Wireshark

Dr. Xiqun Lu
College of Computer Science and Technology,
Zhejiang University, Hangzhou

实验目的

- 通过分析各种不同网络协议，加深理解第一堂课中重点：“Protocol layering”
- Network architecture: a set of layers and protocols
- **Protocol stack**: a list of the protocols used by a certain system, one protocol per layer
  - A **protocol** defines the *format* and the *order* of messages exchanged between two or more communication entities, as well as the *actions* taken on the transmission and/or receipt of a message or other event. [2]

The TCP/IP Reference Model (IV)

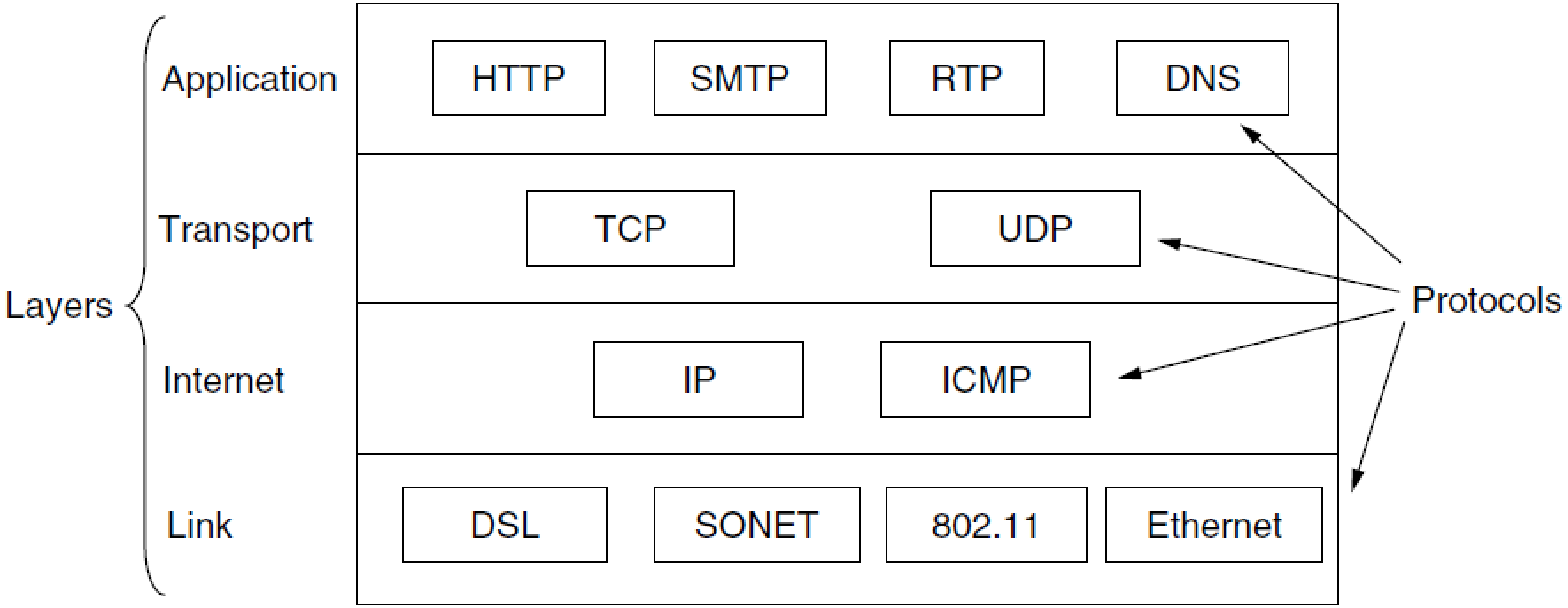
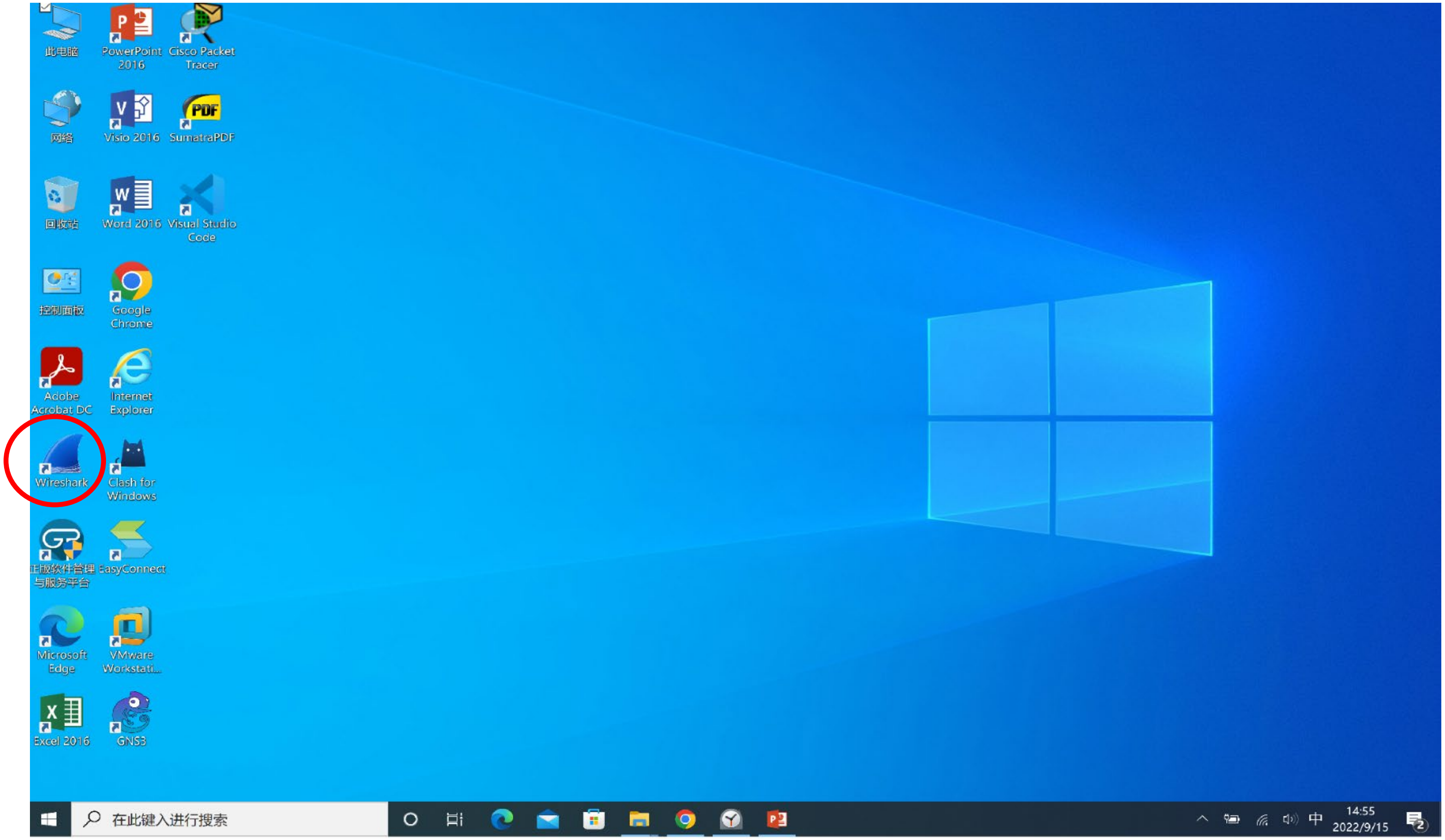


Figure 1-22. The TCP/IP model with some protocols we will study.

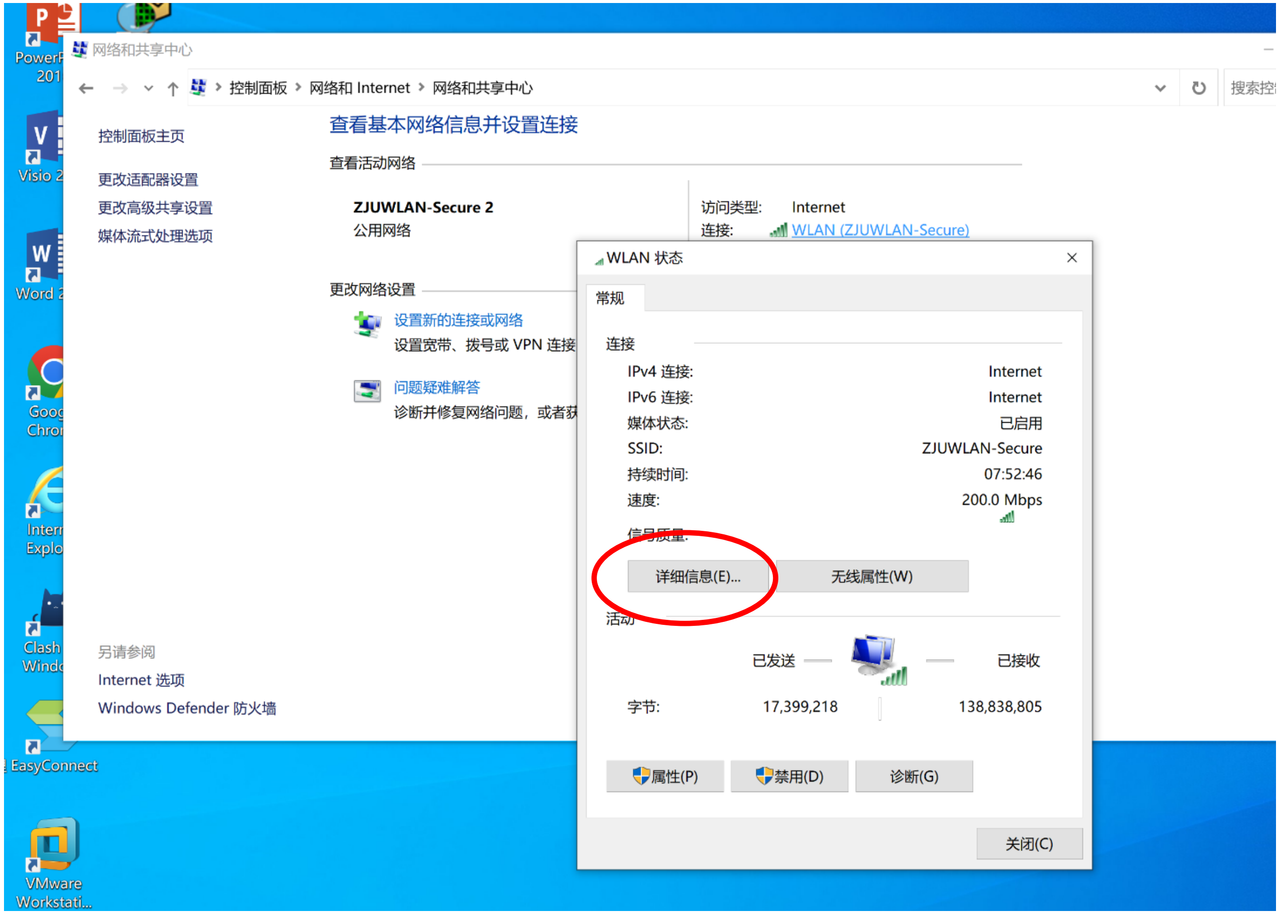
Step 1: WireShark

- 安装WireShark
  - 下载地址： https://www.wireshark.org/
  - 安装成功，桌面上会出现一个“鲨鱼鳍”的图标，如下图红圆圈中图标。



Step 2:了解自己电脑的一些网络一些设置

- 先在“控制面板” 中打开网络中心，然后详细信息里有你电脑当前所使用的IP地址，你也可以看一下你电脑的物理地址（MAC地址）



查看基本网络信息并设置连接

查看活动网络

ZJUWLAN-Secure 2
公用网络

访问类型: Internet
连接: WLAN (ZJUWLAN-Secure)

更改网络设置

设置新的连接或网络
设置宽带、拨号或 VPN 连接

问题疑难解答
诊断并修复网络问题，或者获

WLAN 状态

连接

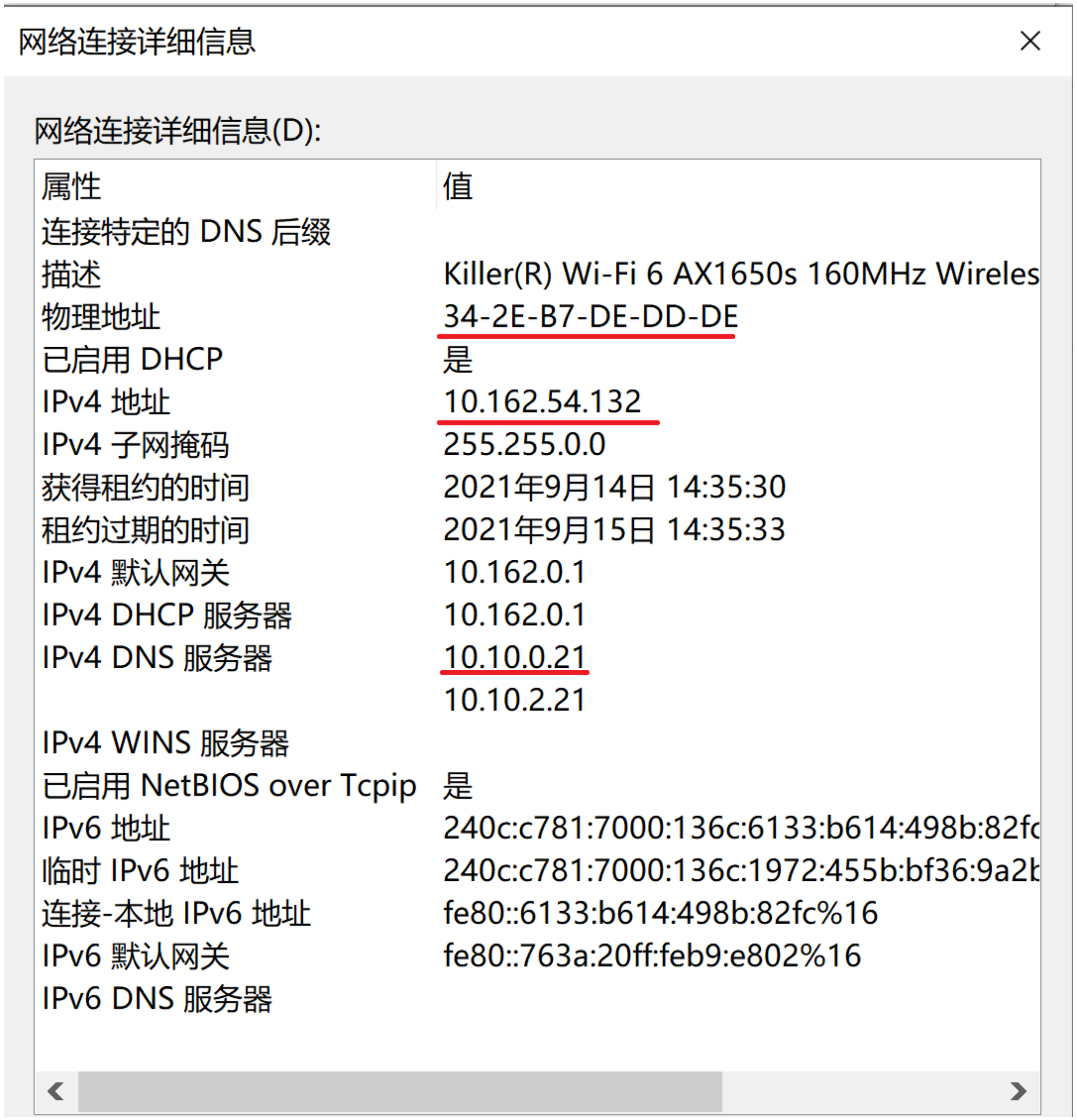
IPv4 连接: Internet
IPv6 连接: Internet
媒体状态: 已启用
SSID: ZJUWLAN-Secure
持续时间: 07:52:46
速度: 200.0 Mbps
信号质量:

