

# Praktikum Rechnernetze

Protokoll zu Versuch 2 (Protokollanalyse mit Wireshark) von  
Gruppe 1

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# Einführung

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Diese Materialien basieren auf Professor Kiefers "Praktikum Rechnernetze"-Vorlesung der HdM Stuttgart.

**Sie haben einen Fehler gefunden oder haben einen Verbesserungsvorschlag?** Bitte eröffnen Sie ein Issue auf GitHub ([github.com/pojntfx/uni-netpractice-notes](https://github.com/pojntfx/uni-netpractice-notes)):



**Abbildung 1:** QR-Code zum Quelltext auf GitHub

# Lizenz

Dieses Dokument und der enthaltene Quelltext ist freie Kultur bzw. freie Software.



**Abbildung 2:** Badge der AGPL-3.0-Lizenz

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SPDX-License-Identifier: AGPL-3.0

# Wireshark

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# Einführung

**An welchem Koppelement im Systemschrank sollte der Hardware-Analysator/Netzwerk-Sniffer sinnvollerweise angeschlossen werden und warum? Welche grundsätzlichen Möglichkeiten gibt es noch?**

- Switch, damit Nachrichten auf Layer 2 auch abgefangen werden können
- Grundsätzlich könnte, vor allem auch in Heimnetzwerken, der Router hierzu verwendet werden, da hier oft Router und Switch zu einem Gerät kombiniert sind.

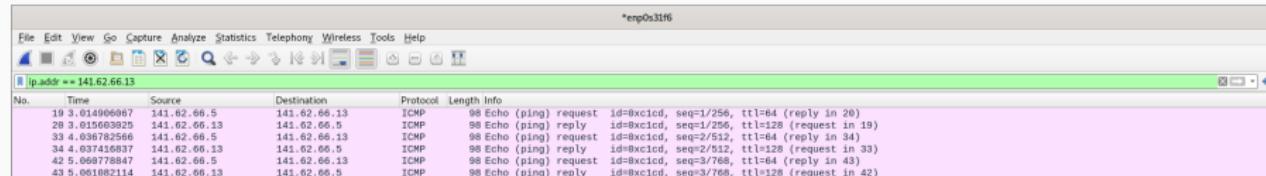
**Starten Sie Wireshark und capturern Sie den aktuellen Traffic. Dokumentieren Sie zunächst, was alles auf Wireshark einprasselt.**



# Ping

Senden Sie einen Ping zu nachfolgenden Empfängern und zeichnen Sie die entsprechenden Protokolle gezielt mit Wireshark auf. Vergleichen Sie die Protokollabläufe: wer sendet welches Protokoll warum an wen? Pingen Sie an . . . .

Einen Rechner Ihrer Wahl im Labornetz:



The screenshot shows a Wireshark interface with the following details:

- File Edit View Go Capture Analyze Statistics Telephone Wireless Tools Help
- Filter: ip.addr == 141.62.66.13
- Selected packet: \*eng0s31f6
- Table Headers: No., Time, Source, Destination, Protocol, Length, Info
- Table Data:

| No. | Time        | Source       | Destination  | Protocol | Length | Info  |
|-----|-------------|--------------|--------------|----------|--------|---|
| 19  | 3.014906067 | 141.62.66.5  | 141.62.66.13 | ICMP     | 98     | Echo (ping) request id=0xc1cd, seq=1/256, ttl=64 (reply in 20)  |
| 29  | 3.015693825 | 141.62.66.13 | 141.62.66.5  | ICMP     | 98     | Echo (ping) reply id=0xc1cd, seq=1/256, ttl=128 (request in 19) |
| 33  | 4.036782566 | 141.62.66.13 | 141.62.66.13 | ICMP     | 98     | Echo (ping) request id=0xc1cd, seq=2/512, ttl=64 (reply in 34)  |
| 34  | 4.037416837 | 141.62.66.13 | 141.62.66.5  | ICMP     | 98     | Echo (ping) reply id=0xc1cd, seq=2/512, ttl=128 (request in 33) |
| 42  | 5.068778847 | 141.62.66.5  | 141.62.66.13 | ICMP     | 98     | Echo (ping) request id=0xc1cd, seq=3/768, ttl=64 (reply in 43)  |
| 43  | 5.061982114 | 141.62.66.13 | 141.62.66.5  | ICMP     | 98     | Echo (ping) reply id=0xc1cd, seq=3/768, ttl=128 (request in 42) |

