间                     : 30000 毫秒
重传间隔                 : 1000 毫秒
DAD 传输                           : 3
站点前缀长度                       : 64
站点 ID                            : 1
转发                               : disabled
播发                               : disabled
邻居发现                       : enabled
邻居无法访问检测   : enabled
路由器发现                         : dhcp
受管理的地址配置         : enabled
其他有状态的配置         : enabled
弱主机发送                         : disabled
弱主机接收                       : disabled
使用自动跃点数                     : enabled
忽略默认路由                     : disabled
播发的路由器生存期               : 1800 秒
播发默认路由                 : disabled
当前跃点限制                       : 0
强制 ARPND 唤醒模式        : disabled
定向 MAC 唤醒模式        : disabled
ECN 功能                           : application
基于 RA 的 DNS 配置(RFC 6106)      : disabled
DHCP/静态 IP 共存          : disabled
```

基本可访问时间为 30000 毫秒，所以 ARP cache TTL 为 30000