活动

已发送 — 已接收
字节: 17,399,218 | 138,838,805

Step 2:了解自己电脑的一些网络设置

- 一些协议名称
  - IPv4, IPv6
  - DHCP
  - DNS
- 一些地址信息与概念：
  - 物理地址(MAC, 48bits): 34-2E-B7-DE-DD-DE
    - 一般是用小横杆-分开6个部分，每部分有2两个16进制数表示，所以2×4×6=48 bit
    - 如同人的身份证号，每个网卡都有唯一的MAC地址，这个地址是网卡在出产时就配置好，不会随着使用环境的变化而变化。



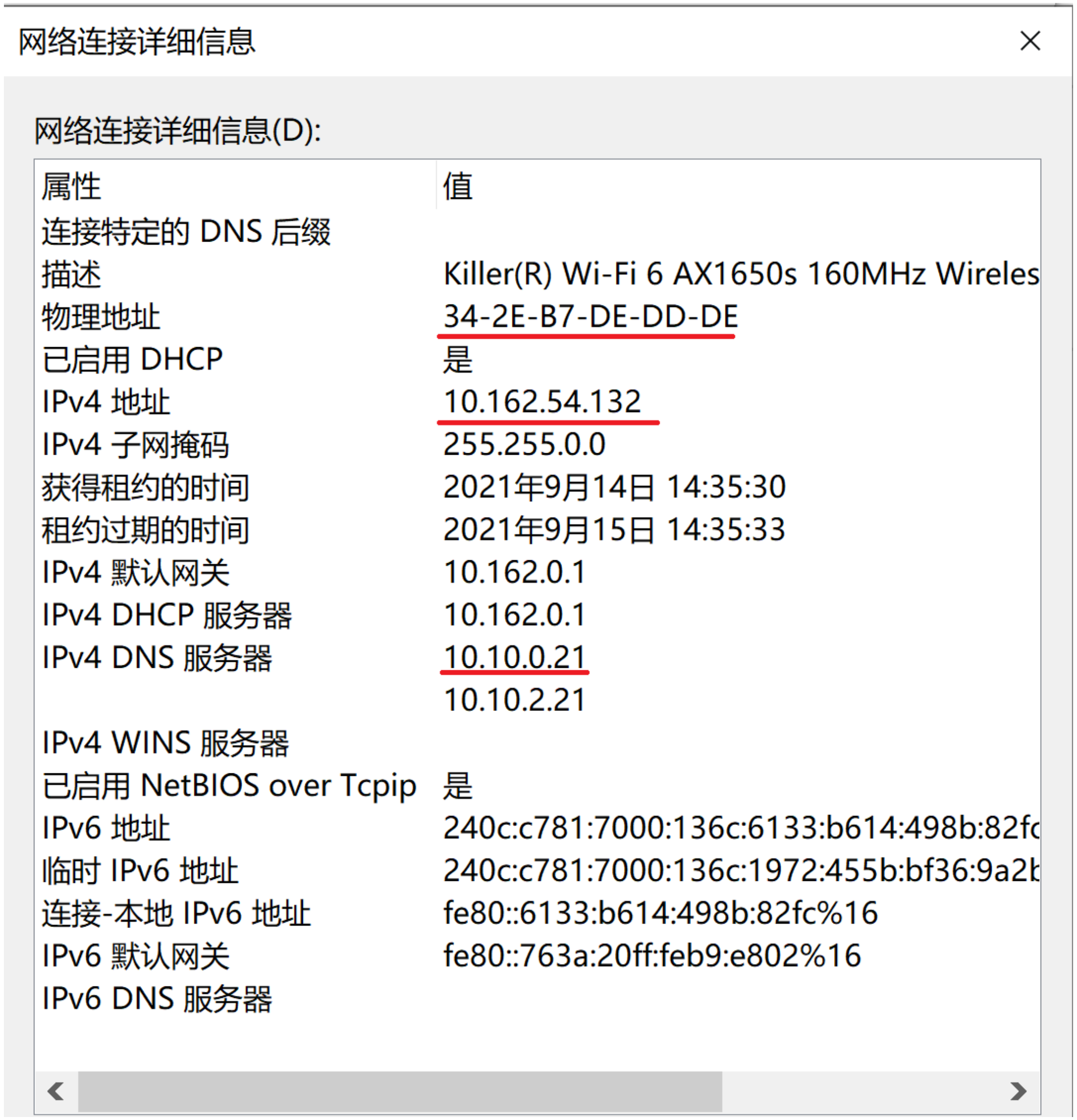
网络连接详细信息

网络连接详细信息(D):

属性	值
连接特定的 DNS 后缀	
描述	Killer(R) Wi-Fi 6 AX1650s 160MHz Wireles
物理地址	34-2E-B7-DE-DD-DE
已启用 DHCP	是
IPv4 地址	10.162.54.132
IPv4 子网掩码	255.255.0.0
获得租约的时间	2021年9月14日 14:35:30
租约过期的时间	2021年9月15日 14:35:33
IPv4 默认网关	10.162.0.1
IPv4 DHCP 服务器	10.162.0.1
IPv4 DNS 服务器	10.10.0.21 10.10.2.21
IPv4 WINS 服务器	
已启用 NetBIOS over Tcpip	是
IPv6 地址	240c:c781:7000:136c:6133:b614:498b:82fc
临时 IPv6 地址	240c:c781:7000:136c:1972:455b:bf36:9a2b
连接-本地 IPv6 地址	fe80::6133:b614:498b:82fc%16
IPv6 默认网关	fe80::763a:20ff:feb9:e802%16
IPv6 DNS 服务器	

Step 2:了解自己电脑的一些网络设置

- 一些地址信息与概念：
  - IPv4地址(32bits)：10.162.54.132
    - 格式为用点号分开四个部分，每一部分的值在0~255之间的十进制数，也就是说每一部分值需要用8bit表示，4×8 = 32 bit
  - 子网掩码：255.255.0.0
    - 可以判定哪些机器是在同意子网内，比如子网如果是255.255.0.0，那么地址为10.162.37.25和10.162.54.132在同一子网内，而地址为10.192.22.23的机器就不在同一子网。
  - IPv6地址(128bits)：240c:c781:7000:2d93:6133:b614:498b:82fc
    - 一般格式是用冒号分开8个部分，每部分有4个16进制数表示，所以4×4×8=128 bit
    - 如果出现多个“0”，可以两个冒号的简化形式。
  - IP地址会随着使用环境变化而变化，所以会有一个租用时间，一般为24小时。



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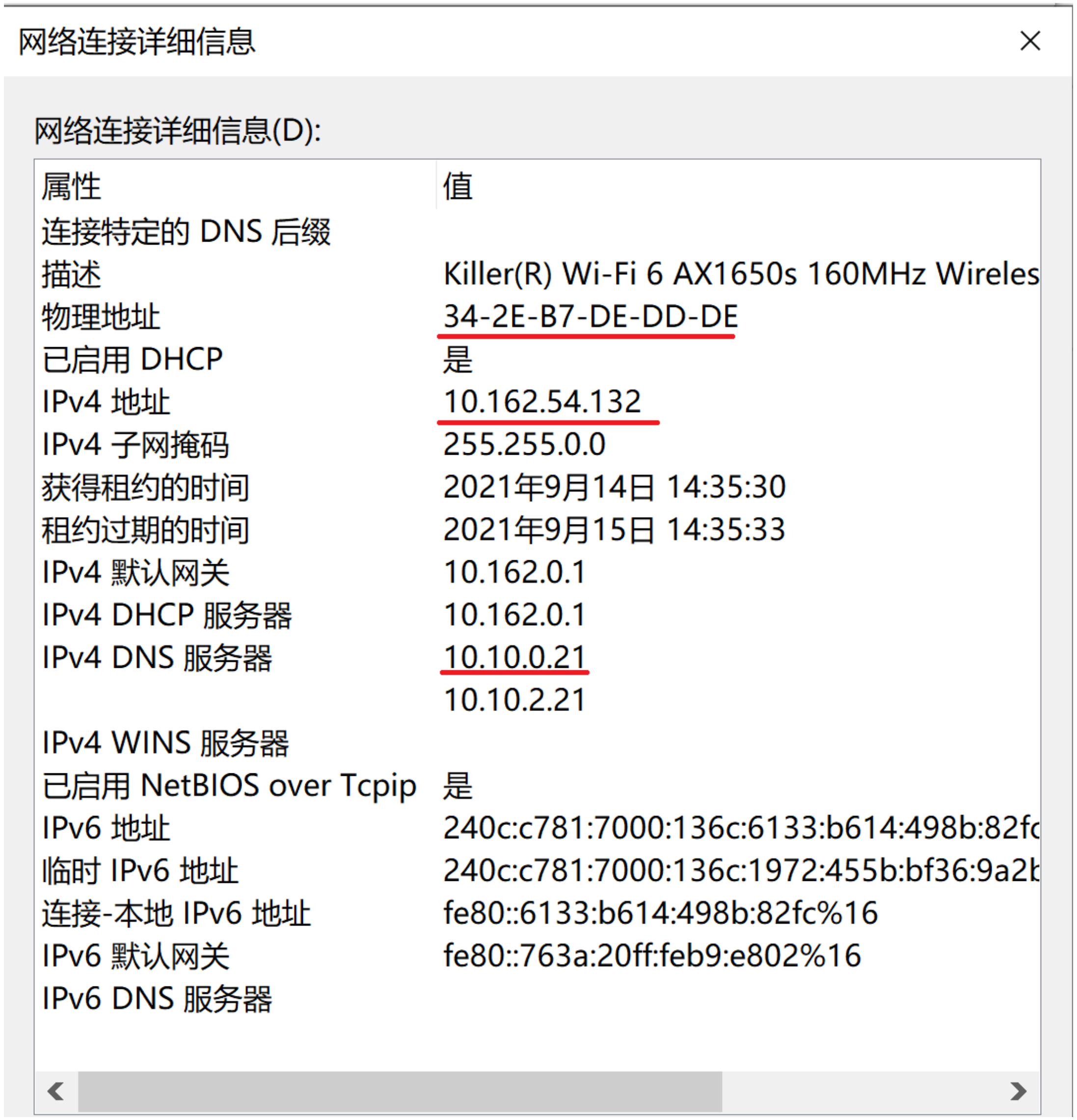
IPv6 DNS 服务器	

Step 2:了解自己电脑的一些网络设置

- 一些地址信息与概念：
  - 默认的网关地址：10.162.0.1
    - 一般采用子网内的最小地址10.162.0.1，或最大地址10.162.255.254
    - 注意全“0”地址是机器进入一个新网络环境中还未分配IP地址的初始化地址，比如在这个子网中10.162.0.0。
    - 注意全“1”地址是子网中的广播地址，比如在这个子网中10.162.255.255是广播地址，凡是数据包中目标地址为全“1”地址，是子网中所有机器都要接受的数据包。
    - 网关是机器进入Internet第一跳，在无线环境中通常就是接入点路由器(Access Point)的IP地址。



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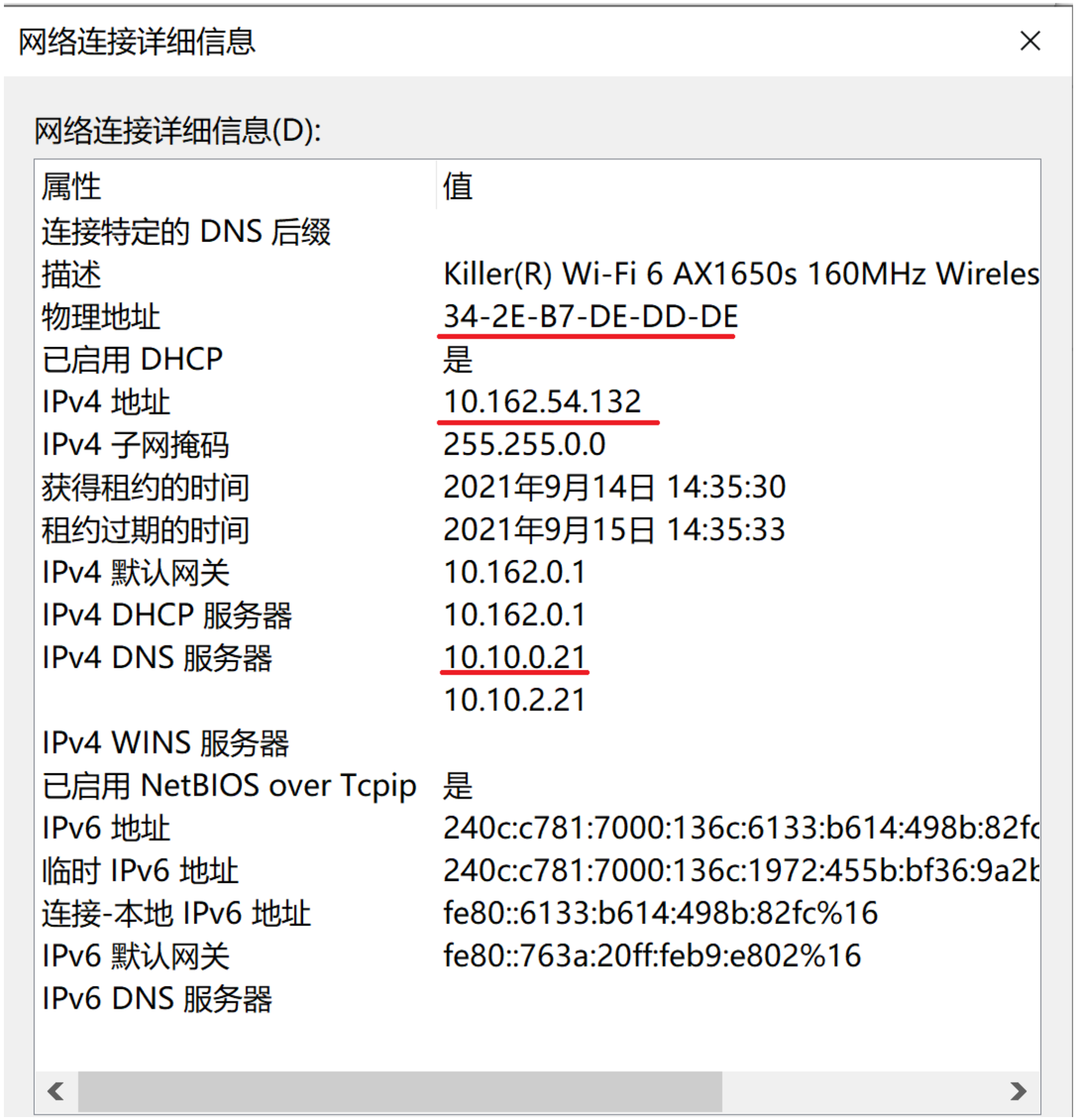
Step 2:了解自己电脑的一些网络设置

- 一些重要的协议：
  - DHCP (Dynamic Host Configuration Protocol)
    - DHCP 是一种运行在TCP/IP 网络中的网络协议，主要作用是为网络中的设备（如电脑、手机、智能设备等）自动分配 IP 地址、子网掩码、网关、DNS 服务器地址等网络配置信息，无需管理员手动为每台设备逐一设置，极大简化了网络管理。
    - DHCP服务器的地址通常就是该子网的网关地址。