# DHCP

**Analysieren Sie die Abläufe bei DHCP (im Labor installiert).  
Ihre Teilgruppe am Nachbartisch bootet den PC am Arbeitsplatz, protokollieren Sie die DHCP-Abläufe sowie sonstigen Netzverkehr, den der PC bis zum Erhalt der IP-Adresse erzeugt.**

Während des Startens werden drei DHCP-Requests für verschiedene Komponenten abgehandelt.

| No. | Time         | Source                 | Destination     | Protocol | Length | Info                                       |
|-----|--------------|------------------------|-----------------|----------|--------|--|
| 47  | 36.248724335 | 0.0.0.0                | 255.255.255.255 | DHCP     | 59     | DHCP Discover - Transaction ID 0x620e53eb  |
| 48  | 36.248844227 | opnsense-router.rml... | 255.255.255.255 | DHCP     | 343    | DHCP Offer - Transaction ID 0x620e53eb     |
| 55  | 49.259252500 | 0.0.0.0                | 255.255.255.255 | DHCP     | 598    | DHCP Request - Transaction ID 0x620e53eb   |
| 56  | 49.259252529 | opnsense-router.rml... | 255.255.255.255 | DHCP     | 348    | DHCP ACK - Transaction ID 0x620e53eb       |
| 57  | 49.259797973 | linux.local            | Broadcast       | ARP      | 60     | Who has 141.62.66.236? Tell 141.62.66.4    |
| 58  | 49.278416173 | linux.local            | Broadcast       | ARP      | 60     | Who has 141.62.66.250? Tell 141.62.66.4    |
| 63  | 49.476659439 | fog.rnlabor.hds-stu... | linux.local     | ARP      | 60     | Who has 141.62.66.4? Tell 141.62.66.236    |
| 65  | 49.592657513 | fog.rnlabor.hds-stu... | linux.local     | ARP      | 60     | Who has 141.62.66.4? Tell 141.62.66.236    |
| 79  | 49.526653895 | fog.rnlabor.hds-stu... | linux.local     | ARP      | 60     | Who has 141.62.66.4? Tell 141.62.66.236    |
| 72  | 49.497126304 | 0.0.0.0                | 255.255.255.255 | DHCP     | 451    | DHCP Discover - Transaction ID 0xc1470931  |
| 73  | 49.497126305 | opnsense-router.rml... | 255.255.255.255 | DHCP     | 343    | DHCP Offer - Transaction ID 0xc1470931     |
| 79  | 49.526653895 | 0.0.0.0                | 255.255.255.255 | DHCP     | 343    | DHCP Request - Transaction ID 0xc1470931   |
| 88  | 50.531124982 | opnsense-router.rml... | 255.255.255.255 | DHCP     | 348    | DHCP ACK - Transaction ID 0xc1470931       |
| 81  | 50.531125138 | linux.local            | Broadcast       | ARP      | 60     | ARP Announcement for 141.62.66.4           |
| 82  | 50.584564498 | linux.local            | Broadcast       | ARP      | 60     | Who has 141.62.66.236? Tell 141.62.66.4    |
| 85  | 54.826519700 | linux.local            | Broadcast       | ARP      | 60     | Who has 141.62.66.236? Tell 141.62.66.4    |
| 92  | 66.340215769 | 0.0.0.0                | 255.255.255.255 | DHCP     | 342    | DHCP Discover - Transaction ID 0xadc0bd5d8 |
| 93  | 66.342356749 | 0.0.0.0                | 255.255.255.255 | DHCP     | 345    | DHCP Request - Transaction ID 0xadc0bd5d8  |
| 95  | 66.629416649 | linux.local            | Broadcast       | ARP      | 60     | Who has 141.62.66.250? Tell 141.62.66.4    |

