Lab 3: More on Wireshark and Introduction to Network Programming

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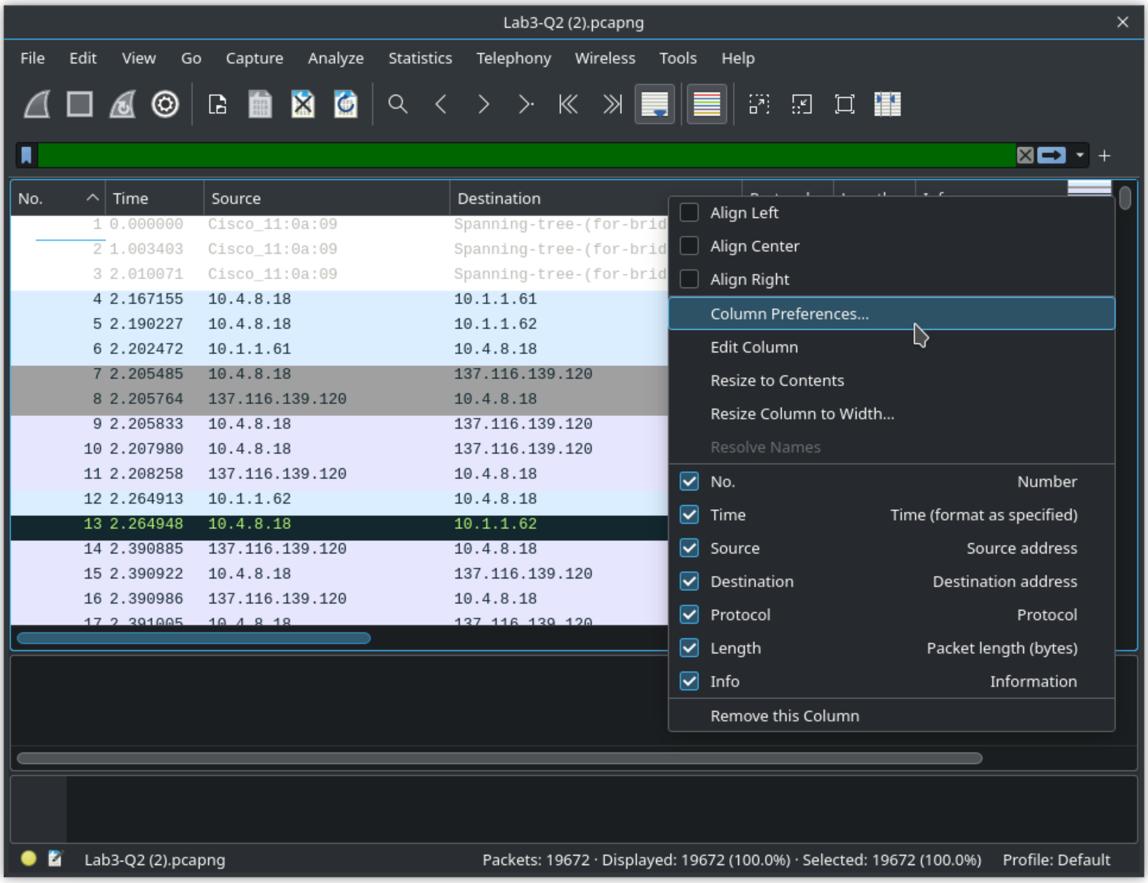
1. Arrange and add columns in WireShark

- Right click column header and choose `Column Preferences`

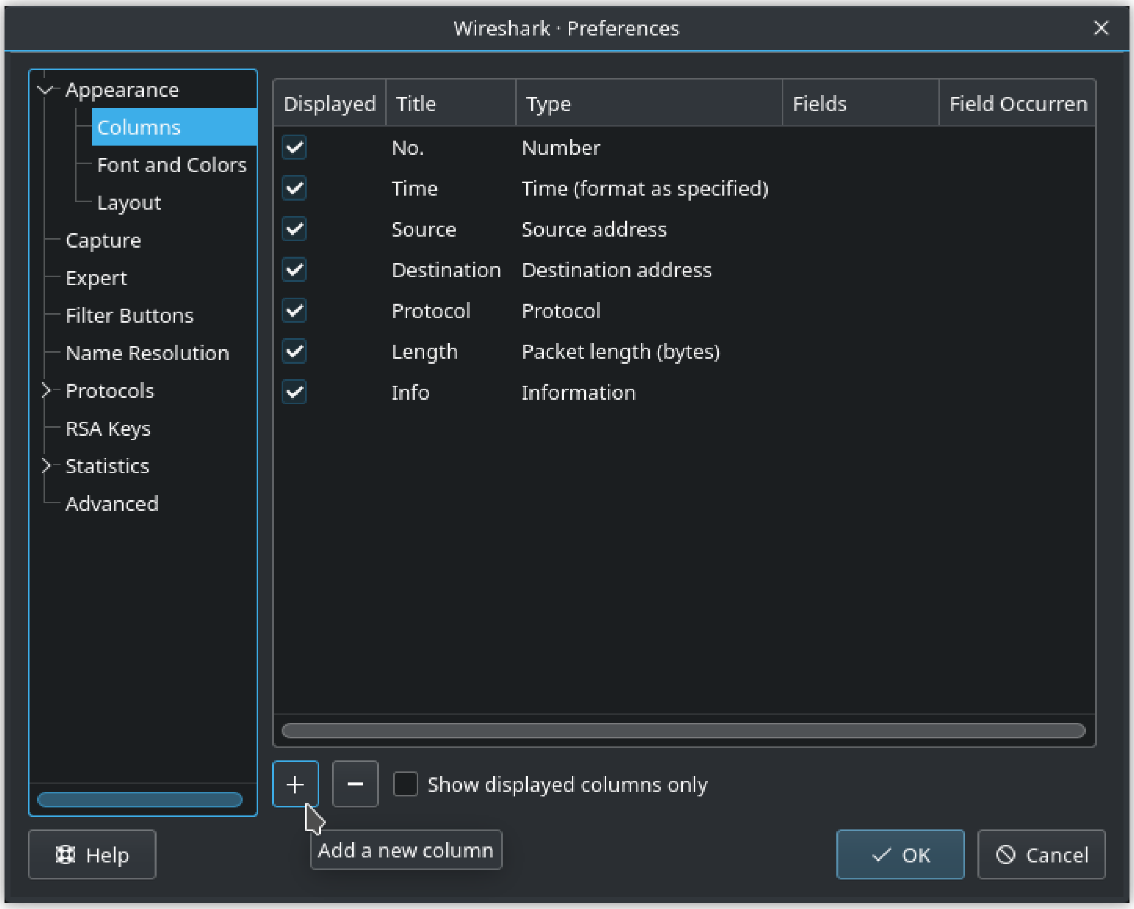


No.	Time	Source	Destination
1	0.000000	Cisco_11:0a:09	Spanning-tree-(for-brid
2	1.003403	Cisco_11:0a:09	Spanning-tree-(for-brid
3	2.010071	Cisco_11:0a:09	Spanning-tree-(for-brid
4	2.167155	10.4.8.18	10.1.1.61
5	2.190227	10.4.8.18	10.1.1.62
6	2.202472	10.1.1.61	10.4.8.18
7	2.205485	10.4.8.18	137.116.139.120
8	2.205764	137.116.139.120	10.4.8.18
9	2.205833	10.4.8.18	137.116.139.120
10	2.207980	10.4.8.18	137.116.139.120
11	2.208258	137.116.139.120	10.4.8.18
12	2.264913	10.1.1.62	10.4.8.18
13	2.264948	10.4.8.18	10.1.1.62
14	2.390885	137.116.139.120	10.4.8.18
15	2.390922	10.4.8.18	137.116.139.120
16	2.390986	137.116.139.120	10.4.8.18
17	2.391005	10.4.8.18	137.116.139.120

☑	No.	Number
☑	Time	Time (format as specified)
☑	Source	Source address
☑	Destination	Destination address
☑	Protocol	Protocol
☑	Length	Packet length (bytes)
☑	Info	Information

Lab3-Q2 (2).pcapng Packets: 19672 · Displayed: 19672 (100.0%) · Selected: 19672 (100.0%) Profile: Default