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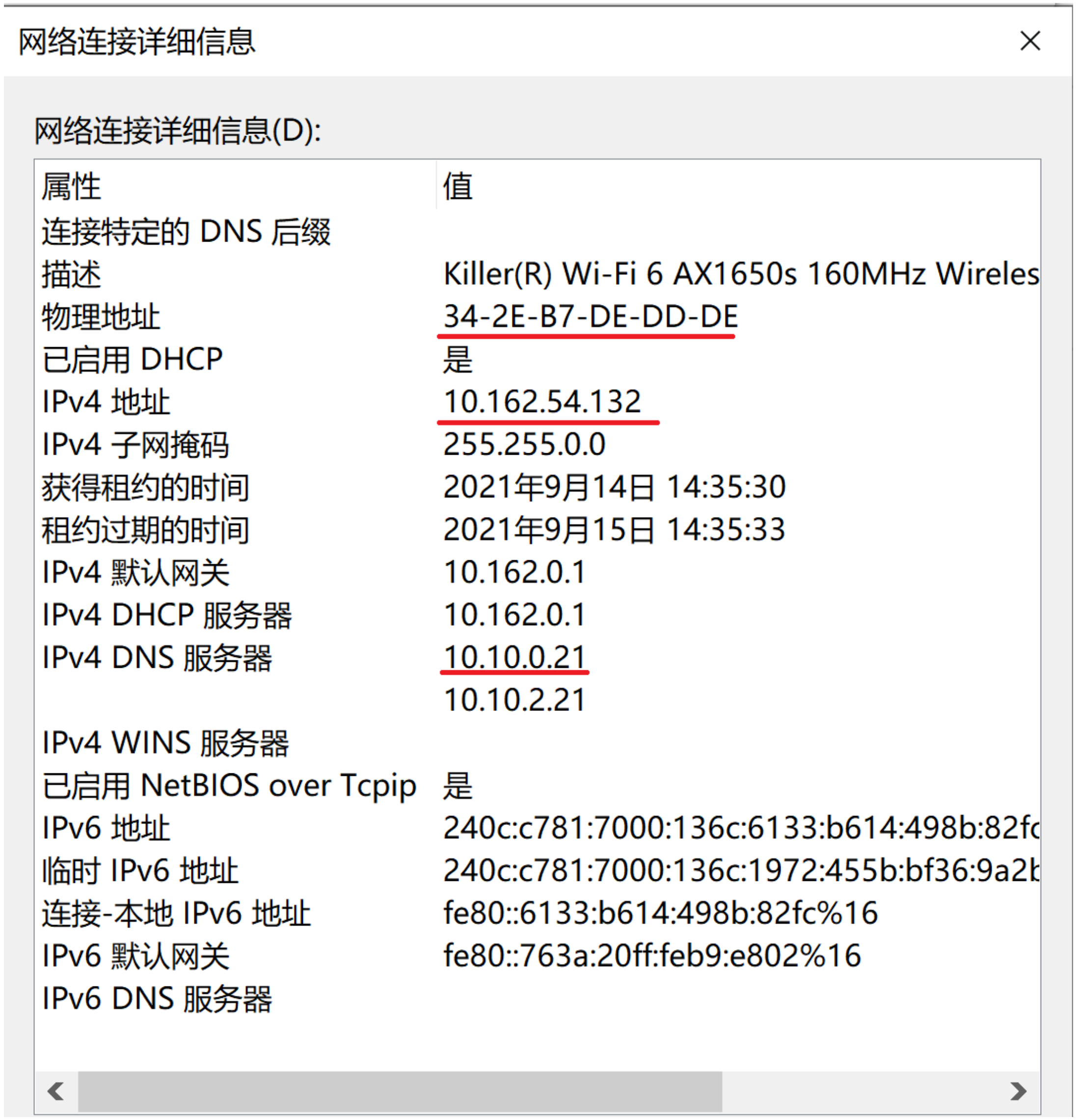
Step 2:了解自己电脑的一些网络设置

- 一些重要的协议：
  - DNS (Domain Name System)
    - 核心任务就是域名和IP地址的映射关系。
    - 将人类易于理解的 域名，比如www.baidu.com转换为机器可识别的 IP 地址，从而实现网络访问。
    - DNS 并非由单一服务器管理，而是一个 **分布式的数据库系统，** 通过多层级的服务器协作完成解析。
    - 这里10.10.0.21或10.10.2.21是本地local DNS服务器。



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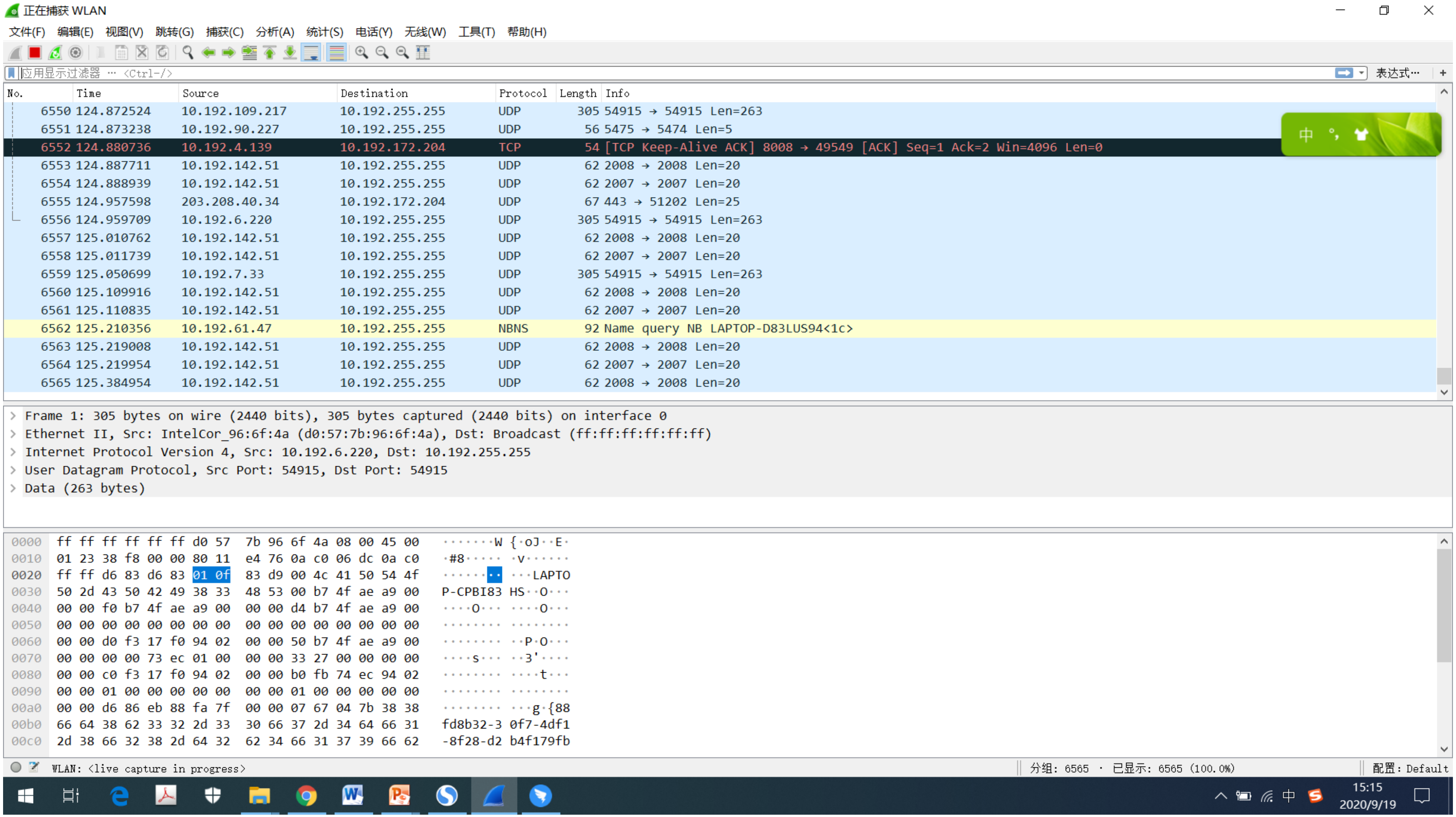
IPv6 DNS 服务器	

Interface of WireShark


正在捕获 WLAN
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)
应用显示过滤器 … <Ctrl-/>
表达式…
+
中

```
No.   Time       Source          Destination     Protocol Length Info
 6550 124.872524 10.192.109.217  10.192.255.255  UDP       305 54915 → 54915 Len=263
 6551 124.873238 10.192.90.227   10.192.255.255  UDP        56 5475 → 5474 Len=5
 6552 124.880736 10.192.4.139    10.192.172.204  TCP        54 [TCP Keep-Alive ACK] 8008 → 49549 [ACK] Seq=1 Ack=2 Win=4096 Len=0
 6553 124.887711 10.192.142.51   10.192.255.255  UDP        62 2008 → 2008 Len=20
 6554 124.888939 10.192.142.51   10.192.255.255  UDP        62 2007 → 2007 Len=20
 6555 124.957598 203.208.40.34   10.192.172.204  UDP        67 443 → 51202 Len=25
 6556 124.959709 10.192.6.220    10.192.255.255  UDP       305 54915 → 54915 Len=263
 6557 125.010762 10.192.142.51   10.192.255.255  UDP        62 2008 → 2008 Len=20
 6558 125.011739 10.192.142.51   10.192.255.255  UDP        62 2007 → 2007 Len=20
 6559 125.050699 10.192.7.33     10.192.255.255  UDP       305 54915 → 54915 Len=263
 6560 125.109916 10.192.142.51   10.192.255.255  UDP        62 2008 → 2008 Len=20
 6561 125.110835 10.192.142.51   10.192.255.255  UDP        62 2007 → 2007 Len=20
 6562 125.210356 10.192.61.47    10.192.255.255  NBNS       92 Name query NB LAPTOP-D83LUS94<1c>
 6563 125.219008 10.192.142.51   10.192.255.255  UDP        62 2008 → 2008 Len=20
 6564 125.219954 10.192.142.51   10.192.255.255  UDP        62 2007 → 2007 Len=20
 6565 125.384954 10.192.142.51   10.192.255.255  UDP        62 2008 → 2008 Len=20
```

```
> Frame 1: 305 bytes on wire (2440 bits), 305 bytes captured (2440 bits) on interface 0
> Ethernet II, Src: IntelCor_96:6f:4a (d0:57:7b:96:6f:4a), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
> Internet Protocol Version 4, Src: 10.192.6.220, Dst: 10.192.255.255
> User Datagram Protocol, Src Port: 54915, Dst Port: 54915
> Data (263 bytes)
```

```
0000  ff ff ff ff ff ff d0 57  7b 96 6f 4a 08 00 45 00   ·······W {·oJ··E·
0010  01 23 38 f8 00 00 80 11  e4 76 0a c0 06 dc 0a c0   ·#8····· ·v······
0020  ff ff d6 83 d6 83 01 0f  83 d9 00 4c 41 50 54 4f   ········ ···LAPTO
0030  50 2d 43 50 42 49 38 33  48 53 00 b7 4f ae a9 00   P-CPBI83 HS··O···
0040  00 00 f0 b7 4f ae a9 00  00 00 d4 b7 4f ae a9 00   ····O··· ····O···
0050  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
0060  00 00 d0 f3 17 f0 94 02  00 00 50 b7 4f ae a9 00   ········ ··P·O···
0070  00 00 00 00 73 ec 01 00  00 00 33 27 00 00 00 00   ····s··· ··3'····
0080  00 00 c0 f3 17 f0 94 02  00 00 b0 fb 74 ec 94 02   ········ ····t···
0090  00 00 01 00 00 00 00 00  00 00 01 00 00 00 00 00   ········ ········
00a0  00 00 d6 86 eb 88 fa 7f  00 00 07 67 04 7b 38 38   ········ ···g·{88
00b0  66 64 38 62 33 32 2d 33  30 66 37 2d 34 64 66 31   fd8b32-3 0f7-4df1
00c0  2d 38 66 32 38 2d 64 32  62 34 66 31 37 39 66 62   -8f28-d2 b4f179fb
```

WLAN: <live capture in progress>

分组: 6565 · 已显示: 6565 (100.0%)

配置: Default

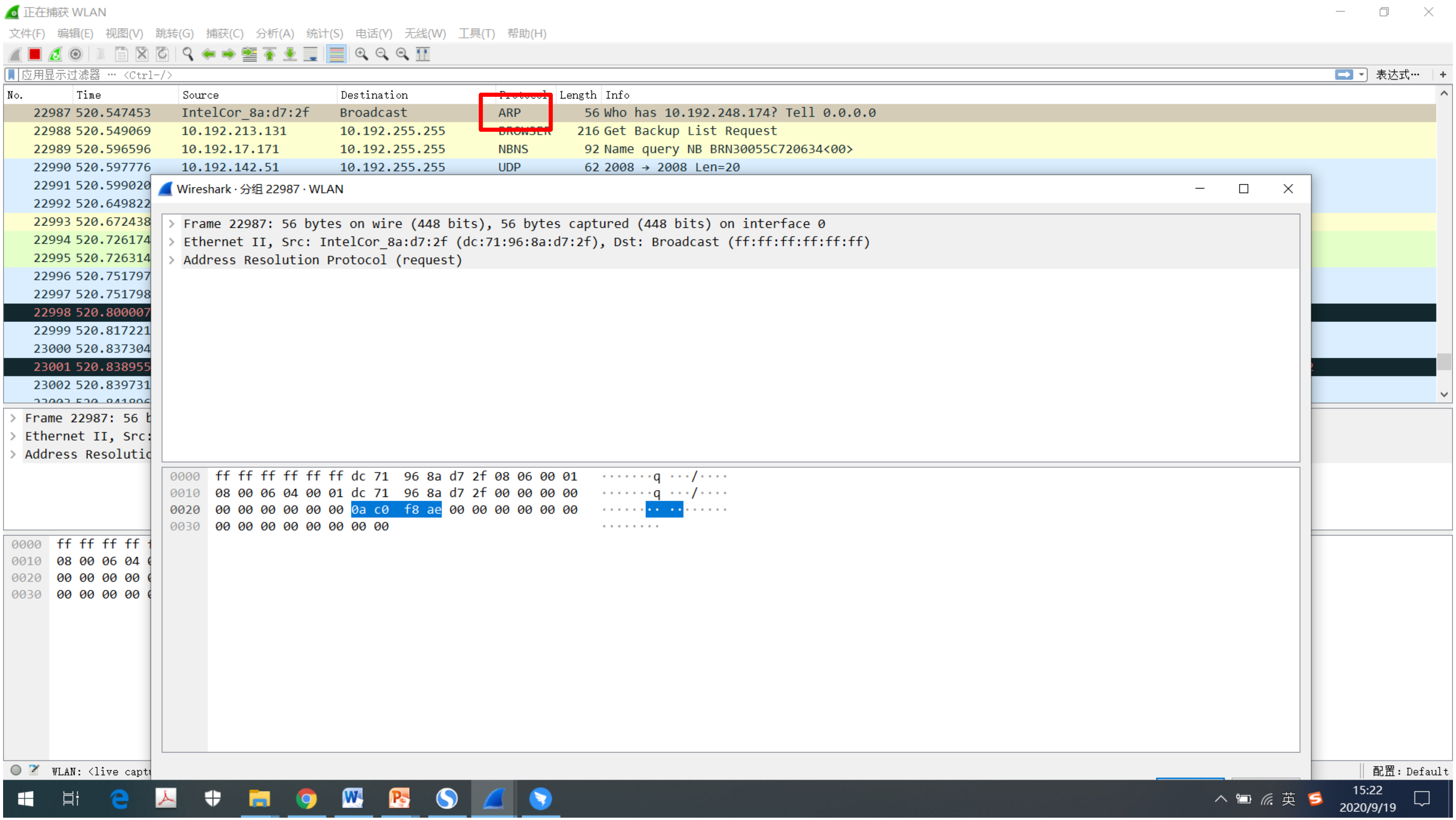
15:15
2020/9/19

- 至上而下Wireshark三个面板：“Packet List”（分组列表），“Packet Detail”(分组详情)，“Packet Byte”(分组字节流)