**Abbildung 9:** Gesamter Bootprozess

## Dokumentieren Sie den Ablauf bei einer DNS-Abfrage

### Fall 1: DNS-Server 141.62.66.250:

Mittels folgendem Command wurde eine DNS-Abfrage gemacht:

```
$ dig @141.62.66.250 google.com  
google.com.      163 IN  A    142.250.186.174
```

| No. | Time        | Source                                     | Destination            | Protocol | Length                | Info  |
|-----|-------------|--|------------------------|----------|-----------------------|---|
| 11  | 1.357358800 | rn05.rn1abor.hdm-st... opnsense-router.rnL | DNS                    | 93       | Standard query 0xa276 | A google.com OPT  |
| 12  | 1.371050270 | opnsense-router.rnL                        | rn05.rn1abor.hdm-ST... | DNS      | 97                    | Standard query Response 0xa276 A google.com A 142.250.186.174 OPT |

**Abbildung 12:** Ablauf der Anfrage

Hier nutzten wir den internen DNS Server und machen eine Anfrage auf google.com.

### Fall 2: DNS-Server 1.1.1.1 (Cloudflare):

Mittels folgendem Command wurde eine DNS-Abfrage gemacht:

## Lösen Sie eine ARP-Anfrage aus und protokollieren Sie die Datenpakete.

Hierzu wurde ein Rechner, welcher zuvor nicht im lokalen ARP-Cache war, neu gestartet.

| All | Time | Source             | Dest          | Type          | Protocol | Length | Info                                  |
|-----|------|--------------------|---------------|---------------|----------|--------|---------------------------------------|
|     |      | 214.110.5155670211 | linux-2.local | broadcast     | ARP      | 46     | who has 141.62.66.6? Tell 141.62.66.5 |
|     |      | 215.110.5155667208 | linux-3.local | linux-2.local | ARP      | 60     | 141.62.66.6 is at 4c:52:0e:54:2b      |
|     |      | 231.115.673164798  | linux-3.local | linux-2.local | ARP      | 60     | who has 141.62.66.5? Tell 141.62.66.6 |
|     |      | 232.115.673180788  | linux-2.local | linux-3.local | ARP      | 42     | 141.62.66.5 is at 4c:52:0e:54:8b      |

Abbildung 15: Ablauf der Anfrage

## Wann wird eine ARP-Anfrage gestartet?

Sobald ein Paket an die Zieladresse (in unserem Fall 141.62.66.6) gesendet werden soll, wird eine ARP-Anfrage in Form eines Broadcasts gestartet, um das Zielgerät im Netzwerk zu ermitteln, sofern sich diese nicht bereits im ARP-Cache befindet. Dieser kann mit ip neigh show ausgelesen werden. Mit ip neigh flush all

## Layer-2-Protokolle

**Gelegentlich werden vom Analyzer Broadcasts erkannt. Wer sendet sie, warum und in welchen zeitlichen Abständen?**

Die Broadcasts sind ARP-Requests. Sie entstehen dadurch, da Geräte versuchen Daten an andere Geräte zu übertragen, für welche sie keinen Eintrag in ihrem ARP-Cache haben, deshalb muss eine ARP-Anfrage in Form eines Broadcasts gesendet werden, da jeder Host potenziell der gesuchte Host sein kann. Dieser besitzt gesuchte IP X und antwortet daraufhin mit seiner Mac.