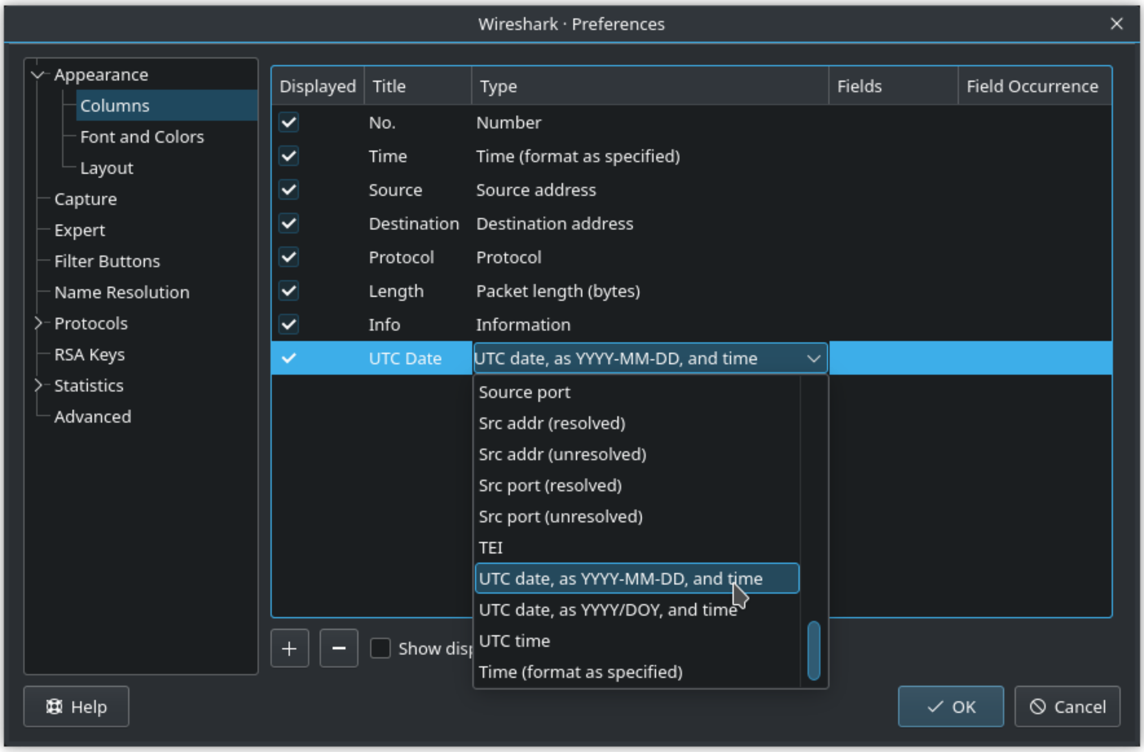
- Under `Appearance` > `Columns`, click `+` to add new column



Displayed	Title	Type	Fields	Field Occurren
☑	No.	Number		
☑	Time	Time (format as specified)		
☑	Source	Source address		
☑	Destination	Destination address		
☑	Protocol	Protocol		
☑	Length	Packet length (bytes)		
☑	Info	Information		

□ Show displayed columns only

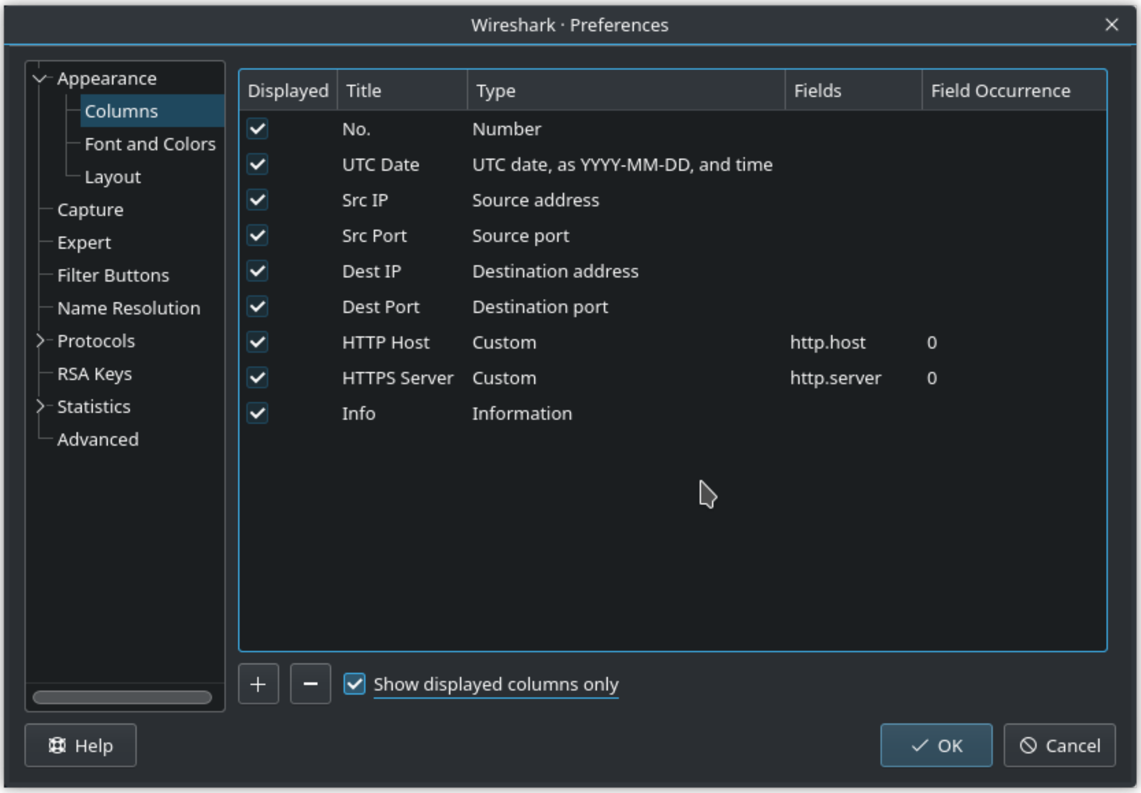
- Set `Title` and `Type`



Displayed	Title	Type	Fields	Field Occurrence
☑	No.	Number		
☑	Time	Time (format as specified)		
☑	Source	Source address		
☑	Destination	Destination address		
☑	Protocol	Protocol		
☑	Length	Packet length (bytes)		
☑	Info	Information		
☑	UTC Date	UTC date, as YYYY-MM-DD, and time		

□ Show disp

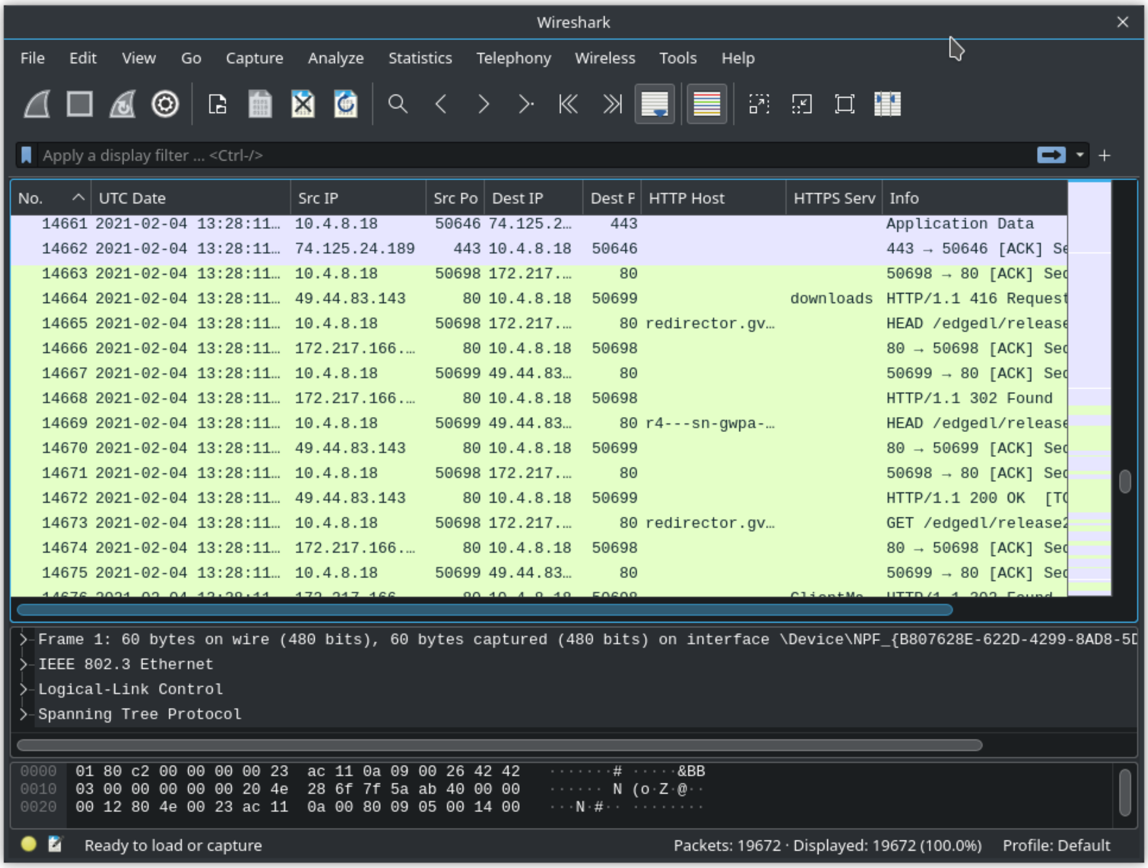
- Repeat for other columns. Columns with `Custom Type` will also require `Fields` to be set. Rows can be dragged to change column order.