Interface of Wireshark

- Wireshark三个面板：
  - “Packet List” （分组列表）
  - “Packet Detail” (分组详情)
  - “Packet Byte” (分组字节流)
- 列表中的每行显示捕捉文件的一个包。如果你的鼠标移到其中一行上，该包的更多详细信息会显示在“Packet Detail/分组详情”和"Packet Byte/分组字节流"面板。
- 在分析(解剖)分组时，Wireshark会将协议信息放到各个列。因为高层协议通常会覆盖底层协议，您通常在分组列表面板看到的都是每个包的最高层协议描述。（在Wireshark中最高层是应用层，底层是数据链路层）

Example I: ARP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应用显示过滤器 … <Ctrl-/>
表达式…
Wireshark · 分组 22987 · WLAN
WLAN: <live capt
配置: Default
15:22
2020/9/19

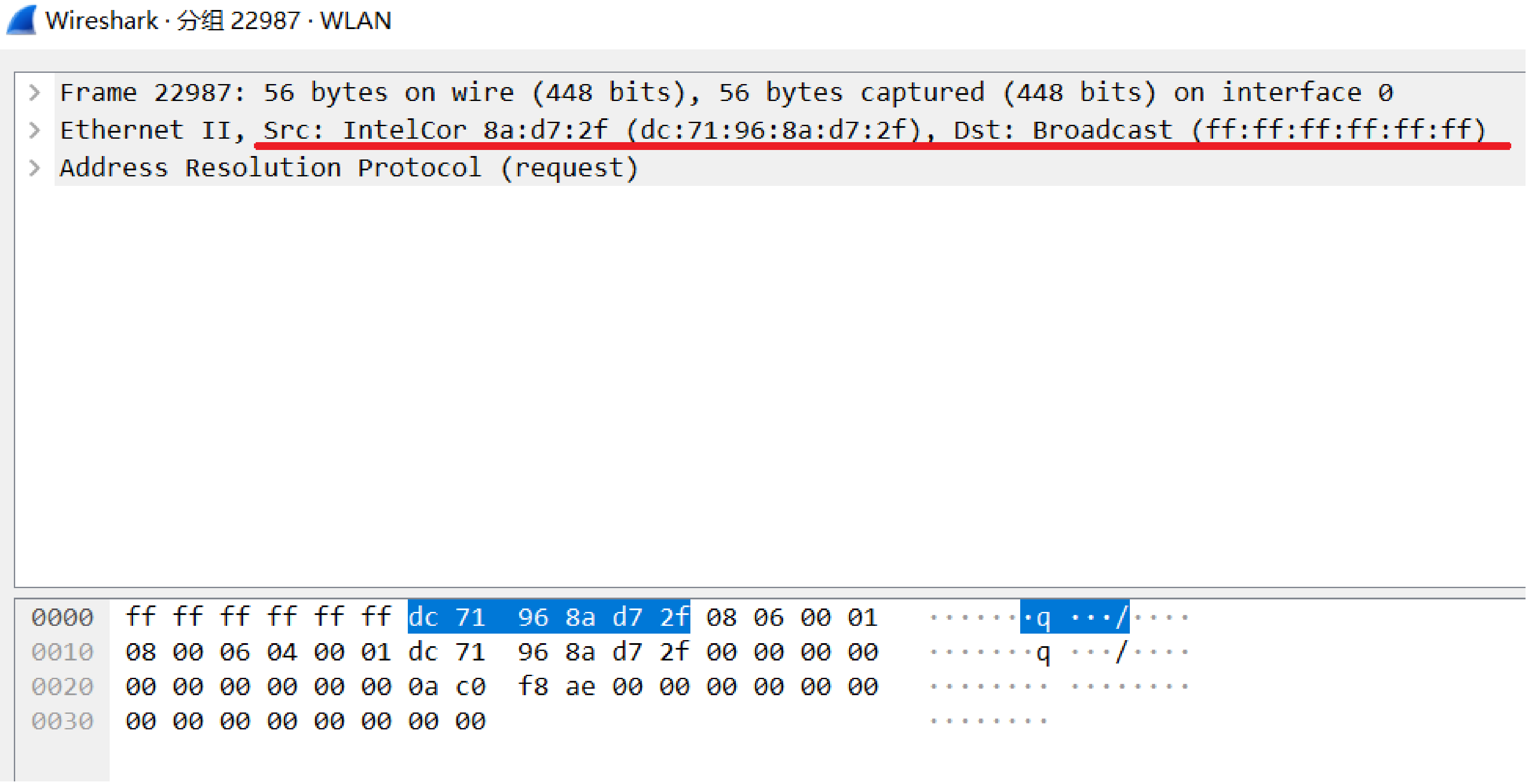
```
No.   Time        Source             Destination      Protocol Length Info
22987 520.547453  IntelCor_8a:d7:2f  Broadcast        ARP        56 Who has 10.192.248.174? Tell 0.0.0.0
22988 520.549069  10.192.213.131     10.192.255.255   BROWSER   216 Get Backup List Request
22989 520.596596  10.192.17.171      10.192.255.255   NBNS       92 Name query NB BRN30055C720634<00>
22990 520.597776  10.192.142.51      10.192.255.255   UDP        62 2008 → 2008 Len=20
22991 520.599020
22992 520.649822
22993 520.672438
22994 520.726174
22995 520.726314
22996 520.751797
22997 520.751798
22998 520.800007
22999 520.817221
23000 520.837304
23001 520.838955
23002 520.839731
```

```
> Frame 22987: 56 bytes on wire (448 bits), 56 bytes captured (448 bits) on interface 0
> Ethernet II, Src: IntelCor_8a:d7:2f (dc:71:96:8a:d7:2f), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
> Address Resolution Protocol (request)
```

```
0000  ff ff ff ff ff ff dc 71  96 8a d7 2f 08 06 00 01   ·······q ···/····
0010  08 00 06 04 00 01 dc 71  96 8a d7 2f 00 00 00 00   ·······q ···/····
0020  00 00 00 00 00 00 0a c0  f8 ae 00 00 00 00 00 00   ········ ········
0030  00 00 00 00 00 00 00 00                            ········
```

ARP: Address Resolution Protocol [2]

- Because there are both *network-layer addresses* (for example, Internet **IP addresses**) and *link-layer addresses* (that is, **MAC addresses**), there is a need to translate between them. For the Internet, this is the job of the **Address Resolution Protocol (ARP)** [RFC826]



Wireshark · 分组 22987 · WLAN

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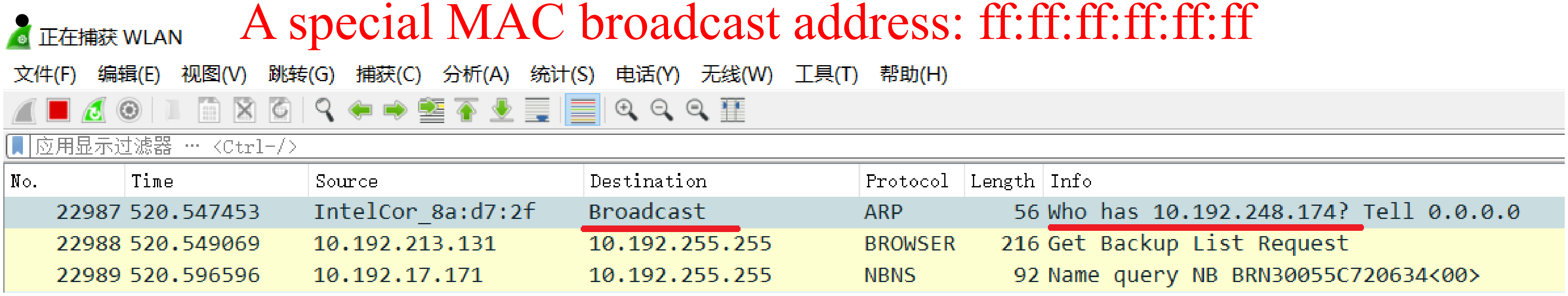
```

```
0000  ff ff ff ff ff ff dc 71  96 8a d7 2f 08 06 00 01   ······ ·q ···/····
0010  08 00 06 04 00 01 dc 71  96 8a d7 2f 00 00 00 00   ·······q ···/····
0020  00 00 00 00 00 00 0a c0  f8 ae 00 00 00 00 00 00   ········ ········
0030  00 00 00 00 00 00 00 00                            ········
```

ARP: Address Resolution Protocol [2]

- The purpose of the ARP query packet is to query all the other nodes on the subnet to determine the MAC address corresponding to the IP address that is being resolved.
- An ARP query packet (In this example: it give the IP address: 10.192.248.174, want to know the MAC address of the IP address. A IPv4 address has 32 bits and expressed in decimals (十进制) ×××.×××.×××.×××)
- The MAC addresses are 6 bytes long, giving 2^{48} possible MAC addresses, and are expressed in hexadecimal (十六进制). (In this example: the MAC address of the source is dc:71:96:8a:d7:2f)
- A special MAC broadcast address: ff:ff:ff:ff:ff:ff

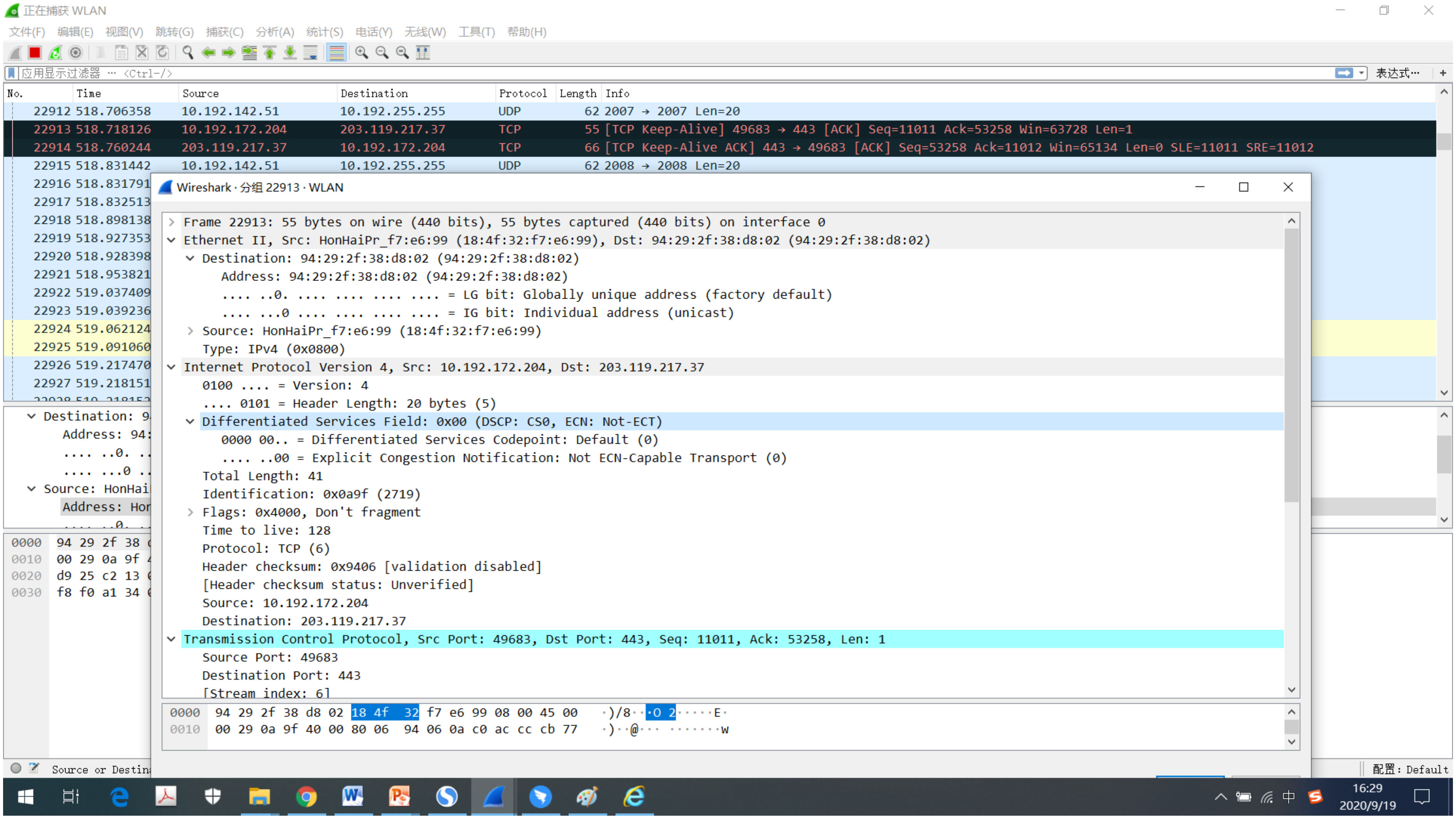

正在捕获 WLAN
文件(F) 编辑(E) 视图(V) 跳转(G) 捕获(C) 分析(A) 统计(S) 电话(Y) 无线(W) 工具(T) 帮助(H)
应用显示过滤器 … <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
22987	520.547453	IntelCor_8a:d7:2f	Broadcast	ARP	56	Who has 10.192.248.174? Tell 0.0.0.0
22988	520.549069	10.192.213.131	10.192.255.255	BROWSER	216	Get Backup List Request
22989	520.596596	10.192.17.171	10.192.255.255	NBNS	92	Name query NB BRN30055C720634<00>

ARP: Address Resolution Protocol [2]

- Each node (host and router) has **an ARP table** in its memory, which contains mappings of IP addresses to MAC addresses.
- The ARP table contains a time-to-live (**TTL**) value, which indicates when each mapping will be deleted from the table.
  - A typical expiration time for an entry is 20 minutes from when an entry is placed in an ARP table.
- ARP vs. DNS
  - ARP resolves an IP address to a MAC address only for nodes on the same subnet.
  - DNS resolves host names to IP addresses for hosts anywhere in the Internet.
- ARP is probably best considered a protocol that straddles the boundary between the link and network layers.

Example II: TCP



正在捕获 WLAN
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)
应用显示过滤器 … <Ctrl-/>
表达式…