| No.   | Time                     | Source                   | Destination            | Protocol  | Length Info  |
|---|--------------------------|--------------------------|------------------------|---|--|
| 178   | 1993-07-23T06:48:00.000Z | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 178   | 1993-07-23T06:48:00.000Z | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| <b>175 72 .8867515887</b>   | <b>Linux-3.local</b>     | <b>224.0.0.251</b>       | <b>MHDN</b>            | <b>82 Standard query @0x8000 PTR _opkey-hkp._tcp.local. "Qn" question</b> |  |
| 178   | 1993-07-23T06:48:00.000Z | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 178   | 1993-07-23T06:48:00.000Z | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 178   | 1993-07-23T06:48:00.000Z | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 179   | 1993-07-23T06:48:00.000Z | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 181   | 1993-07-23T06:48:00.000Z | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 182   | 84.699546741             | Librennes-226.rnlabor.de | Broadcast              | ARP   | 60 Who has 141.62.66.29? Tell 141.62.66.220  |
| 183   | 84.731177897             | Librennes-226.rnlabor.de | Broadcast              | ARP   | 60 Who has 141.62.66.227? Tell 141.62.66.226   |
| 184   | 85.674657721             | Librennes-226.rnlabor.de | Broadcast              | ARP   | 60 Who has 141.62.66.29? Tell 141.62.66.226  |
| 185   | 85.674657721             | Librennes-226.rnlabor.de | Broadcast              | ARP   | 60 Who has 141.62.66.29? Tell 141.62.66.226  |
| 186   | 85.954876527             | Linux-2.local            | opensec_rnlabor.hds    | DNS   | 86 Standard query @0x9e2a PTR 226.66.62.141.in-addr.arpa   |
| 187   | 85.956236998             | opensec_rnlabor.hds      | Linux-2.local          | DNS   | 137 Standard query response 0x9e2a PTR 226.66.62.141.in-addr.arpa PTR Librennes-226.rnlabor.hdm-stuttgart.de |
| 188   | 86.721457449             | Librennes-226.rnlabor.de | Broadcast              | ARP   | 60 Who has 141.62.66.29? Tell 141.62.66.226  |
| 189   | 86.758478381             | Librennes-226.rnlabor.de | Broadcast              | ARP   | 60 Who has 141.62.66.227? Tell 141.62.66.226   |
| 191   | 87.899791212             | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/9/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 192   | 88.6269704988            | Linux-3.local            | 224.0.0.251            | MHDN  | 81 Standard query @0x8000 PTR _newa_0183._tcp.local. "Qn" question   |
| 193   | 89.899791212             | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/9/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 194   | 90.8676590494            | Linux-2.local            | opensec_rnlabor.hds    | DNS   | 42 Who has 141.62.66.29? Tell 341.62.66.5  |
| 195   | 91.8997172080            | opensec_rnlabor.hds      | Linux-2.local          | ARP   | 60 141.62.66.29b is at 00:00:09:4fb:14   |
| 197   | 93.886571335             | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 198   | 95.899796112             | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 199   | 95.899796112             | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| 200   | 95.899796112             | NewlettPc_as-80-be       | Spanning-tree-(For...) | STP   | 119 MST Root = 32768/8/0/0.1a:c1:Se0/0:0 Cost = 228020 Port = 8x8002   |
| Frames 302: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface em0fa0, id 9 |                          |                          |                        |   |  |

# HTTP und TCP

## Initiiieren Sie eine HTTP-TCP-Sitzung (beliebige Website) und zeichnen Sie die Protokollabläufe auf

Zuerst wird ein DNS-Request getätigt. Daraufhin folgt der 3-Way-Handshake. Dieser ist an der charakteristischen Abfolge SYN, SYN-ACK, ACK zu erkennen.