Displayed	Title	Type	Fields	Field Occurrence
☑	No.	Number		
☑	UTC Date	UTC date, as YYYY-MM-DD, and time		
☑	Src IP	Source address		
☑	Src Port	Source port		
☑	Dest IP	Destination address		
☑	Dest Port	Destination port		
☑	HTTP Host	Custom	http.host	0
☑	HTTPS Server	Custom	http.server	0
☑	Info	Information		

☑ Show displayed columns only

- Click `OK`



No.	UTC Date	Src IP	Src Po	Dest IP	Dest F	HTTP Host	HTTPS Serv	Info
14661	2021-02-04 13:28:11…	10.4.8.18	50646	74.125.2…	443			Application Data
14662	2021-02-04 13:28:11…	74.125.24.189	443	10.4.8.18	50646			443 → 50646 [ACK] Se
14663	2021-02-04 13:28:11…	10.4.8.18	50698	172.217.…	80			50698 → 80 [ACK] Sec
14664	2021-02-04 13:28:11…	49.44.83.143	80	10.4.8.18	50699		downloads	HTTP/1.1 416 Request
14665	2021-02-04 13:28:11…	10.4.8.18	50698	172.217.…	80	redirector.gv…		HEAD /edgedl/release
14666	2021-02-04 13:28:11…	172.217.166.…	80	10.4.8.18	50698			80 → 50698 [ACK] Sec
14667	2021-02-04 13:28:11…	10.4.8.18	50699	49.44.83…	80			50699 → 80 [ACK] Sec
14668	2021-02-04 13:28:11…	172.217.166.…	80	10.4.8.18	50698			HTTP/1.1 302 Found
14669	2021-02-04 13:28:11…	10.4.8.18	50699	49.44.83…	80	r4---sn-gwpa-…		HEAD /edgedl/release
14670	2021-02-04 13:28:11…	49.44.83.143	80	10.4.8.18	50699			80 → 50699 [ACK] Sec
14671	2021-02-04 13:28:11…	10.4.8.18	50698	172.217.…	80			50698 → 80 [ACK] Sec
14672	2021-02-04 13:28:11…	49.44.83.143	80	10.4.8.18	50699			HTTP/1.1 200 OK [TC
14673	2021-02-04 13:28:11…	10.4.8.18	50698	172.217.…	80	redirector.gv…		GET /edgedl/release2
14674	2021-02-04 13:28:11…	172.217.166.…	80	10.4.8.18	50698			80 → 50698 [ACK] Sec
14675	2021-02-04 13:28:11…	10.4.8.18	50699	49.44.83…	80			50699 → 80 [ACK] Sec

```
> Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface \Device\NPF_{B807628E-622D-4299-8AD8-5D
> IEEE 802.3 Ethernet
> Logical-Link Control
> Spanning Tree Protocol
```

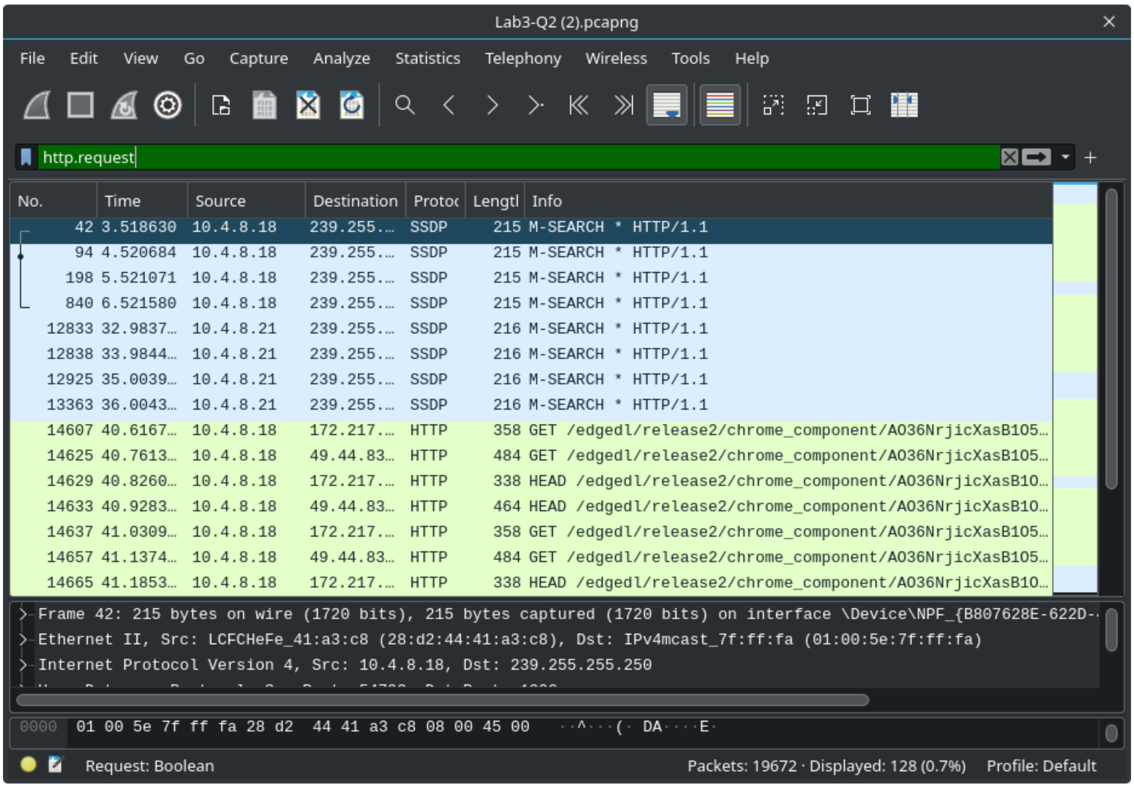
```
0000  01 80 c2 00 00 00 00 23  ac 11 0a 09 00 26 42 42   ·······# ·····&BB
0010  03 00 00 00 00 00 20 4e  28 6f 7f 5a ab 40 00 00   ······ N (o·Z·@··
0020  00 12 80 4e 00 23 ac 11  0a 00 80 09 05 00 14 00   ···N·#·· ········
```

Ready to load or capture   Packets: 19672 · Displayed: 19672 (100.0%)   Profile: Default

2.