```
No.    Time        Source          Destination     Protocol Length Info
22912 518.706358  10.192.142.51   10.192.255.255  UDP        62 2007 → 2007 Len=20
22913 518.718126  10.192.172.204  203.119.217.37  TCP        55 [TCP Keep-Alive] 49683 → 443 [ACK] Seq=11011 Ack=53258 Win=63728 Len=1
22914 518.760244  203.119.217.37  10.192.172.204  TCP        66 [TCP Keep-Alive ACK] 443 → 49683 [ACK] Seq=53258 Ack=11012 Win=65134 Len=0 SLE=11011 SRE=11012
22915 518.831442  10.192.142.51   10.192.255.255  UDP        62 2008 → 2008 Len=20
22916 518.831791
22917 518.832513
22918 518.898138
22919 518.927353
22920 518.928398
22921 518.953821
22922 519.037409
22923 519.039236
22924 519.062124
22925 519.091060
22926 519.217470
22927 519.218151
```

Wireshark · 分组 22913 · WLAN

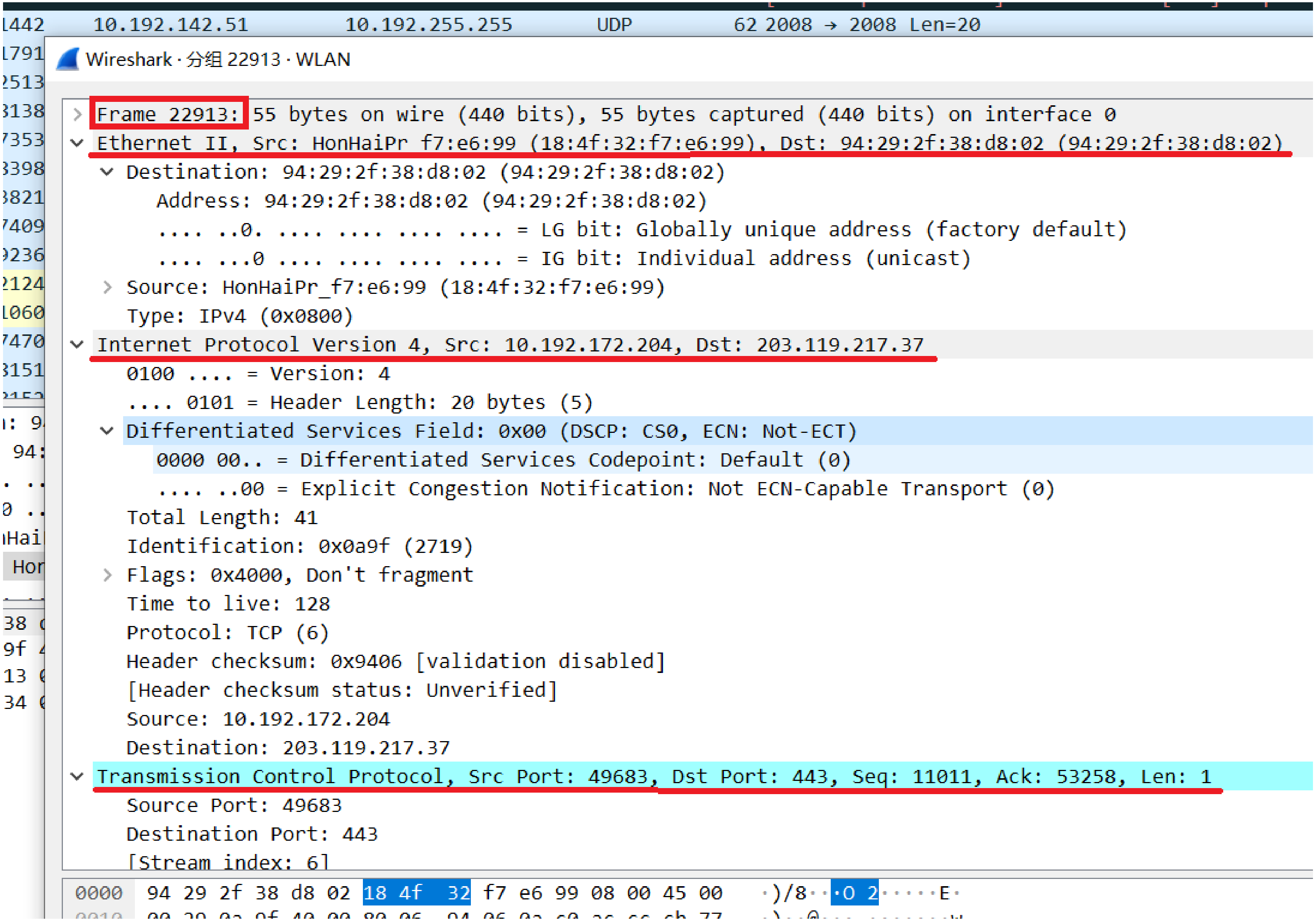
```
> Frame 22913: 55 bytes on wire (440 bits), 55 bytes captured (440 bits) on interface 0
v Ethernet II, Src: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99), Dst: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
  v Destination: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
      Address: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  > Source: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
    Type: IPv4 (0x0800)
v Internet Protocol Version 4, Src: 10.192.172.204, Dst: 203.119.217.37
    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: 41
    Identification: 0x0a9f (2719)
  > Flags: 0x4000, Don't fragment
    Time to live: 128
    Protocol: TCP (6)
    Header checksum: 0x9406 [validation disabled]
    [Header checksum status: Unverified]
    Source: 10.192.172.204
    Destination: 203.119.217.37
v Transmission Control Protocol, Src Port: 49683, Dst Port: 443, Seq: 11011, Ack: 53258, Len: 1
    Source Port: 49683
    Destination Port: 443
    [Stream index: 6]
```

```
0000  94 29 2f 38 d8 02 18 4f  32 f7 e6 99 08 00 45 00   ·)/8···O 2····E·
0010  00 29 0a 9f 40 00 80 06  94 06 0a c0 ac cc cb 77   ·)··@··· ·······w
```

```
v Destination: 9
    Address: 94:
    .... ..0. .
    .... ...0 .
v Source: HonHai
    Address: Hon
    .... ..0.

0000  94 29 2f 38 
0010  00 29 0a 9f 
0020  d9 25 c2 13 
0030  f8 f0 a1 34 
```

Example II: TCP



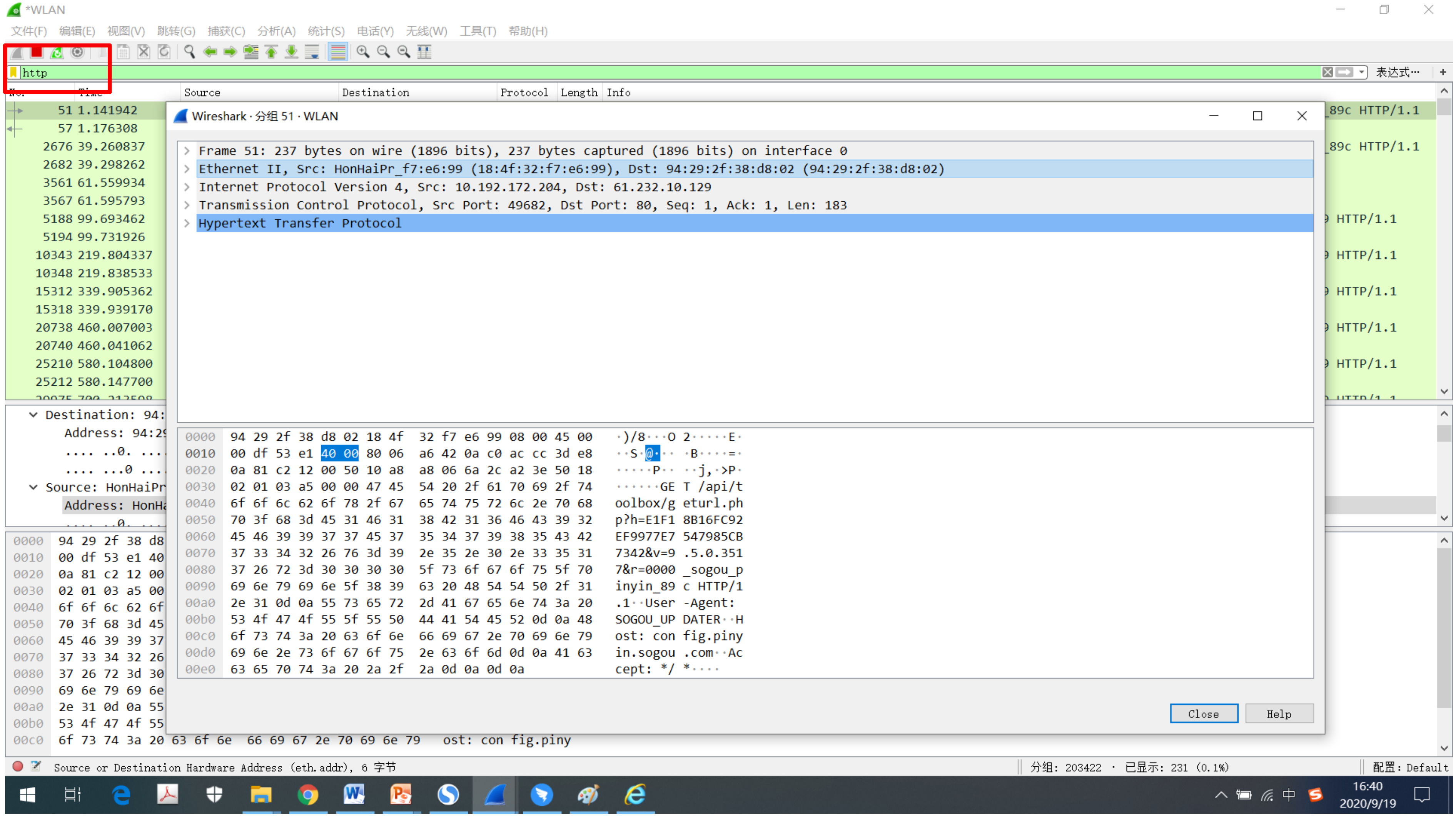
```
1442    10.192.142.51      10.192.255.255      UDP       62 2008 → 2008 Len=20
```

Wireshark · 分组 22913 · WLAN

```
> Frame 22913: 55 bytes on wire (440 bits), 55 bytes captured (440 bits) on interface 0
v Ethernet II, Src: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99), Dst: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
   v Destination: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
        Address: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
        .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
        .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
   > Source: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
     Type: IPv4 (0x0800)
v Internet Protocol Version 4, Src: 10.192.172.204, Dst: 203.119.217.37
     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: 41
     Identification: 0x0a9f (2719)
   > Flags: 0x4000, Don't fragment
     Time to live: 128
     Protocol: TCP (6)
     Header checksum: 0x9406 [validation disabled]
     [Header checksum status: Unverified]
     Source: 10.192.172.204
     Destination: 203.119.217.37
v Transmission Control Protocol, Src Port: 49683, Dst Port: 443, Seq: 11011, Ack: 53258, Len: 1
     Source Port: 49683
     Destination Port: 443
     [Stream index: 6]

0000   94 29 2f 38 d8 02 18 4f  32 f7 e6 99 08 00 45 00   ·)/8··O 2·····E·
```

Example III: HTTP


*WLAN
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)
表达式…
Wireshark · 分组 51 · WLAN
Close
Help

http

```
No.    Time          Source    Destination    Protocol    Length    Info
   51 1.141942                                                      _89c HTTP/1.1
   57 1.176308
 2676 39.260837                                                     _89c HTTP/1.1
 2682 39.298262
 3561 61.559934
 3567 61.595793
 5188 99.693462                                                     HTTP/1.1
 5194 99.731926
10343 219.804337                                                    HTTP/1.1
10348 219.838533
15312 339.905362                                                    HTTP/1.1
15318 339.939170
20738 460.007003                                                    HTTP/1.1
20740 460.041062
25210 580.104800                                                    HTTP/1.1
25212 580.147700
```

```
> Frame 51: 237 bytes on wire (1896 bits), 237 bytes captured (1896 bits) on interface 0
> Ethernet II, Src: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99), Dst: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
> Internet Protocol Version 4, Src: 10.192.172.204, Dst: 61.232.10.129
> Transmission Control Protocol, Src Port: 49682, Dst Port: 80, Seq: 1, Ack: 1, Len: 183
> Hypertext Transfer Protocol
```

```
0000  94 29 2f 38 d8 02 18 4f  32 f7 e6 99 08 00 45 00   ·)/8···O 2·····E·
0010  00 df 53 e1 40 00 80 06  a6 42 0a c0 ac cc 3d e8   ··S·@···  ·B····=·
0020  0a 81 c2 12 00 50 10 a8  a8 06 6a 2c a2 3e 50 18   ·····P··  ··j,·>P·
0030  02 01 03 a5 00 00 47 45  54 20 2f 61 70 69 2f 74   ······GE T /api/t
0040  6f 6f 6c 62 6f 78 2f 67  65 74 75 72 6c 2e 70 68   oolbox/g eturl.ph
0050  70 3f 68 3d 45 31 46 31  38 42 31 36 46 43 39 32   p?h=E1F1 8B16FC92
0060  45 46 39 39 37 37 45 37  35 34 37 39 38 35 43 42   EF9977E7 547985CB
0070  37 33 34 32 26 76 3d 39  2e 35 2e 30 2e 33 35 31   7342&v=9 .5.0.351
0080  37 26 72 3d 30 30 30 30  5f 73 6f 67 6f 75 5f 70   7&r=0000 _sogou_p
0090  69 6e 79 69 6e 5f 38 39  63 20 48 54 54 50 2f 31   inyin_89 c HTTP/1
00a0  2e 31 0d 0a 55 73 65 72  2d 41 67 65 6e 74 3a 20   .1··User -Agent:
00b0  53 4f 47 4f 55 5f 55 50  44 41 54 45 52 0d 0a 48   SOGOU_UP DATER··H
00c0  6f 73 74 3a 20 63 6f 6e  66 69 67 2e 70 69 6e 79   ost: con fig.piny
00d0  69 6e 2e 73 6f 67 6f 75  2e 63 6f 6d 0d 0a 41 63   in.sogou .com··Ac
00e0  63 65 70 74 3a 20 2a 2f  2a 0d 0a 0d 0a            cept: */ *····
```

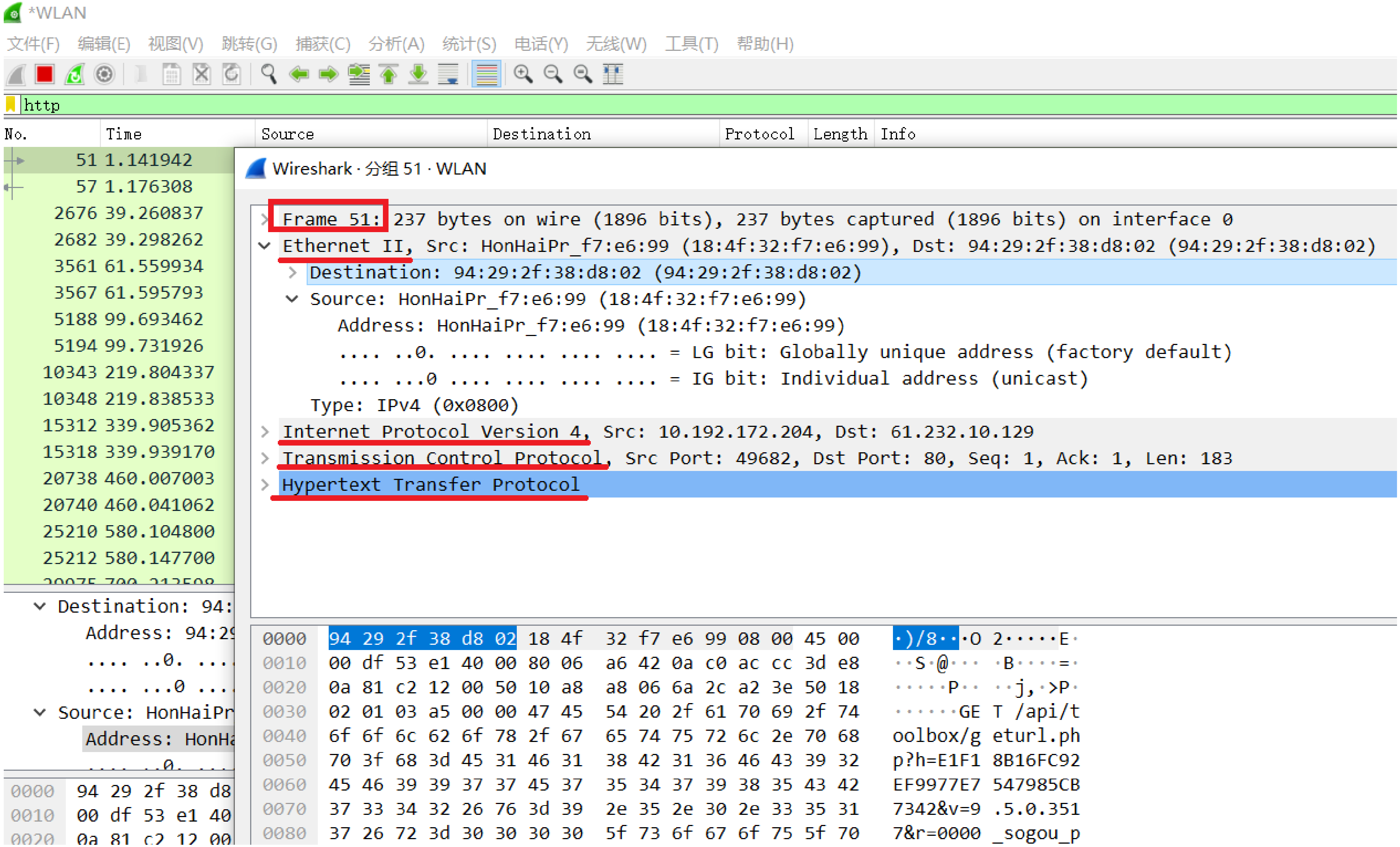
```
v Destination: 94:
    Address: 94:29
    .... ..0. ....
    .... ...0 ....
v Source: HonHaiPr
    Address: HonHa
    .... ..0. ....
```

```
00c0  6f 73 74 3a 20 63 6f 6e  66 69 67 2e 70 69 6e 79   ost: con fig.piny
```

Source or Destination Hardware Address (eth.addr), 6 字节   分组: 203422 · 已显示: 231 (0.1%)   配置: Default

16:40
2020/9/19

Example III: HTTP


*WLAN
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)

http

No.	Time	Source	Destination	Protocol	Length	Info
51	1.141942					
57	1.176308					
2676	39.260837					
2682	39.298262					
3561	61.559934					
3567	61.595793					
5188	99.693462					
5194	99.731926					
10343	219.804337					
10348	219.838533					
15312	339.905362					
15318	339.939170					
20738	460.007003					
20740	460.041062					
25210	580.104800					
25212	580.147700					

```
  v Destination: 94:
      Address: 94:2
      .... ..0. ...
      .... ...0 ...
  v Source: HonHaiPr
      Address: HonHa
      .... ..0. ...