| No. | Time      | Source          | Destination     | Protocol | Length | Info   |
|-----|-----------|-----------------|-----------------|----------|--------|--|
| 714 | 7.5,98625 | 100.64.84.66    | 141.70.124.5    | DNS      | 88     | Standard query 0x189d A news.ycombinator.com   |
| 715 | 7.5,98881 | 100.64.84.66    | 141.70.124.5    | DNS      | 88     | Standard query 0x58df AAAA news.ycombinator.com  |
| 716 | 7.6,08834 | 141.70.124.5    | 100.64.84.66    | DNS      | 158    | Standard query response 0x58df AAAA news.ycombinator.com SOA ns-225.awsdns-28.com  |
| 717 | 7.6,13971 | 141.70.124.5    | 100.64.84.66    | DNS      | 233    | Standard query response 0x189d A news.ycombinator.com A 209.216.230.240 NS ns-1411.awsdns-48.org NS ns-1914.awsdns-47.co.l                   |
| 718 | 7.6,14386 | 100.64.84.66    | 209.216.230.248 | TCP      | 78     | 49314 -> 443 [SYN, ECR, CWR] Seq=0 Win=65535 Len=0 MSS=1468 Win=65535 TSecr=> SACK_PERM=1  |
| 719 | 7.6,75218 | 209.216.230.248 | 100.64.84.66    | TCP      | 74     | 443 -> 49314 [SYN, ACK, ECR] Seq=1 Win=65535 Len=0 MSS=1468 Win=65535 TSecr=> SACK_PERM=1  |
| 720 | 7.6,75334 | 209.216.230.248 | 100.64.84.66    | TCP      | 66     | 49314 -> 443 [ACK] Seq=1 Win=131712 Len=0 TSecr=>2045828466  |
| 721 | 7.7,65826 | 100.64.84.66    | 209.216.230.248 | TLSv1_   | 583    | Client Hello   |
| 722 | 7.7,91740 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 1514   | New Session  |
| 723 | 7.7,91748 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 1514   | 443 -> 49314 [ACK] Seq=448 Ack=518 Win=65664 Len=1448 TSecr=>2045828632 TSecr=>2512581211 [TCP segment of a reassembled PDU]                 |
| 724 | 7.7,91749 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 1063   | Certificate, Certificate Status, Server Key Exchange, Server Hello Done  |
| 725 | 7.7,91751 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | 49314 -> 443 [ACK] Seq=189 Win=13083 Win=127972 Len=0 TSecr=>2045828612  |
| 726 | 7.9,17726 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | [TCP Window Update] 49314 -> 443 [ACK] Seq=1812 Ack=3893 Win=131972 Len=0 TSecr=>2512581363 TSecr=>2045828612                                |
| 727 | 7.9,37248 | 100.64.84.66    | 209.216.230.248 | TLSv1_   | 192    | Client Key Exchange, Change Cipher Spec, Encrypted Handshake Message   |
| 728 | 7.9,37649 | 100.64.84.66    | 209.216.230.248 | TLSv1_   | 786    | Application Data   |
| 729 | 7.9,88785 | 209.216.230.248 | 100.64.84.66    | TCP      | 66     | 443 -> 49314 [ACK] Seq=8931 Ack=1364 Win=64832 Len=0 TSecr=>2045828783 TSecr=>2512581383   |
| 730 | 7.9,89369 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 324    | New Session Ticket, Change Cipher Spec, Encrypted Handshake Message  |
| 731 | 7.9,89397 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | 49314 -> 443 [ACK] Seq=1364 Ack=1364 Win=130752 Len=0 TSecr=>2045828788  |
| 732 | 7.9,89625 | 209.216.230.248 | 100.64.84.66    | TCP      | 1514   | 443 -> 49314 [ACK] Seq=4151 Ack=1513 Win=65664 Len=1448 TSecr=>2512581383 [TCP segment of a reassembled PDU]                                 |
| 733 | 7.9,89626 | 209.216.230.248 | 100.64.84.66    | TCP      | 1514   | 443 -> 49314 [ACK] Seq=5999 Ack=1364 Win=65664 Len=1448 TSecr=>2045828789 TSecr=>2512581383 [TCP segment of a reassembled PDU]               |
| 734 | 7.9,89626 | 209.216.230.248 | 100.64.84.66    | TCP      | 1514   | 443 -> 49314 [ACK] Seq=8474 Ack=1364 Win=65664 Len=1448 TSecr=>2045828789 TSecr=>2512581383 [TCP segment of a reassembled PDU]               |
| 735 | 7.9,89627 | 209.216.230.248 | 100.64.84.66    | TCP      | 1514   | 443 -> 49314 [ACK] Seq=8495 Ack=1364 Win=65664 Len=1448 TSecr=>2045828789 TSecr=>2512581383 [TCP segment of a reassembled PDU]               |
| 736 | 7.9,89628 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 681    | Application Data   |
| 737 | 7.9,89631 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | 49314 -> 443 [ACK] Seq=1364 Ack=18588 Win=124688 Len=0 TSecr=>2512581542 TSecr=>2045828789   |
| 738 | 7.9,89648 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | [TCP Window Update] 49314 -> 443 [ACK] Seq=1364 Ack=18588 Win=131872 Len=0 TSecr=>2512581542 TSecr=>2045828789                               |
| 739 | 7.9,22322 | 100.64.84.66    | 209.216.230.248 | TLSv1_   | 691    | Change Cipher Spec, Encrypted Handshake Message  |
| 740 | 7.9,37698 | 100.64.84.66    | 209.216.230.248 | TCP      | 78     | 49314 -> 443 [SYN, ECR, CWR] Seq=0 Win=65535 Len=0 MSS=1468 Win=65535 TSecr=>2045828789 TSecr=>2512581669 [TCP segment of a reassembled PDU] |
| 741 | 7.9,37485 | 209.216.230.248 | 100.64.84.66    | TCP      | 1514   | 443 -> 49314 [ACK] Seq=18558 Ack=1989 Win=65664 Len=1448 TSecr=>2045829076 TSecr=>2512581669 [TCP segment of a reassembled PDU]              |
| 742 | 7.9,37487 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 823    | Application Data   |
| 743 | 7.9,37463 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | 49314 -> 443 [ACK] Seq=1989 Ack=12763 Win=128832 Len=0 TSecr=>2512581828 TSecr=>2045829076   |
| 744 | 7.9,37691 | 100.64.84.66    | 209.216.230.248 | TLSv1_   | 674    | Application Data   |
| 750 | 7.9,41934 | 209.216.230.248 | 100.64.84.66    | TCP      | 74     | 443 -> 49314 [SYN, ACK, ECR] Seq=1 Win=65535 Len=0 MSS=1468 Win=65535 TSecr=>1535768379 TSecr=>3827897587                                    |
| 751 | 7.9,41956 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | 49314 -> 443 [ACK] Seq=1 Win=131712 Len=0 TSecr=>382789754 TSecr=>1535768379   |
| 752 | 7.9,42437 | 100.64.84.66    | 209.216.230.248 | TLSv1_   | 585    | Client Hello   |
| 759 | 7.9,52767 | 209.216.230.248 | 100.64.84.66    | TCP      | 1514   | 443 -> 49314 [ACK] Seq=12763 Ack=597 Win=65664 Len=1448 TSecr=>2045829221 TSecr=>2512581821 [TCP segment of a reassembled PDU]               |
| 766 | 7.9,52768 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 793    | Application Data   |
| 761 | 7.9,52715 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | 49314 -> 443 [ACK] Seq=1989 Ack=12763 Win=128832 Len=0 TSecr=>2512581972 TSecr=>2045829221   |
| 762 | 7.9,59143 | 209.216.230.248 | 100.64.84.66    | TLSv1_   | 222    | Server Hello, Change Cipher Spec, Encrypted Handshake Message  |
| 763 | 7.9,59147 | 100.64.84.66    | 209.216.230.248 | TCP      | 66     | 49315 -> 443 [ACK] Seq=157 Win=131586 Len=0 TSecr=>3827897926 TSecr=>1535768058  |
| 764 | 7.9,59169 | 100.64.84.66    | 209.216.230.248 | TLSv1_   | 117    | Change Cipher Spec, Encrypted Handshake Message  |