a. Identify the http request packet

- Use `http.request` display filter



http.request

```
No.      Time      Source     Destination Protoc Lengtl Info
    42 3.518630  10.4.8.18  239.255.…  SSDP    215 M-SEARCH * HTTP/1.1
    94 4.520684  10.4.8.18  239.255.…  SSDP    215 M-SEARCH * HTTP/1.1
   198 5.521071  10.4.8.18  239.255.…  SSDP    215 M-SEARCH * HTTP/1.1
   840 6.521580  10.4.8.18  239.255.…  SSDP    215 M-SEARCH * HTTP/1.1
 12833 32.9837…  10.4.8.21  239.255.…  SSDP    216 M-SEARCH * HTTP/1.1
 12838 33.9844…  10.4.8.21  239.255.…  SSDP    216 M-SEARCH * HTTP/1.1
 12925 35.0039…  10.4.8.21  239.255.…  SSDP    216 M-SEARCH * HTTP/1.1
 13363 36.0043…  10.4.8.21  239.255.…  SSDP    216 M-SEARCH * HTTP/1.1
 14607 40.6167…  10.4.8.18  172.217.…  HTTP    358 GET /edgedl/release2/chrome_component/AO36NrjicXasB105…
 14625 40.7613…  10.4.8.18  49.44.83…  HTTP    484 GET /edgedl/release2/chrome_component/AO36NrjicXasB105…
 14629 40.8260…  10.4.8.18  172.217.…  HTTP    338 HEAD /edgedl/release2/chrome_component/AO36NrjicXasB10…
 14633 40.9283…  10.4.8.18  49.44.83…  HTTP    464 HEAD /edgedl/release2/chrome_component/AO36NrjicXasB10…
 14637 41.0309…  10.4.8.18  172.217.…  HTTP    358 GET /edgedl/release2/chrome_component/AO36NrjicXasB105…
 14657 41.1374…  10.4.8.18  49.44.83…  HTTP    484 GET /edgedl/release2/chrome_component/AO36NrjicXasB105…
 14665 41.1853…  10.4.8.18  172.217.…  HTTP    338 HEAD /edgedl/release2/chrome_component/AO36NrjicXasB10…
```

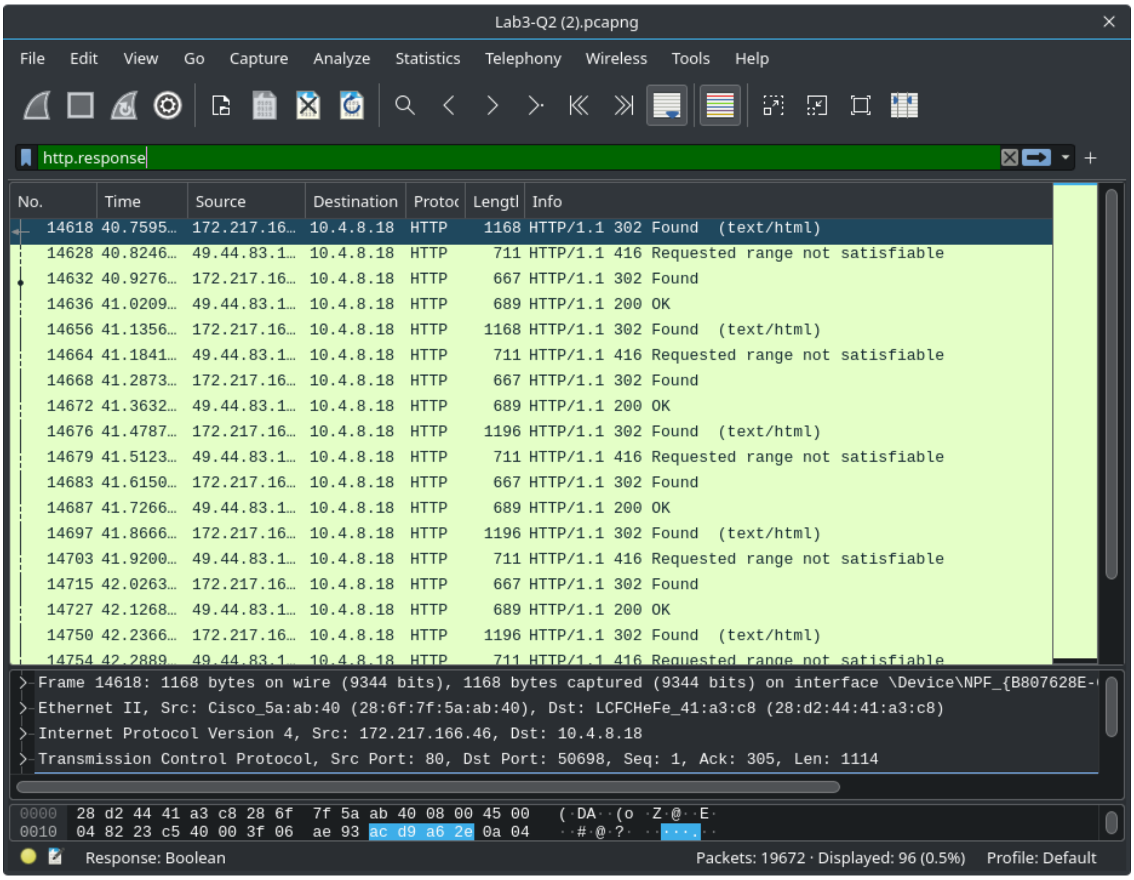
```
> Frame 42: 215 bytes on wire (1720 bits), 215 bytes captured (1720 bits) on interface \Device\NPF_{B807628E-622D-
> Ethernet II, Src: LCFCHeFe_41:a3:c8 (28:d2:44:41:a3:c8), Dst: IPv4mcast_7f:ff:fa (01:00:5e:7f:ff:fa)
> Internet Protocol Version 4, Src: 10.4.8.18, Dst: 239.255.255.250
```

```
0000  01 00 5e 7f ff fa 28 d2  44 41 a3 c8 08 00 45 00   ··^···(· DA····E·
```

Request: Boolean   Packets: 19672 · Displayed: 128 (0.7%)   Profile: Default

b. Identify the http response packet

- Use `http.response` display filter



http.response

```
No.      Time      Source       Destination Protoc Lengtl Info
 14618 40.7595…  172.217.16…  10.4.8.18  HTTP   1168 HTTP/1.1 302 Found  (text/html)
 14628 40.8246…  49.44.83.1…  10.4.8.18  HTTP    711 HTTP/1.1 416 Requested range not satisfiable
 14632 40.9276…  172.217.16…  10.4.8.18  HTTP    667 HTTP/1.1 302 Found
 14636 41.0209…  49.44.83.1…  10.4.8.18  HTTP    689 HTTP/1.1 200 OK
 14656 41.1356…  172.217.16…  10.4.8.18  HTTP   1168 HTTP/1.1 302 Found  (text/html)
 14664 41.1841…  49.44.83.1…  10.4.8.18  HTTP    711 HTTP/1.1 416 Requested range not satisfiable
 14668 41.2873…  172.217.16…  10.4.8.18  HTTP    667 HTTP/1.1 302 Found
 14672 41.3632…  49.44.83.1…  10.4.8.18  HTTP    689 HTTP/1.1 200 OK
 14676 41.4787…  172.217.16…  10.4.8.18  HTTP   1196 HTTP/1.1 302 Found  (text/html)
 14679 41.5123…  49.44.83.1…  10.4.8.18  HTTP    711 HTTP/1.1 416 Requested range not satisfiable
 14683 41.6150…  172.217.16…  10.4.8.18  HTTP    667 HTTP/1.1 302 Found
 14687 41.7266…  49.44.83.1…  10.4.8.18  HTTP    689 HTTP/1.1 200 OK
 14697 41.8666…  172.217.16…  10.4.8.18  HTTP   1196 HTTP/1.1 302 Found  (text/html)
 14703 41.9200…  49.44.83.1…  10.4.8.18  HTTP    711 HTTP/1.1 416 Requested range not satisfiable
 14715 42.0263…  172.217.16…  10.4.8.18  HTTP    667 HTTP/1.1 302 Found
 14727 42.1268…  49.44.83.1…  10.4.8.18  HTTP    689 HTTP/1.1 200 OK
 14750 42.2366…  172.217.16…  10.4.8.18  HTTP   1196 HTTP/1.1 302 Found  (text/html)
 14754 42.2889…  49.44.83.1…  10.4.8.18  HTTP    711 HTTP/1.1 416 Requested range not satisfiable
```