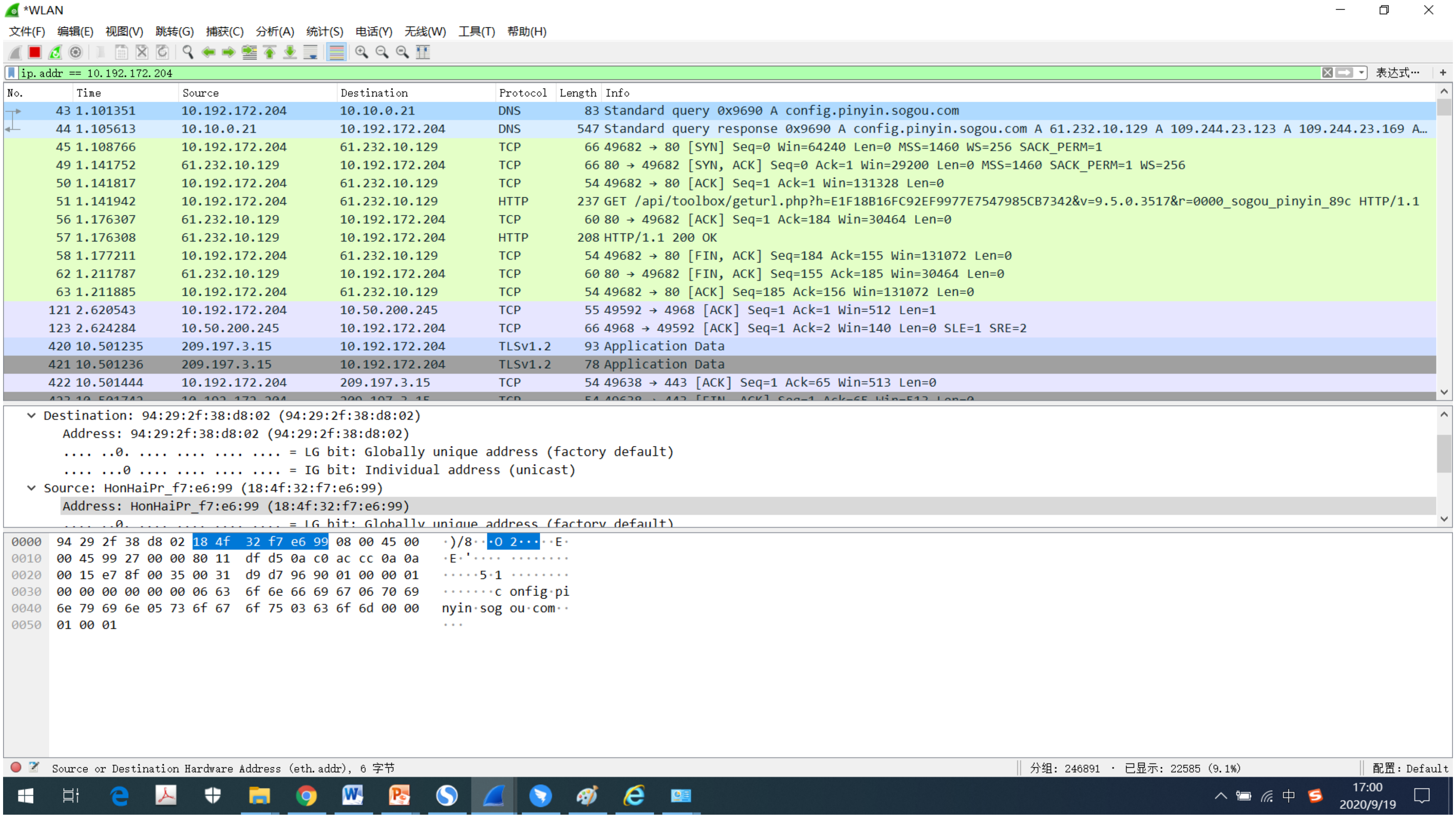
0000  94 29 2f 38 d8
0010  00 df 53 e1 40
0020  0a 81 c2 12 00
```

Wireshark · 分组 51 · WLAN

```
> Frame 51: 237 bytes on wire (1896 bits), 237 bytes captured (1896 bits) on interface 0
v Ethernet II, Src: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99), Dst: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
  > Destination: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
  v Source: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
      Address: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
> Internet Protocol Version 4, Src: 10.192.172.204, Dst: 61.232.10.129
> Transmission Control Protocol, Src Port: 49682, Dst Port: 80, Seq: 1, Ack: 1, Len: 183
> Hypertext Transfer Protocol
```

```
0000  94 29 2f 38 d8 02 18 4f  32 f7 e6 99 08 00 45 00   ·)/8···O 2·····E·
0010  00 df 53 e1 40 00 80 06  a6 42 0a c0 ac cc 3d e8   ··S·@···  ·B····=·
0020  0a 81 c2 12 00 50 10 a8  a8 06 6a 2c a2 3e 50 18   ·····P··  ··j,·>P·
0030  02 01 03 a5 00 00 47 45  54 20 2f 61 70 69 2f 74   ······GE T /api/t
0040  6f 6f 6c 62 6f 78 2f 67  65 74 75 72 6c 2e 70 68   oolbox/g eturl.ph
0050  70 3f 68 3d 45 31 46 31  38 42 31 36 46 43 39 32   p?h=E1F1 8B16FC92
0060  45 46 39 39 37 37 45 37  35 34 37 39 38 35 43 42   EF9977E7 547985CB
0070  37 33 34 32 26 76 3d 39  2e 35 2e 30 2e 33 35 31   7342&v=9 .5.0.351
0080  37 26 72 3d 30 30 30 30  5f 73 6f 67 6f 75 5f 70   7&r=0000 _sogou_p
```

Example IV: ip.addr == 10.192.172.204


*WLAN
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)
表达式…
+

ip.addr == 10.192.172.204

No.	Time	Source	Destination	Protocol	Length	Info
43	1.101351	10.192.172.204	10.10.0.21	DNS	83	Standard query 0x9690 A config.pinyin.sogou.com
44	1.105613	10.10.0.21	10.192.172.204	DNS	547	Standard query response 0x9690 A config.pinyin.sogou.com A 61.232.10.129 A 109.244.23.123 A 109.244.23.169 A…
45	1.108766	10.192.172.204	61.232.10.129	TCP	66	49682 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
49	1.141752	61.232.10.129	10.192.172.204	TCP	66	80 → 49682 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM=1 WS=256
50	1.141817	10.192.172.204	61.232.10.129	TCP	54	49682 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0
51	1.141942	10.192.172.204	61.232.10.129	HTTP	237	GET /api/toolbox/geturl.php?h=E1F18B16FC92EF9977E7547985CB7342&v=9.5.0.3517&r=0000_sogou_pinyin_89c HTTP/1.1
56	1.176307	61.232.10.129	10.192.172.204	TCP	60	80 → 49682 [ACK] Seq=1 Ack=184 Win=30464 Len=0
57	1.176308	61.232.10.129	10.192.172.204	HTTP	208	HTTP/1.1 200 OK
58	1.177211	10.192.172.204	61.232.10.129	TCP	54	49682 → 80 [FIN, ACK] Seq=184 Ack=155 Win=131072 Len=0
62	1.211787	61.232.10.129	10.192.172.204	TCP	60	80 → 49682 [FIN, ACK] Seq=155 Ack=185 Win=30464 Len=0
63	1.211885	10.192.172.204	61.232.10.129	TCP	54	49682 → 80 [ACK] Seq=185 Ack=156 Win=131072 Len=0
121	2.620543	10.192.172.204	10.50.200.245	TCP	55	49592 → 4968 [ACK] Seq=1 Ack=1 Win=512 Len=1
123	2.624284	10.50.200.245	10.192.172.204	TCP	66	4968 → 49592 [ACK] Seq=1 Ack=2 Win=140 Len=0 SLE=1 SRE=2
420	10.501235	209.197.3.15	10.192.172.204	TLSv1.2	93	Application Data
421	10.501236	209.197.3.15	10.192.172.204	TLSv1.2	78	Application Data
422	10.501444	10.192.172.204	209.197.3.15	TCP	54	49638 → 443 [ACK] Seq=1 Ack=65 Win=513 Len=0
423	10.501743	10.192.172.204	209.197.3.15	TCP	54	49638 → 443 [FIN, ACK] Seq=1 Ack=65 Win=513 Len=0

```
  Destination: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
      Address: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  Source: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
      Address: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
```

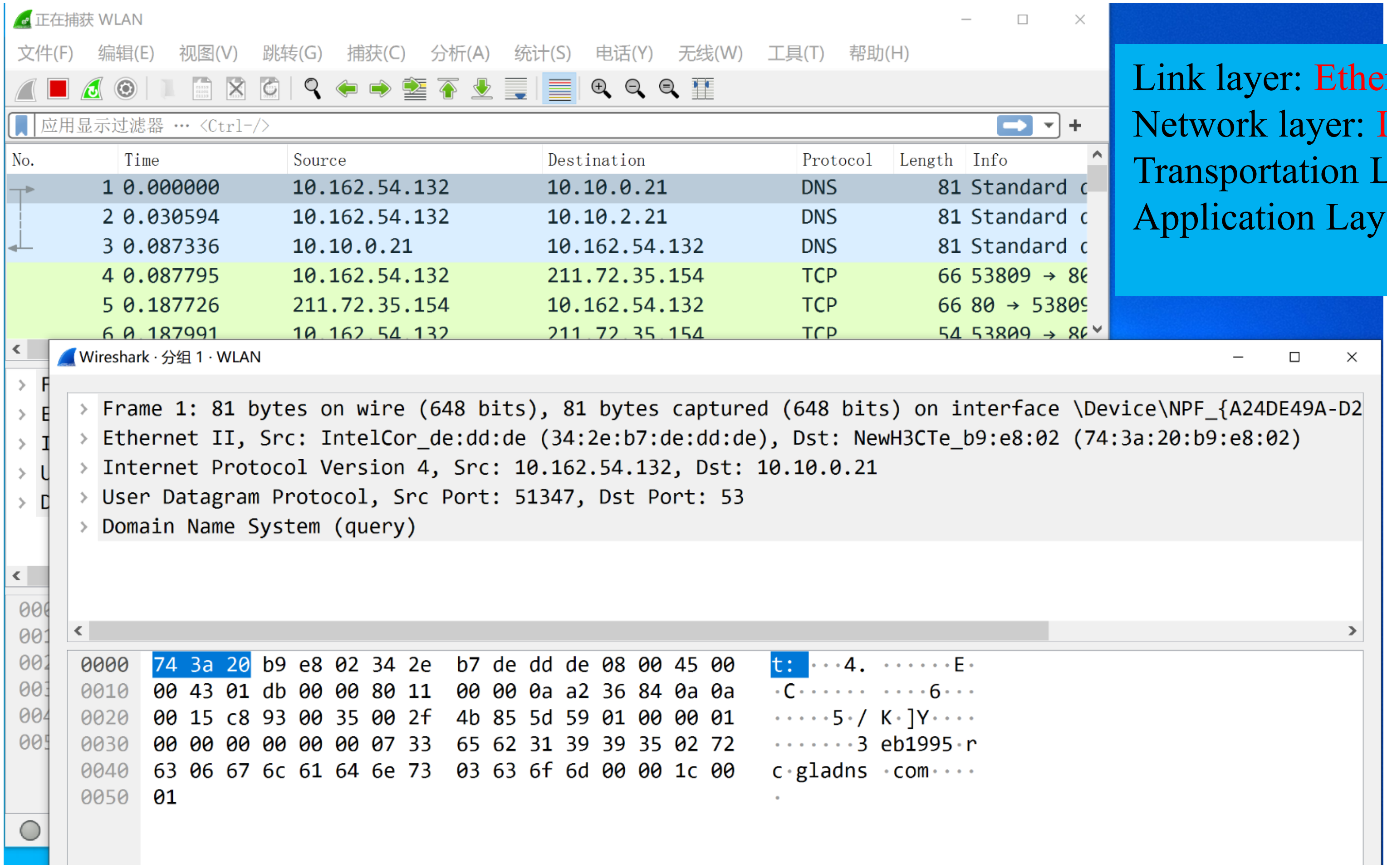
```
0000  94 29 2f 38 d8 02 18 4f  32 f7 e6 99 08 00 45 00   ·)/8··O 2·····E·
0010  00 45 99 27 00 00 80 11  df d5 0a c0 ac cc 0a 0a   ·E·'···· ········
0020  00 15 e7 8f 00 35 00 31  d9 d7 96 90 01 00 00 01   ·····5·1 ········
0030  00 00 00 00 00 00 06 63  6f 6e 66 69 67 06 70 69   ·······c onfig·pi
0040  6e 79 69 6e 05 73 6f 67  6f 75 03 63 6f 6d 00 00   nyin·sog ou·com··
0050  01 00 01                                           ···
```

Source or Destination Hardware Address (eth.addr), 6 字节 | 分组: 246891 · 已显示: 22585 (9.1%) | 配置: Default

ip.addr == x.x.x.x vs. ip.host == x.x.x.x

- 实验中第4部分和第5部分相比，区别在于ip.addr == x.x.x.x是捕获所有数据包，但是只显示与ip地址为x.x.x.x有关的数据包，而host.addr == x.x.x.x只捕获ip地址为x.x.x.x的数据包。检查一下实验结果， host.addr = x.x.x.x命令下抓获数据包量要小很多。
- 注意命令“host.addr = x.x.x.x”已经停用，改为“ip.host = x.x.x.x”
- 或者用这两个命令：ip.src_host == x.x.x.x 只抓数据包中源地址为x.x.x.x的数据包；或 ip.dst_host == x.x.x.x只抓数据包中目标地址为 x.x.x.x的数据包。

Example: DNS


正在捕获 WLAN
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)
应用显示过滤器 … <Ctrl-/>
Wireshark · 分组 1 · WLAN

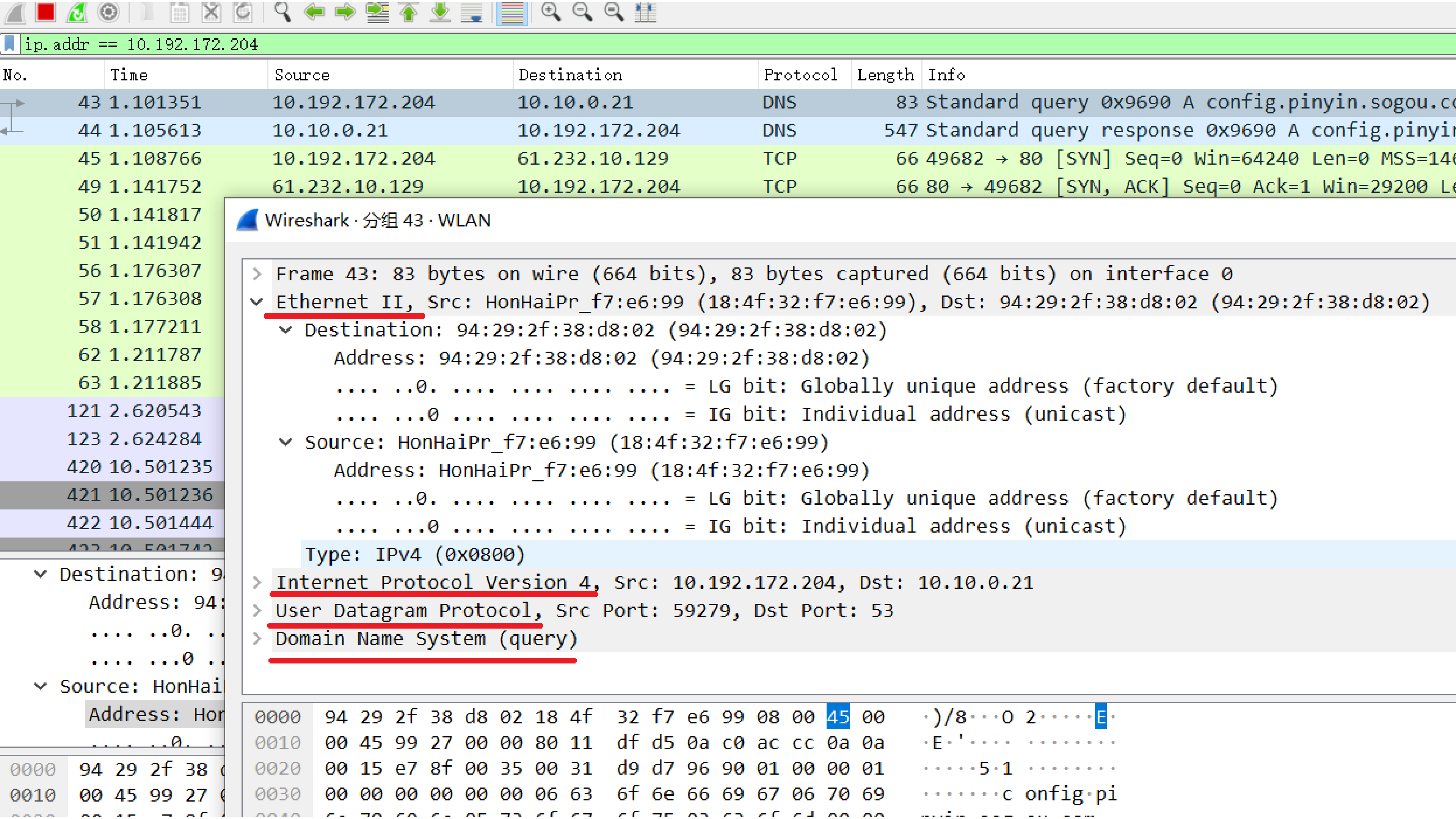
```
No.  Time        Source          Destination     Protocol  Length  Info
  1 0.000000    10.162.54.132   10.10.0.21      DNS           81  Standard c
  2 0.030594    10.162.54.132   10.10.2.21      DNS           81  Standard c
  3 0.087336    10.10.0.21      10.162.54.132   DNS           81  Standard c
  4 0.087795    10.162.54.132   211.72.35.154   TCP           66  53809 → 80
  5 0.187726    211.72.35.154   10.162.54.132   TCP           66  80 → 53809
  6 0.187991    10.162.54.132   211.72.35.154   TCP           54  53809 → 80
```