## Wie lauten die MAC-Adressen der im Labor befindlichen Ethernet-Switches? Wie haben Sie die Switches identifizieren können. Welche Möglichkeiten der Identifizierung gibt es?

Beim Spanning-Tree-Protocol lässt sich sehen, dass die Quelle der Nachrichten immer ein HP-Gerät ist. Dieses muss ein fähiges Kopplungselement des Netzwerkes sein, welches das Spanning-Tree-Protocol unterstützt. Daher wird dies mit hoher Wahrscheinlichkeit der Ethernet-Switch sein.

**MAC-Adresse:** 04:09:73:aa:8b:be

| No. | Time            | Source             | Destination          | Protocol | Length | Info  |
|-----|-----------------|--------------------|----------------------|----------|--------|---|
| 170 | 63. 999710934   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 171 | 65. 999832879   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 172 | 67. 999832879   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 173 | 70. 999817336   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 174 | 71. 999817336   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 178 | 72. 999729543   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 177 | 73. 999729543   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 178 | 74. 999729543   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 179 | 75. 999806699   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 178 | 76. 999806699   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 179 | 77. 999806699   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 180 | 78. 999806699   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 181 | 80. 999802388   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 182 | 83. 999531792   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 183 | 84. 999531792   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 184 | 85. 999531792   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 185 | 86. 999807785   | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 186 | 89. 9998034042  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 188 | 91. 9998071526  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 189 | 93. 9998071526  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 190 | 95. 9998071526  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 206 | 97. 9995306051  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 201 | 100. 980216873  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 203 | 103. 980216873  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 204 | 103. 999772305  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 205 | 103. 999772305  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 212 | 108. 9802409879 | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 213 | 108. 999891429  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |
| 191 | 87. 9997191212  | HewlettPc_aa:bb:be | Spanning-tree-(For-) | STP      | 119    | MST. Root = 32768/0/08:1a:c1:5e:eb:c0 Cost = 220020 Port = 0x8002 |