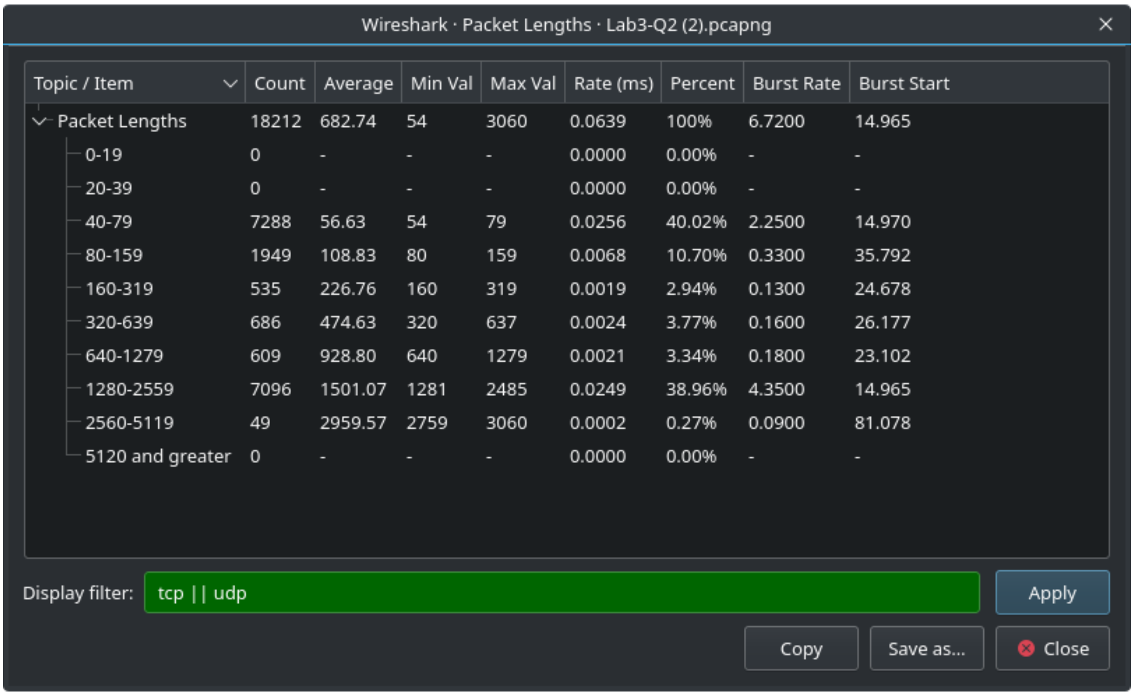
```
> Frame 14618: 1168 bytes on wire (9344 bits), 1168 bytes captured (9344 bits) on interface \Device\NPF_{B807628E-
> Ethernet II, Src: Cisco_5a:ab:40 (28:6f:7f:5a:ab:40), Dst: LCFCHeFe_41:a3:c8 (28:d2:44:41:a3:c8)
> Internet Protocol Version 4, Src: 172.217.166.46, Dst: 10.4.8.18
> Transmission Control Protocol, Src Port: 80, Dst Port: 50698, Seq: 1, Ack: 305, Len: 1114
```

```
0000  28 d2 44 41 a3 c8 28 6f  7f 5a ab 40 08 00 45 00   (·DA··(o ·Z·@··E·
0010  04 82 23 c5 40 00 3f 06  ae 93 ac d9 a6 2e 0a 04   ··#·@·?· ·······
```

Response: Boolean   Packets: 19672 · Displayed: 96 (0.5%)   Profile: Default

c. Display the statistics of the TCP and UDP packets

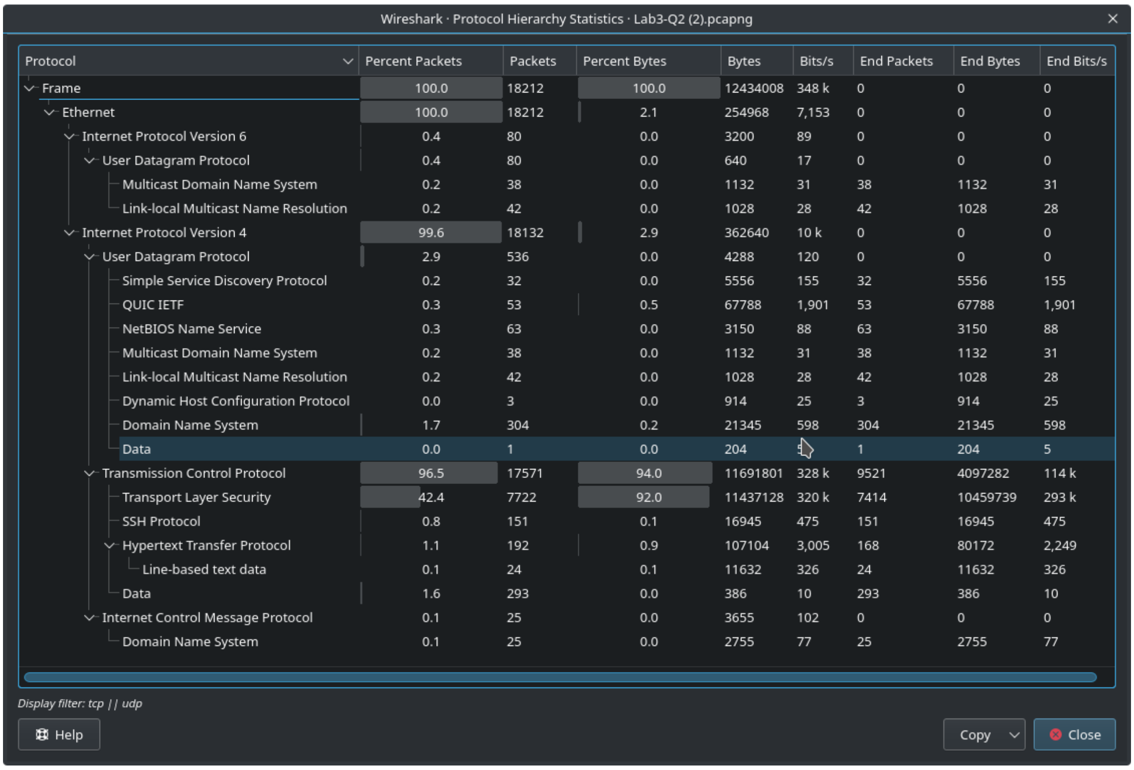
- `Statistics` > `Packet Length`
- Apply `tcp || udp`, `tcp`, or `udp` display filters



Topic / Item	Count	Average	Min Val	Max Val	Rate (ms)	Percent	Burst Rate	Burst Start
Packet Lengths	18212	682.74	54	3060	0.0639	100%	6.7200	14.965
0-19	0	-	-	-	0.0000	0.00%	-	-
20-39	0	-	-	-	0.0000	0.00%	-	-
40-79	7288	56.63	54	79	0.0256	40.02%	2.2500	14.970
80-159	1949	108.83	80	159	0.0068	10.70%	0.3300	35.792
160-319	535	226.76	160	319	0.0019	2.94%	0.1300	24.678
320-639	686	474.63	320	637	0.0024	3.77%	0.1600	26.177
640-1279	609	928.80	640	1279	0.0021	3.34%	0.1800	23.102
1280-2559	7096	1501.07	1281	2485	0.0249	38.96%	4.3500	14.965
2560-5119	49	2959.57	2759	3060	0.0002	0.27%	0.0900	81.078
5120 and greater	0	-	-	-	0.0000	0.00%	-	-

Display filter: tcp || udp

- Use `tcp || udp`, `tcp`, or `udp` display filters
- `Statistics` > `Protocol Hierarchy`