```
> Frame 1: 81 bytes on wire (648 bits), 81 bytes captured (648 bits) on interface \Device\NPF_{A24DE49A-D2
> Ethernet II, Src: IntelCor_de:dd:de (34:2e:b7:de:dd:de), Dst: NewH3CTe_b9:e8:02 (74:3a:20:b9:e8:02)
> Internet Protocol Version 4, Src: 10.162.54.132, Dst: 10.10.0.21
> User Datagram Protocol, Src Port: 51347, Dst Port: 53
> Domain Name System (query)
```

```
0000  74 3a 20 b9 e8 02 34 2e  b7 de dd de 08 00 45 00   t: ···4. ······E·
0010  00 43 01 db 00 00 80 11  00 00 0a a2 36 84 0a 0a   ·C······ ····6···
0020  00 15 c8 93 00 35 00 2f  4b 85 5d 59 01 00 00 01   ·····5·/ K·]Y····
0030  00 00 00 00 00 00 07 33  65 62 31 39 39 35 02 72   ·······3 eb1995·r
0040  63 06 67 6c 61 64 6e 73  03 63 6f 6d 00 00 1c 00   c·gladns ·com····
0050  01                                                  ·
```

Link layer: Ethernet II
Network layer: IPv4
Transportation Layer: UDP
Application Layer: DNS

Example V: DNS



ip.addr == 10.192.172.204

```
No.   Time         Source           Destination      Protocol  Length  Info
 43 1.101351  10.192.172.204   10.10.0.21       DNS        83 Standard query 0x9690 A config.pinyin.sogou.co
 44 1.105613  10.10.0.21       10.192.172.204   DNS       547 Standard query response 0x9690 A config.pinyi
 45 1.108766  10.192.172.204   61.232.10.129    TCP        66 49682 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=14
 49 1.141752  61.232.10.129    10.192.172.204   TCP        66 80 → 49682 [SYN, ACK] Seq=0 Ack=1 Win=29200 Le
 50 1.141817
 51 1.141942
 56 1.176307
 57 1.176308
 58 1.177211
 62 1.211787
 63 1.211885
121 2.620543
123 2.624284
420 10.501235
421 10.501236
422 10.501444
```

Wireshark · 分组 43 · WLAN

```
> Frame 43: 83 bytes on wire (664 bits), 83 bytes captured (664 bits) on interface 0
v Ethernet II, Src: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99), Dst: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
  v Destination: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
      Address: 94:29:2f:38:d8:02 (94:29:2f:38:d8:02)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  v Source: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
      Address: HonHaiPr_f7:e6:99 (18:4f:32:f7:e6:99)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: IPv4 (0x0800)
> Internet Protocol Version 4, Src: 10.192.172.204, Dst: 10.10.0.21
> User Datagram Protocol, Src Port: 59279, Dst Port: 53
> Domain Name System (query)
```

```
0000  94 29 2f 38 d8 02 18 4f  32 f7 e6 99 08 00 45 00   ·)/8···O 2·····E·
0010  00 45 99 27 00 00 80 11  df d5 0a c0 ac cc 0a 0a   ·E·'···· ········
0020  00 15 e7 8f 00 35 00 31  d9 d7 96 90 01 00 00 01   ·····5·1 ········
0030  00 00 00 00 00 00 06 63  6f 6e 66 69 67 06 70 69   ·······c onfig·pi
```

注意：在DNS数据包中传输层用的协议是UDP，不是TCP协议！ Port number: 53

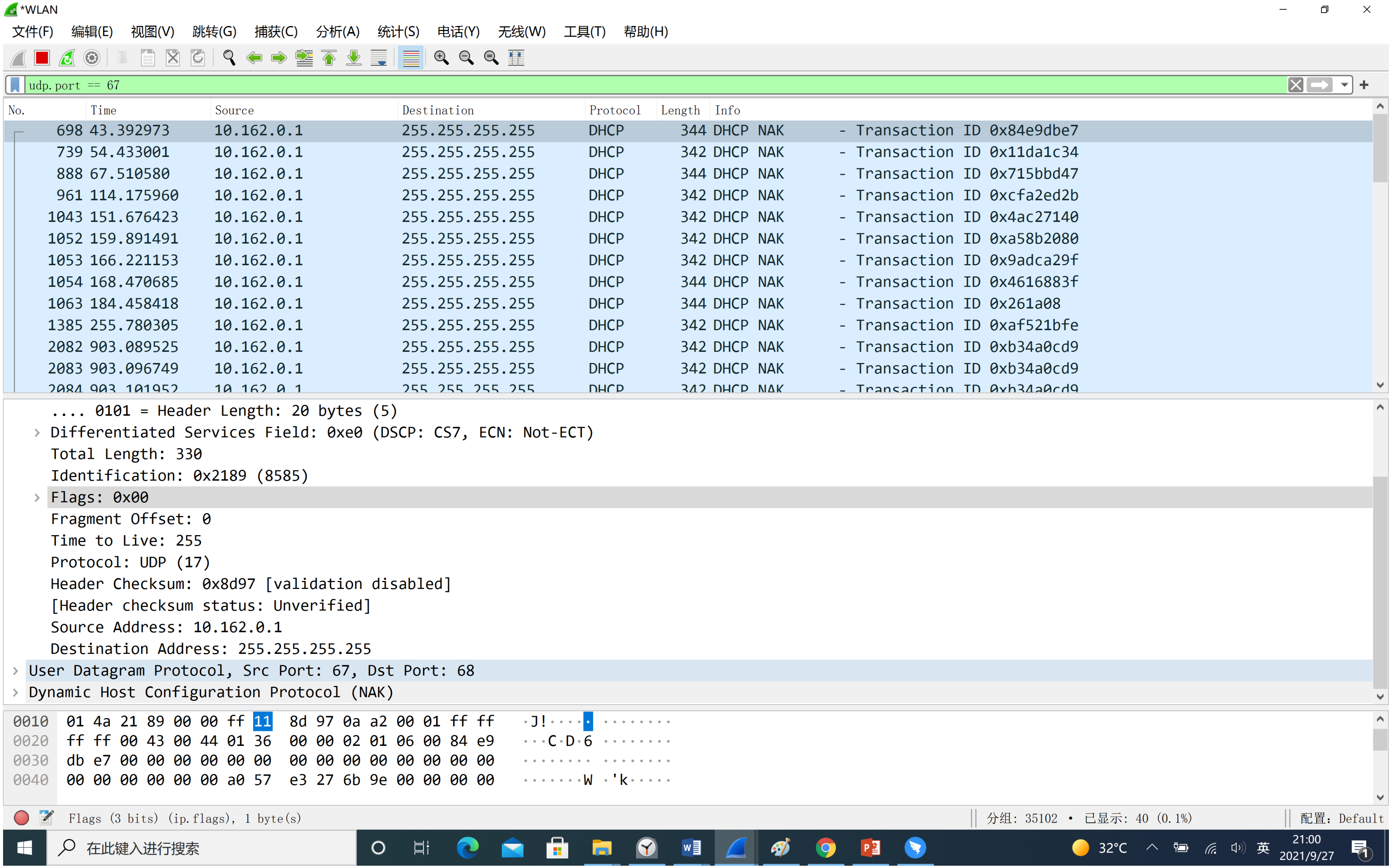
tcp.port == 443 (or 80, or 25)

- 实验1中Part 1第6题变为tcp.port == X 和udp.port == X

TCP 20 =文件传输(FTP，控制)
TCP 21 = 文件传输(FTP，文件传输)
TCP 22 = ssh应用端口，ssh用于远程连接Linux云服务器。
TCP 23 = 远程登录
TCP 25 = 电子邮件 (SMTP)
TCP 80 = http
TCP 110 = 电子邮件(Pop3)
TCP 179 = Border 网关协议 (BGP)
TCP 443 = 网页安全服务

UDP 53 = 域名解析 DNS
UDP 67 = 动态IP服务 DHCP
UDP 68 = 客户端向68端口DHCP服务器广播请求地址配置， DHCP服务器向67端口广播回应请求。

“udp.port == 67” Example



udp.port == 67

```
No.    Time          Source        Destination        Protocol  Length  Info
  698  43.392973     10.162.0.1    255.255.255.255    DHCP         344  DHCP NAK    - Transaction ID 0x84e9dbe7
  739  54.433001     10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0x11da1c34
  888  67.510580     10.162.0.1    255.255.255.255    DHCP         344  DHCP NAK    - Transaction ID 0x715bbd47
  961  114.175960    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0xcfa2ed2b
 1043  151.676423    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0x4ac27140
 1052  159.891491    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0xa58b2080
 1053  166.221153    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0x9adca29f
 1054  168.470685    10.162.0.1    255.255.255.255    DHCP         344  DHCP NAK    - Transaction ID 0x4616883f
 1063  184.458418    10.162.0.1    255.255.255.255    DHCP         344  DHCP NAK    - Transaction ID 0x261a08
 1385  255.780305    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0xaf521bfe
 2082  903.089525    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0xb34a0cd9
 2083  903.096749    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0xb34a0cd9
 2084  903.101952    10.162.0.1    255.255.255.255    DHCP         342  DHCP NAK    - Transaction ID 0xb34a0cd9
```

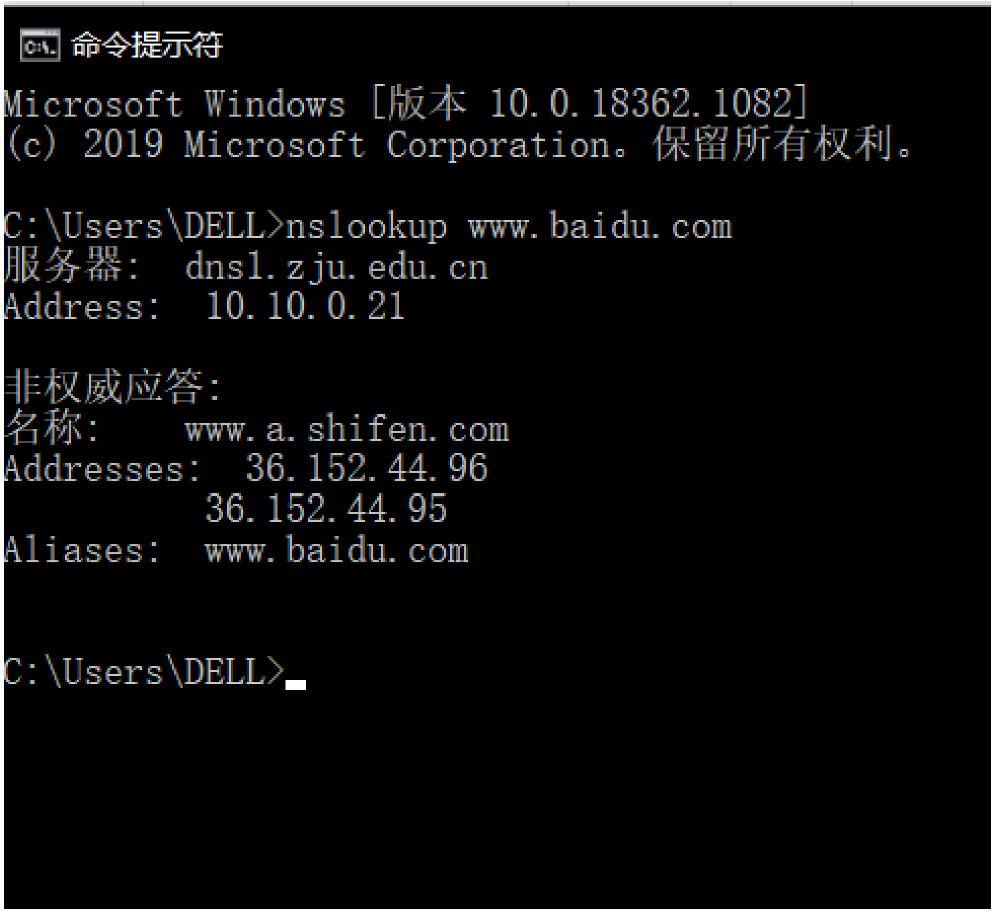
```
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0xe0 (DSCP: CS7, ECN: Not-ECT)
    Total Length: 330
    Identification: 0x2189 (8585)
  > Flags: 0x00
    Fragment Offset: 0
    Time to Live: 255
    Protocol: UDP (17)
    Header Checksum: 0x8d97 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 10.162.0.1
    Destination Address: 255.255.255.255
> User Datagram Protocol, Src Port: 67, Dst Port: 68
> Dynamic Host Configuration Protocol (NAK)
```