## Filtern Sie auf das Protokoll BPDU/STP. Wer sendet es und welchen Sinn hat dieses Protokoll?

Das STP-Protokoll ist das Spanning Tree Protocol. Das STP-Protokoll verhindert Schleifenbildung; dies ist besonders dann von Nutzen, wenn Redundanzen vorhanden sind. Beim STP-Protokoll werden durch alle am Netz beteiligten Switches eine "Root Bridge" gewählt und redundante Links werden deaktiviert. Wie anhand der OUI der MAC-Adresse erkannt werden kann wird dieses hier von einem HP-Switch verwendet.

| No.               | Time              | Source                  | Destination | Protocol                          | Length        | Info           |
|-------------------|-------------------|-------------------------|-------------|-----------------------------------|---------------|----------------|
| 393 102.000115690 | HeuvelTP.an.Bb:be | Spanning-tree-(For-     | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 394 104.000105982 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 395 106.000056817 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 397 109.000202936 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 398 110.000202937 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 406 192.000560847 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 407 194.000877110 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 408 196.000399860 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 411 200.000399861 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 412 208.000287489 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 413 292.000187163 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 417 204.000254351 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 418 206.000015959 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 420 210.000015960 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 424 218.000028987 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 425 212.000027773 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 426 214.000080847 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 427 216.000078690 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 428 218.000078691 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 430 720.000140895 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |
| 433 222.000177264 | HeuvelTP.an.Bb:be | Spanning-tree-(For- STP | 119 MST     | Root = 32768/0/0/0:1a:cl:Se:eb:c9 | Cost = 226029 | Port = 0x80002 |

# SNMP

**Auf welchen Komponenten im Netzwerk wird das Protokoll SNMP ausgeführt?**

Es konnte kein SNMP-Traffic im Netzwerk gefunden werden. SNMP, das Simple Network Management Protocol, wird jedoch meist zur Wartung von verbundenen Geräte im Network verwendet, woraus sich schließen lässt, dass es auf Komponenten wie Switches, Routern oder Servern zum Einsatz kommen würde.

## Streaming and Downloads

**Starten Sie einen Download einer größeren Datei aus dem Internet und stoppen Sie ihn während der Übertragung. Dokumentieren Sie, wie der Stop-Befehl innerhalb der Protokolle umgesetzt wird**

**Abbildung 28:** Capture beim Canceln des eines Downloads über HTTPS

Da der Download hier via HTTPS durchgeführt wurde, kann erkannt werden, dass die darunterliegende TCP-Verbindung unterbrochen wurde, indem die RST-Flag gesetzt wurde. Auch ein TCP Segment mit der Ziel-IP 192.168.1.100 und der FIN- und ACK-Flag gesetzt.

# Telnet und SSH

Protokollieren Sie den Ablauf einer TELNET-Verbindung zur IP-Adresse 141.62.66.207 (login: praktikum; passwd: versuch). Können Sie Passwörter im Wireshark-Trace identifizieren? Wie verhält sich im Vergleich dazu eine SSH-Verbindung zum gleichen Server?