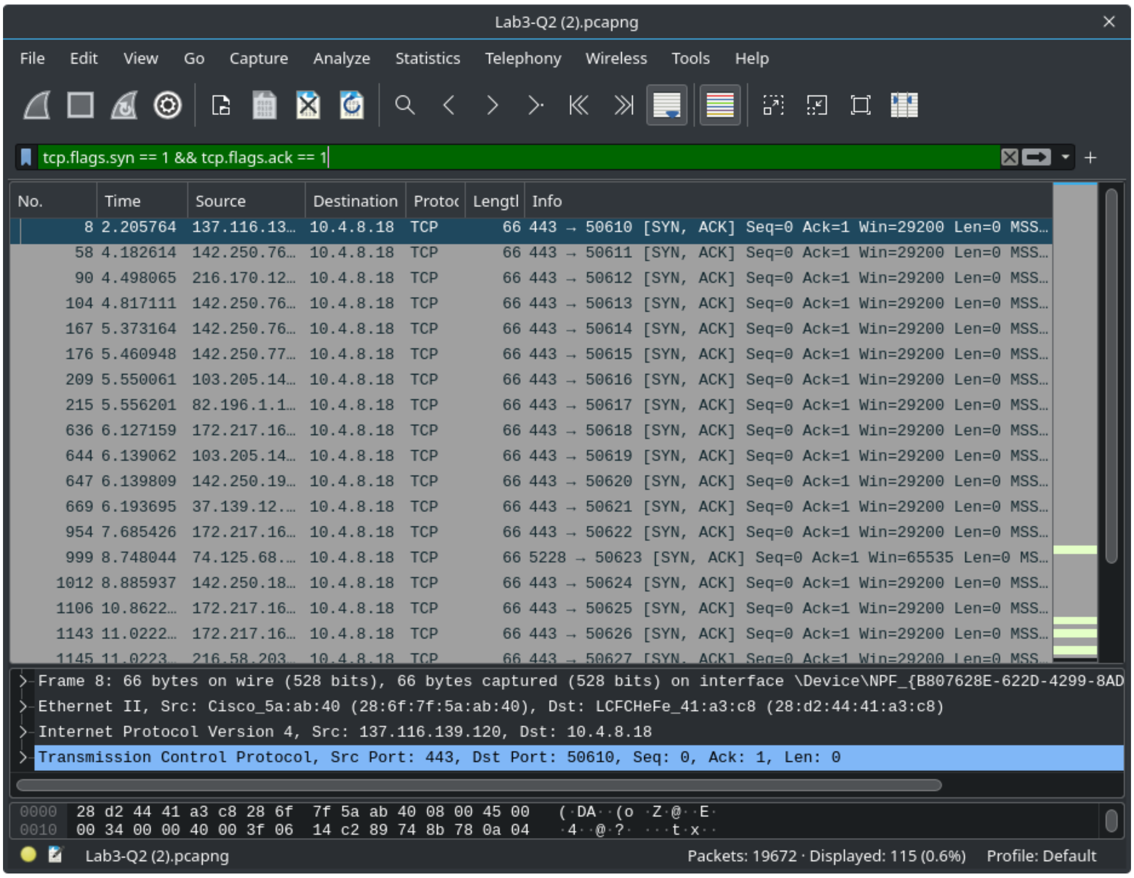
Wireshark · Protocol Hierarchy Statistics · Lab3-Q2 (2).pcapng

Protocol	Percent Packets	Packets	Percent Bytes	Bytes	Bits/s	End Packets	End Bytes	End Bits/s
Frame	100.0	18212	100.0	12434008	348 k	0	0	0
Ethernet	100.0	18212	2.1	254968	7,153	0	0	0
Internet Protocol Version 6	0.4	80	0.0	3200	89	0	0	0
User Datagram Protocol	0.4	80	0.0	640	17	0	0	0
Multicast Domain Name System	0.2	38	0.0	1132	31	38	1132	31
Link-local Multicast Name Resolution	0.2	42	0.0	1028	28	42	1028	28
Internet Protocol Version 4	99.6	18132	2.9	362640	10 k	0	0	0
User Datagram Protocol	2.9	536	0.0	4288	120	0	0	0
Simple Service Discovery Protocol	0.2	32	0.0	5556	155	32	5556	155
QUIC IETF	0.3	53	0.5	67788	1,901	53	67788	1,901
NetBIOS Name Service	0.3	63	0.0	3150	88	63	3150	88
Multicast Domain Name System	0.2	38	0.0	1132	31	38	1132	31
Link-local Multicast Name Resolution	0.2	42	0.0	1028	28	42	1028	28
Dynamic Host Configuration Protocol	0.0	3	0.0	914	25	3	914	25
Domain Name System	1.7	304	0.2	21345	598	304	21345	598
Data	0.0	1	0.0	204	5	1	204	5
Transmission Control Protocol	96.5	17571	94.0	11691801	328 k	9521	4097282	114 k
Transport Layer Security	42.4	7722	92.0	11437128	320 k	7414	10459739	293 k
SSH Protocol	0.8	151	0.1	16945	475	151	16945	475
Hypertext Transfer Protocol	1.1	192	0.9	107104	3,005	168	80172	2,249
Line-based text data	0.1	24	0.1	11632	326	24	11632	326
Data	1.6	293	0.0	386	10	293	386	10
Internet Control Message Protocol	0.1	25	0.0	3655	102	0	0	0
Domain Name System	0.1	25	0.0	2755	77	25	2755	77

Display filter: tcp || udp

d. List out the TCP packets whose syn and ack flags are on

- Use `tcp.flags.syn == 1 && tcp.flags.ack == 1` display filter



tcp.flags.syn == 1 && tcp.flags.ack == 1

No.	Time	Source	Destination	Protoc	Lengtl	Info
8	2.205764	137.116.13…	10.4.8.18	TCP	66	443 → 50610 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
58	4.182614	142.250.76…	10.4.8.18	TCP	66	443 → 50611 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
90	4.498065	216.170.12…	10.4.8.18	TCP	66	443 → 50612 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
104	4.817111	142.250.76…	10.4.8.18	TCP	66	443 → 50613 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
167	5.373164	142.250.76…	10.4.8.18	TCP	66	443 → 50614 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
176	5.460948	142.250.77…	10.4.8.18	TCP	66	443 → 50615 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
209	5.550061	103.205.14…	10.4.8.18	TCP	66	443 → 50616 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
215	5.556201	82.196.1.1…	10.4.8.18	TCP	66	443 → 50617 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
636	6.127159	172.217.16…	10.4.8.18	TCP	66	443 → 50618 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
644	6.139062	103.205.14…	10.4.8.18	TCP	66	443 → 50619 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
647	6.139809	142.250.19…	10.4.8.18	TCP	66	443 → 50620 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
669	6.193695	37.139.12.…	10.4.8.18	TCP	66	443 → 50621 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
954	7.685426	172.217.16…	10.4.8.18	TCP	66	443 → 50622 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
999	8.748044	74.125.68.…	10.4.8.18	TCP	66	5228 → 50623 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MS…
1012	8.885937	142.250.18…	10.4.8.18	TCP	66	443 → 50624 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
1106	10.8622…	172.217.16…	10.4.8.18	TCP	66	443 → 50625 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
1143	11.0222…	172.217.16…	10.4.8.18	TCP	66	443 → 50626 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…
1145	11.0223…	216.58.203…	10.4.8.18	TCP	66	443 → 50627 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS…

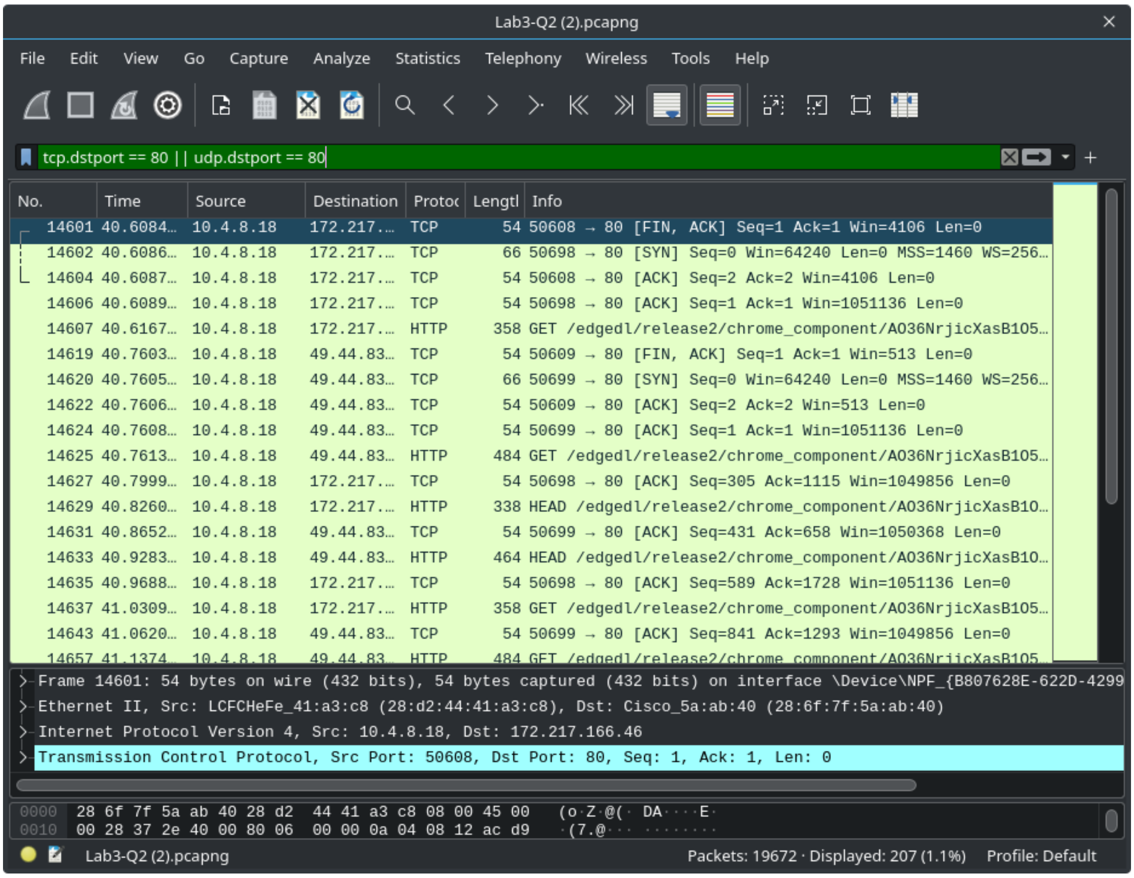
```
> Frame 8: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface \Device\NPF_{B807628E-622D-4299-8AD
> Ethernet II, Src: Cisco_5a:ab:40 (28:6f:7f:5a:ab:40), Dst: LCFCHeFe_41:a3:c8 (28:d2:44:41:a3:c8)
> Internet Protocol Version 4, Src: 137.116.139.120, Dst: 10.4.8.18
> Transmission Control Protocol, Src Port: 443, Dst Port: 50610, Seq: 0, Ack: 1, Len: 0
```

```
0000  28 d2 44 41 a3 c8 28 6f  7f 5a ab 40 08 00 45 00   (·DA··(o ·Z·@··E·
0010  00 34 00 00 40 00 3f 06  14 c2 89 74 8b 78 0a 04   ·4··@·?· ···t·x··
```