```
0010  01 4a 21 89 00 00 ff 11  8d 97 0a a2 00 01 ff ff   ·J!····· ········
0020  ff ff 00 43 00 44 01 36  00 00 02 01 06 00 84 e9   ···C·D·6 ········
0030  db e7 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
0040  00 00 00 00 00 00 a0 57  e3 27 6b 9e 00 00 00 00   ·······W ·'k·····
```

Flags (3 bits) (ip.flags), 1 byte(s)　　分组: 35102 · 已显示: 40 (0.1%)　　配置: Default

Example: nslookup

- 技巧：先退出WireShark，然后重新打开，再运行“nslookup www.baidu.com”在命令行。



```
Microsoft Windows [版本 10.0.18362.1082]
(c) 2019 Microsoft Corporation。保留所有权利。

C:\Users\DELL>nslookup www.baidu.com
服务器:  dns1.zju.edu.cn
Address:  10.10.0.21

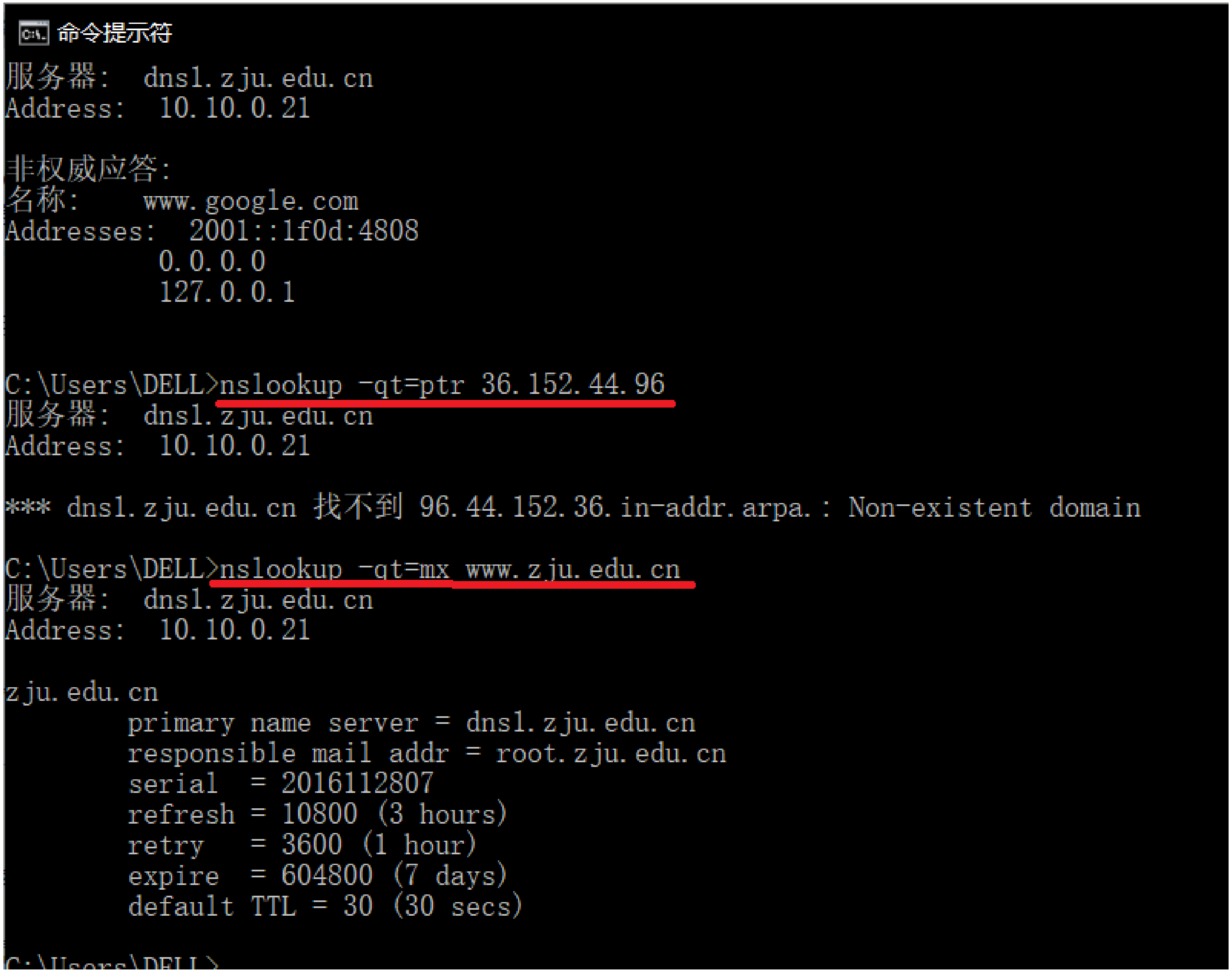
非权威应答:
名称:    www.a.shifen.com
Addresses:  36.152.44.96
          36.152.44.95
Aliases:  www.baidu.com


C:\Users\DELL>_
```

Example: nslookup [4]

- 正向解析：通过域名查找ip；
- 反向解析：通过ip查找域名；
  - IP反向解析主要应用到邮件服务器中来阻拦垃圾邮件，特别是在国外。多数垃圾邮件发送者使用动态分配或者没有注册域名的IP地址来发送垃圾邮件，以逃避追踪，使用了域名反向解析后，就可以大大降低垃圾邮件的数量。
    - 比如你用 xxx@name.com 这个邮箱给我的邮箱 123@163.com 发了一封信。163邮件服务器接到这封信会查看这封信的信头文件，这封信的信头文件会显示这封信是由哪个IP地址发出来的。然后根据这个IP地址进行反向解析，如果反向解析到这个IP所对应的域名是name.com 那么就接受这封邮件，如果反向解析发现这个IP没有对应到name.com，那么就拒绝这封邮件。

Example: nslookup [4]



```
服务器:  dns1.zju.edu.cn
Address:  10.10.0.21

非权威应答:
名称:    www.google.com
Addresses:  2001::1f0d:4808
          0.0.0.0
          127.0.0.1


C:\Users\DELL>nslookup -qt=ptr 36.152.44.96
服务器:  dns1.zju.edu.cn
Address:  10.10.0.21

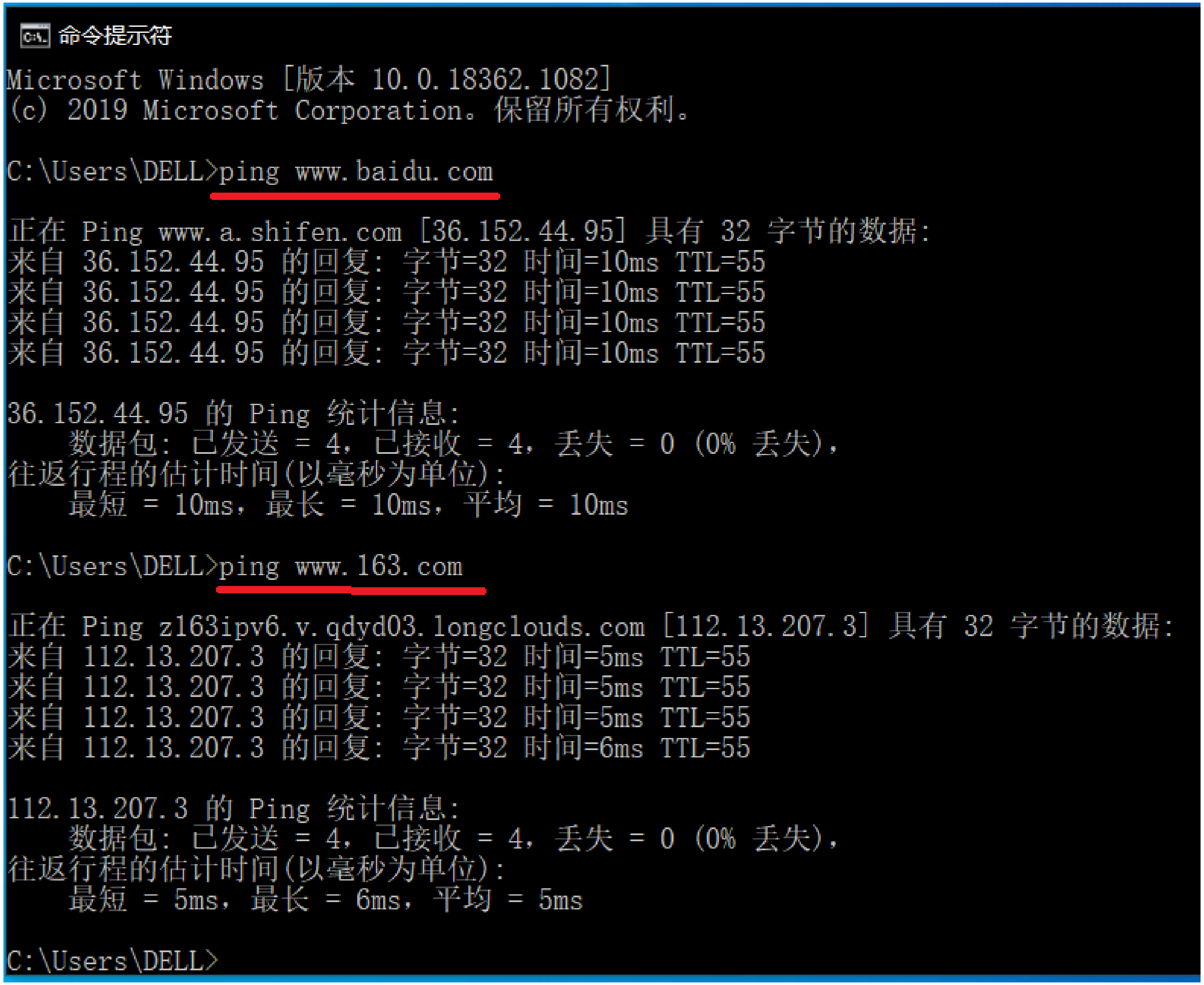
*** dns1.zju.edu.cn 找不到 96.44.152.36.in-addr.arpa.: Non-existent domain

C:\Users\DELL>nslookup -qt=mx www.zju.edu.cn
服务器:  dns1.zju.edu.cn
Address:  10.10.0.21

zju.edu.cn
        primary name server = dns1.zju.edu.cn
        responsible mail addr = root.zju.edu.cn
        serial  = 2016112807
        refresh = 10800 (3 hours)
        retry   = 3600 (1 hour)
        expire  = 604800 (7 days)
        default TTL = 30 (30 secs)

C:\Users\DELL>
```

Example: ping (ICMP, Internet Control Message Protocol)



```
Microsoft Windows [版本 10.0.18362.1082]
(c) 2019 Microsoft Corporation。保留所有权利。

C:\Users\DELL>ping www.baidu.com

正在 Ping www.a.shifen.com [36.152.44.95] 具有 32 字节的数据:
来自 36.152.44.95 的回复: 字节=32 时间=10ms TTL=55
来自 36.152.44.95 的回复: 字节=32 时间=10ms TTL=55
来自 36.152.44.95 的回复: 字节=32 时间=10ms TTL=55
来自 36.152.44.95 的回复: 字节=32 时间=10ms TTL=55

36.152.44.95 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 = 10ms，最长 = 10ms，平均 = 10ms

C:\Users\DELL>ping www.163.com

正在 Ping z163ipv6.v.qdyd03.longclouds.com [112.13.207.3] 具有 32 字节的数据:
来自 112.13.207.3 的回复: 字节=32 时间=5ms TTL=55
来自 112.13.207.3 的回复: 字节=32 时间=5ms TTL=55
来自 112.13.207.3 的回复: 字节=32 时间=5ms TTL=55
来自 112.13.207.3 的回复: 字节=32 时间=6ms TTL=55

112.13.207.3 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 = 6ms，平均 = 5ms

C:\Users\DELL>
```

Internet Control Message Protocol (**ICMP**) [2]

- ICMP is specified in RFC 792.
- The most typical use of ICMP is for **error reporting**.
  - For example, when running a Telnet, FTP, or HTTP session, you may have encountered an error message such as "Destination network unreachable".
- ICMP is often considered part of IP but architecturally it lies just above IP, as ICMP messages are carried inside IP datagrams.
- ICMP messages have a type and a code field, and contain the header and the first 8 bytes of the IP datagram.

ICMP Type	Code	Description
0	0	echo reply (to ping)
3	0	destination network unreachable
3	1	destination host unreachable
3	2	destination protocol unreachable
3	3	destination port unreachable
3	6	destination network unknown
3	7	destination host unknown
4	0	source quench (congestion control)
8	0	echo request
9	0	router advertisement
10	0	router discovery
11	0	TTL expired
12	0	IP header bad

Figure 4.23 ♦ ICMP message types

Example: Tracert (ICMP) (I)

- The **Tracert** program, which allows us to trace a route from a host to any other host in the world.
- Tracert is implemented with ICMP messages, to determine the names and addresses of the routers between source and destination,
  - 1) Tracert in the source sends *a series of ordinary IP datagrams* to the destination.
  - Each of these datagrams carries a **UDP** segment with an unlikely UDP port number.
  - The 1st of these datagrams has a TTL of 1, the 2nd of 2, the 3rd of 3, and so on. The source also starts timers for each of the datagrams.

Example: Tracert (ICMP) (II)

- Tracert is implemented with ICMP messages, to determine the names and addresses of the routers between source and destination,
  - 2) When the *n*th datagram arrives at the *n*th router, the *n*th router observes that *the TTL of the datagram has just expired*.
  - According to the rules of the IP protocol, the router discards the datagram and sends an ICMP warning message to the source (type 11 code 0)
  - This warning message includes the name of the router and its IP address.
  - 3) When this ICMP message arrives back at the source, the source obtains **the round-trip time** from the timer and the name and IP address of the *n*th router from the ICMP message

Example: Tracert (ICMP) (III)

- Tracert is implemented with ICMP messages, to determine the names and addresses of the routers between source and destination,
  - 4) How does a Tracert source know when to **stop** sending UDP segments?
  - Recall that the source increments the TTL field for each datagram it sends. Thus, one of the datagrams will eventually make it all the way to the destination host.
  - Because this datagram contains a UDP segment with an unlikely port number, the destination host sends **a port unreachable ICMP message** (type 3 code 3) back to the source.
  - When the source host receives this particular ICMP message, it knows it does not need to send additional probe packets.
  - The standard Tracert program actually sends sets of three packets with the same TTL; thus the Tracert output provides three results for each TTL.

References

- [1] https://www.wireshark.org/
- [2] J. F. Kurose and K.W. Ross, Computer Networking — A Top-down Approach, 5th Edition, Pearson Education Inc., 2010.
- [3] https://blog.csdn.net/gui951753/article/details/83070180 (这个博客中有解释多个站点对应一个IP地址的问题。)
- [4] https://www.cnblogs.com/machangwei-8/p/10353137.html