Wie zu erkennen ist, wird für eine Telnet-Verbindung eine TCP-Verbindung aufgebaut. Die Passwörter sind zu erkennen.

| No. | Time         | Source        | Destination   | Protocol | Length | Info            |
|-----|--------------|---------------|---------------|----------|--------|-----------------|
| 53  | 13.371899779 | 141.62.66.5   | 141.62.66.207 | TELNET   | 69     | Telnet Data ... |
| 55  | 13.371964177 | 141.62.66.207 | 141.62.66.5   | TELNET   | 69     | Telnet Data ... |
| 57  | 13.372108043 | 141.62.66.5   | 141.62.66.207 | TELNET   | 69     | Telnet Data ... |
| 59  | 13.372108043 | 141.62.66.5   | 141.62.66.207 | TELNET   | 69     | Telnet Data ... |
| 61  | 13.372108043 | 141.62.66.5   | 141.62.66.207 | TELNET   | 69     | Telnet Data ... |
| 65  | 15.536484921 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 67  | 15.537258875 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |
| 69  | 15.537258875 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 71  | 15.537258875 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |
| 73  | 15.784452662 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 74  | 15.784992429 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |
| 76  | 15.864385854 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 77  | 15.865698282 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |
| 79  | 15.992584487 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 80  | 15.992584487 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |
| 82  | 16.056366088 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 83  | 16.057270317 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |
| 86  | 16.176481343 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 87  | 16.176481343 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |
| 89  | 16.444256688 | 141.62.66.5   | 141.62.66.207 | TELNET   | 67     | Telnet Data ... |
| 90  | 16.453501998 | 141.62.66.207 | 141.62.66.5   | TELNET   | 67     | Telnet Data ... |

Frame 61: 89 bytes on wire (648 bits), 88 bytes captured (648 bits) on interface enp3s0f0, id = 0  
Ethernet II, Src: rnlabor (62:39:f6:7b:b8:87) [ethernet], Dst: rn6.rnlabor.hdm-stuttgart.de (4c:52:82:0e:54:8b)  
Internet Protocol Version 4, Src: 141.62.66.207, Dst: 141.62.66.5  
Transmission Control Protocol, Src Port: 23, Dst Port: 30234, Seq: 78, Ack: 163, Len: 34  
Telnet  
Data: telnet login:

# Wireshark-Filter

Entwickeln, testen und dokumentieren Sie Wireshark-Filter zur Lösung folgender Aufgaben:

Nur IP-Pakete, deren TTL größer ist als ein von Ihnen sinnvoll gewählter Referenzwert

| No.   | TTL | Time            | Source         | Destination        | Protocol | Length | Info   |
|-------|-----|-----------------|----------------|--------------------|----------|--------|--|
| 25    | 255 | 1.444955667     | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 26    | 255 | 1.444955673     | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 31    | 255 | 1.451978337     | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 89    | 255 | 1.498643116     | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 98    | 255 | 1.3.500598080   | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 112   | 255 | 1.4.354393550   | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 120   | 255 | 1.4.354393557   | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 1527  | 255 | 1.21.51668853   | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 1567  | 255 | 1.21.654196641  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 2831  | 255 | 1.25.443188947  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 2844  | 255 | 1.25.459619749  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 2850  | 255 | 1.25.459619750  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 2849  | 255 | 1.25.598822269  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 2858  | 255 | 1.25.598822695  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 2851  | 255 | 1.25.598822634  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 2852  | 255 | 1.25.598822635  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 1180  | 255 | 1.451376020     | 100.64.154.255 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QU" quest.  |
| 12818 | 255 | 75.597596960    | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.  |
| 12561 | 255 | 78.567487619    | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 13269 | 255 | 87.681387937    | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 18851 | 255 | 1.134.49841999  | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 18852 | 255 | 1.134.498419994 | 100.64.154.254 | felixx-xps13.local | ICMP     | 78     | Time-to-live exceeded (Time to live exceeded in transit)   |
| 19848 | 255 | 340.929138747   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QU" quest.. |
| 19852 | 255 | 141.955910993   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 23894 | 255 | 144.924217109   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 21865 | 255 | 154.339292380   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 21539 | 255 | 172.657446409   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 22148 | 255 | 158.657433864   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 22784 | 255 | 167.657446649   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |
| 22852 | 255 | 168.579565631   | 100.64.154.245 | 224.0.0.251        | MDNS     | 198    | Standard query 0x0000 PTR lb_.dns-sd._udp.local. "QM" question PTR companion-link._tcp.local. "QM" quest.. |

Abbildung 34: Capture der TTL-Werte ab 200

Der Linux-Kernel stellt standardmäßig die TTL auf 64; hier wurde ab 200 gefiltert, damit ausschließlich „ungewöhnliche“ Pakete wie