Lab3-Q2 (2).pcapng   Packets: 19672 · Displayed: 115 (0.6%)   Profile: Default

e. List out the TCP and UDP packets where dest port=80

- Use `tcp.dstport == 80 || udp.dstport == 80` display filter



tcp.dstport == 80 || udp.dstport == 80

No.	Time	Source	Destination	Protoc	Lengtl	Info
14601	40.6084…	10.4.8.18	172.217.…	TCP	54	50608 → 80 [FIN, ACK] Seq=1 Ack=1 Win=4106 Len=0
14602	40.6086…	10.4.8.18	172.217.…	TCP	66	50698 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256…
14604	40.6087…	10.4.8.18	172.217.…	TCP	54	50608 → 80 [ACK] Seq=2 Ack=2 Win=4106 Len=0
14606	40.6089…	10.4.8.18	172.217.…	TCP	54	50698 → 80 [ACK] Seq=1 Ack=1 Win=1051136 Len=0
14607	40.6167…	10.4.8.18	172.217.…	HTTP	358	GET /edgedl/release2/chrome_component/AO36NrjicXasB105…
14619	40.7603…	10.4.8.18	49.44.83…	TCP	54	50609 → 80 [FIN, ACK] Seq=1 Ack=1 Win=513 Len=0
14620	40.7605…	10.4.8.18	49.44.83…	TCP	66	50699 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256…
14622	40.7606…	10.4.8.18	49.44.83…	TCP	54	50609 → 80 [ACK] Seq=2 Ack=2 Win=513 Len=0
14624	40.7608…	10.4.8.18	49.44.83…	TCP	54	50699 → 80 [ACK] Seq=1 Ack=1 Win=1051136 Len=0
14625	40.7613…	10.4.8.18	49.44.83…	HTTP	484	GET /edgedl/release2/chrome_component/AO36NrjicXasB105…
14627	40.7999…	10.4.8.18	172.217.…	TCP	54	50698 → 80 [ACK] Seq=305 Ack=1115 Win=1049856 Len=0
14629	40.8260…	10.4.8.18	172.217.…	HTTP	338	HEAD /edgedl/release2/chrome_component/AO36NrjicXasB10…
14631	40.8652…	10.4.8.18	49.44.83…	TCP	54	50699 → 80 [ACK] Seq=431 Ack=658 Win=1050368 Len=0
14633	40.9283…	10.4.8.18	49.44.83…	HTTP	464	HEAD /edgedl/release2/chrome_component/AO36NrjicXasB10…
14635	40.9688…	10.4.8.18	172.217.…	TCP	54	50698 → 80 [ACK] Seq=589 Ack=1728 Win=1051136 Len=0
14637	41.0309…	10.4.8.18	172.217.…	HTTP	358	GET /edgedl/release2/chrome_component/AO36NrjicXasB105…
14643	41.0620…	10.4.8.18	49.44.83…	TCP	54	50699 → 80 [ACK] Seq=841 Ack=1293 Win=1049856 Len=0
14657	41.1374…	10.4.8.18	49.44.83…	HTTP	484	GET /edgedl/release2/chrome_component/AO36NrjicXasB105…

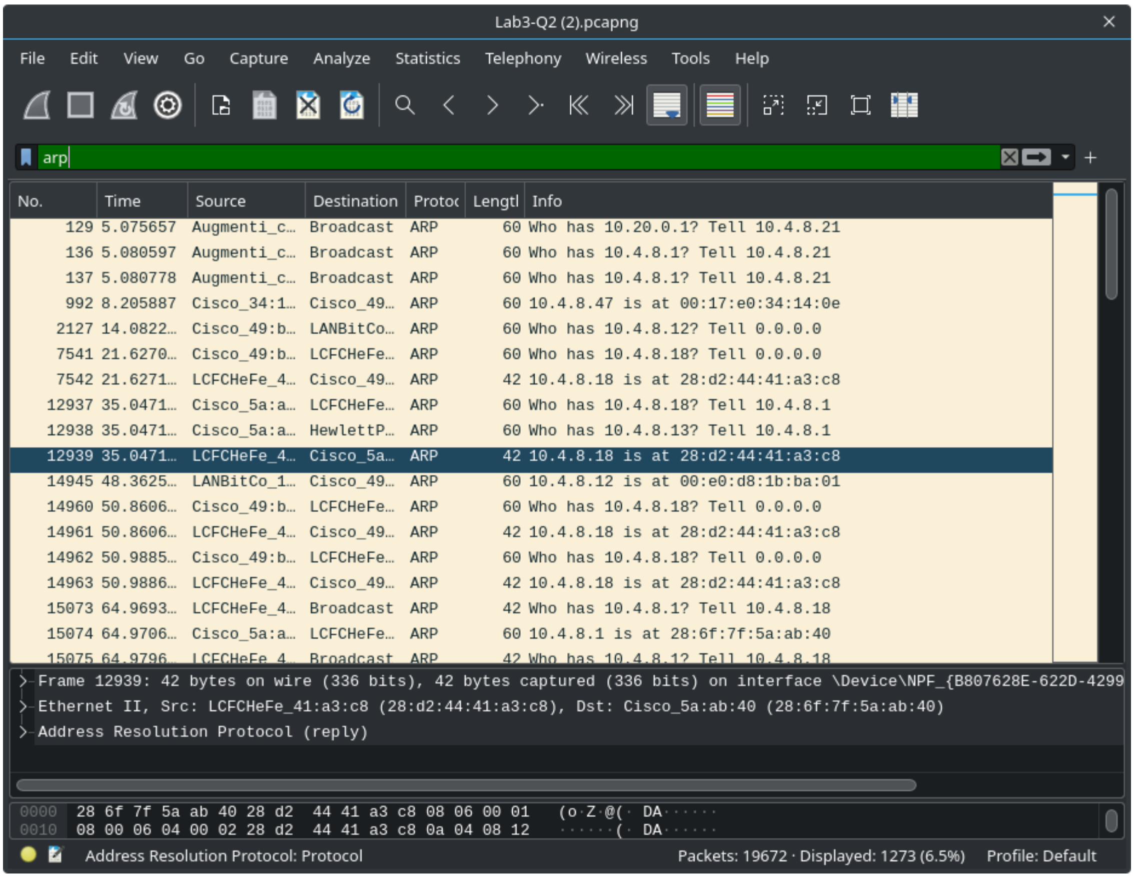
```
> Frame 14601: 54 bytes on wire (432 bits), 54 bytes captured (432 bits) on interface \Device\NPF_{B807628E-622D-4299
> Ethernet II, Src: LCFCHeFe_41:a3:c8 (28:d2:44:41:a3:c8), Dst: Cisco_5a:ab:40 (28:6f:7f:5a:ab:40)
> Internet Protocol Version 4, Src: 10.4.8.18, Dst: 172.217.166.46
> Transmission Control Protocol, Src Port: 50608, Dst Port: 80, Seq: 1, Ack: 1, Len: 0
```

```
0000  28 6f 7f 5a ab 40 28 d2  44 41 a3 c8 08 00 45 00   (o·Z·@(· DA····E·
0010  00 28 37 2e 40 00 80 06  00 00 0a 04 08 12 ac d9   ·(7.@··· ········
```

Lab3-Q2 (2).pcapng   Packets: 19672 · Displayed: 207 (1.1%)   Profile: Default

f. List out the ARP packets

- Use `arp` display filter



No.	Time	Source	Destination	Protoc	Lengtl	Info
129	5.075657	Augmenti_c…	Broadcast	ARP	60	Who has 10.20.0.1? Tell 10.4.8.21
136	5.080597	Augmenti_c…	Broadcast	ARP	60	Who has 10.4.8.1? Tell 10.4.8.21
137	5.080778	Augmenti_c…	Broadcast	ARP	60	Who has 10.4.8.1? Tell 10.4.8.21
992	8.205887	Cisco_34:1…	Cisco_49…	ARP	60	10.4.8.47 is at 00:17:e0:34:14:0e
2127	14.0822…	Cisco_49:b…	LANBitCo…	ARP	60	Who has 10.4.8.12? Tell 0.0.0.0
7541	21.6270…	Cisco_49:b…	LCFCHeFe…	ARP	60	Who has 10.4.8.18? Tell 0.0.0.0
7542	21.6271…	LCFCHeFe_4…	Cisco_49…	ARP	42	10.4.8.18 is at 28:d2:44:41:a3:c8
12937	35.0471…	Cisco_5a:a…	LCFCHeFe…	ARP	60	Who has 10.4.8.18? Tell 10.4.8.1
12938	35.0471…	Cisco_5a:a…	HewlettP…	ARP	60	Who has 10.4.8.13? Tell 10.4.8.1
12939	35.0471…	LCFCHeFe_4…	Cisco_5a…	ARP	42	10.4.8.18 is at 28:d2:44:41:a3:c8
14945	48.3625…	LANBitCo_1…	Cisco_49…	ARP	60	10.4.8.12 is at 00:e0:d8:1b:ba:01
14960	50.8606…	Cisco_49:b…	LCFCHeFe…	ARP	60	Who has 10.4.8.18? Tell 0.0.0.0
14961	50.8606…	LCFCHeFe_4…	Cisco_49…	ARP	42	10.4.8.18 is at 28:d2:44:41:a3:c8
14962	50.9885…	Cisco_49:b…	LCFCHeFe…	ARP	60	Who has 10.4.8.18? Tell 0.0.0.0
14963	50.9886…	LCFCHeFe_4…	Cisco_49…	ARP	42	10.4.8.18 is at 28:d2:44:41:a3:c8
15073	64.9693…	LCFCHeFe_4…	Broadcast	ARP	42	Who has 10.4.8.1? Tell 10.4.8.18
15074	64.9706…	Cisco_5a:a…	LCFCHeFe…	ARP	60	10.4.8.1 is at 28:6f:7f:5a:ab:40
15075	64.9796…	LCFCHeFe_4…	Broadcast	ARP	42	Who has 10.4.8.1? Tell 10.4.8.18

```
> Frame 12939: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface \Device\NPF_{B807628E-622D-4299
> Ethernet II, Src: LCFCHeFe_41:a3:c8 (28:d2:44:41:a3:c8), Dst: Cisco_5a:ab:40 (28:6f:7f:5a:ab:40)
> Address Resolution Protocol (reply)
```

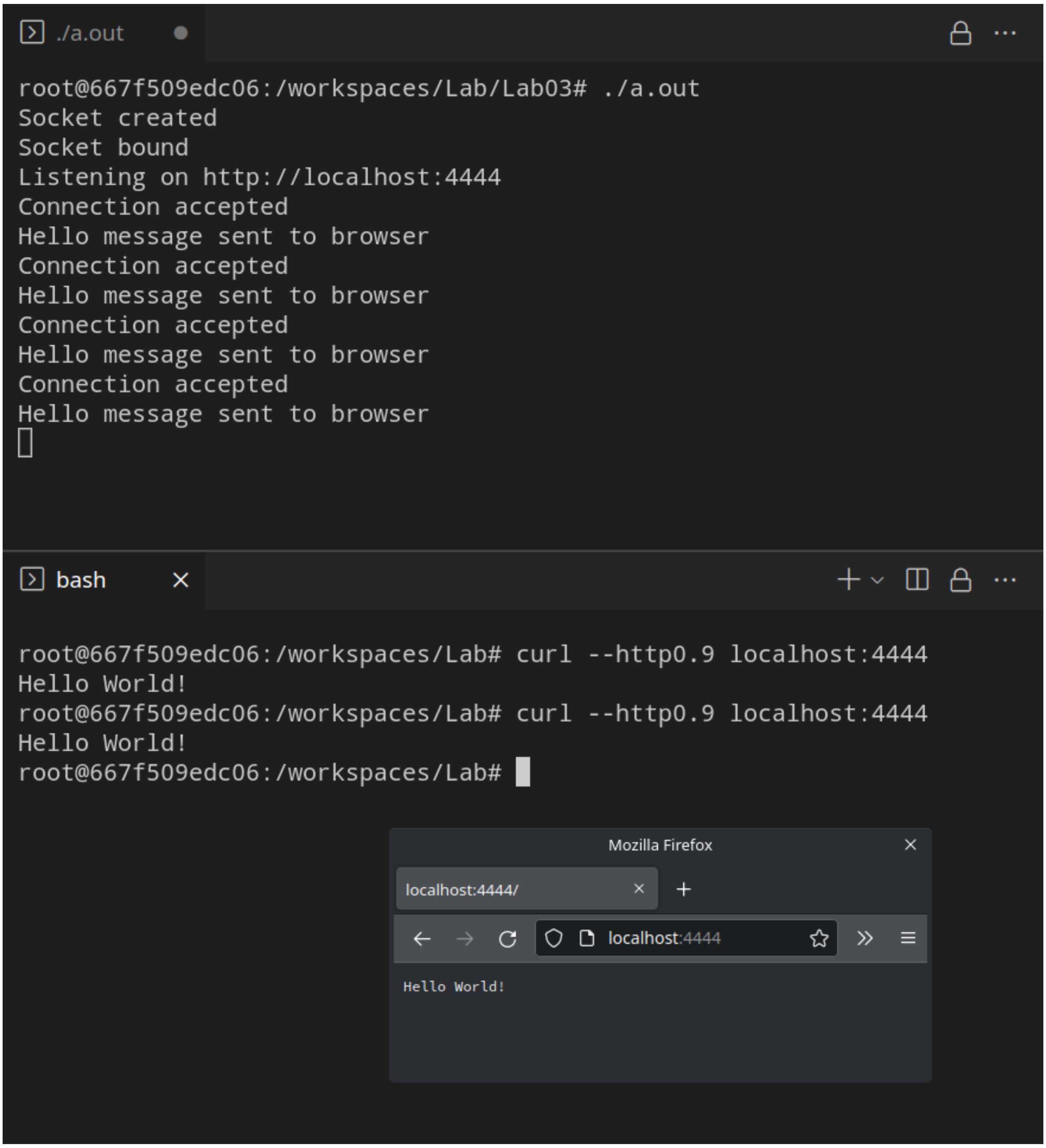
```
0000  28 6f 7f 5a ab 40 28 d2  44 41 a3 c8 08 06 00 01   (o·Z·@(· DA······
0010  08 00 06 04 00 02 28 d2  44 41 a3 c8 0a 04 08 12   ······(· DA······
```

Address Resolution Protocol: Protocol   Packets: 19672 · Displayed: 1273 (6.5%)   Profile: Default

3.

Overview of the code

- The server consists of 2 sections, `setup` and `serve`
- The `setup` part creates a new socket, assigns it an IP and port, binds it, and starts listening on it.
- The `serve` part is a loop which listens to incoming requests and sends them the message



```
root@667f509edc06:/workspaces/Lab/Lab03# ./a.out
Socket created
Socket bound
Listening on http://localhost:4444
Connection accepted
Hello message sent to browser
Connection accepted
Hello message sent to browser
Connection accepted
Hello message sent to browser
Connection accepted
Hello message sent to browser
```

```
root@667f509edc06:/workspaces/Lab# curl --http0.9 localhost:4444
Hello World!
root@667f509edc06:/workspaces/Lab# curl --http0.9 localhost:4444
Hello World!
root@667f509edc06:/workspaces/Lab#
```

```
Hello World!
```