# Tunneling: topology and examples

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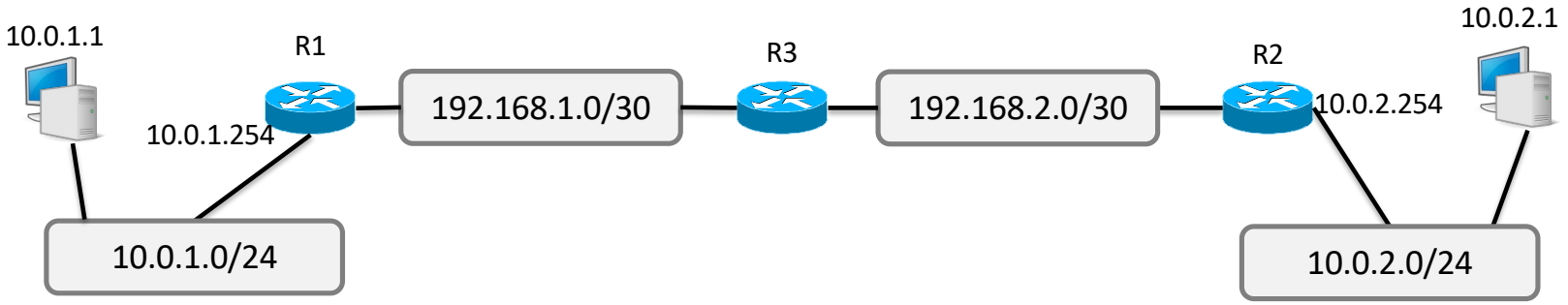
# Topologia


10.0.1.1
R1
R3
R2
10.0.2.1
10.0.1.254
192.168.1.0/30
192.168.2.0/30
10.0.2.254
10.0.1.0/24
10.0.2.0/24

# Tabelle di routing

R3

| Destination | Gateway | Genmask | Flags | Metric | Ref | Use | Iface |
|---|---|---|---|---|---|---|---|
| 10.0.1.0 | 192.168.1.1 | 255.255.255.0 | UG | 0 | 0 | 0 | veth13 |
| 10.0.2.0 | 192.168.2.1 | 255.255.255.0 | UG | 0 | 0 | 0 | veth23 |
| 192.168.1.0 | 0.0.0.0 | 255.255.255.252 | U | 0 | 0 | 0 | veth13 |
| 192.168.2.0 | 0.0.0.0 | 255.255.255.252 | U | 0 | 0 | 0 | veth23 |

R1

| Destination | Gateway | Genmask | Flags | Metric | Ref | Use | Iface |
|---|---|---|---|---|---|---|---|
| 10.0.1.0 | 0.0.0.0 | 255.255.255.0 | U | 0 | 0 | 0 | eth-H1 |
| 10.0.2.0 | 192.168.1.2 | 255.255.255.0 | UG | 0 | 0 | 0 | veth1 |
| 192.168.1.0 | 0.0.0.0 | 255.255.255.252 | U | 0 | 0 | 0 | veth1 |
| 192.168.2.0 | 192.168.1.2 | 255.255.255.252 | UG | 0 | 0 | 0 | veth1 |

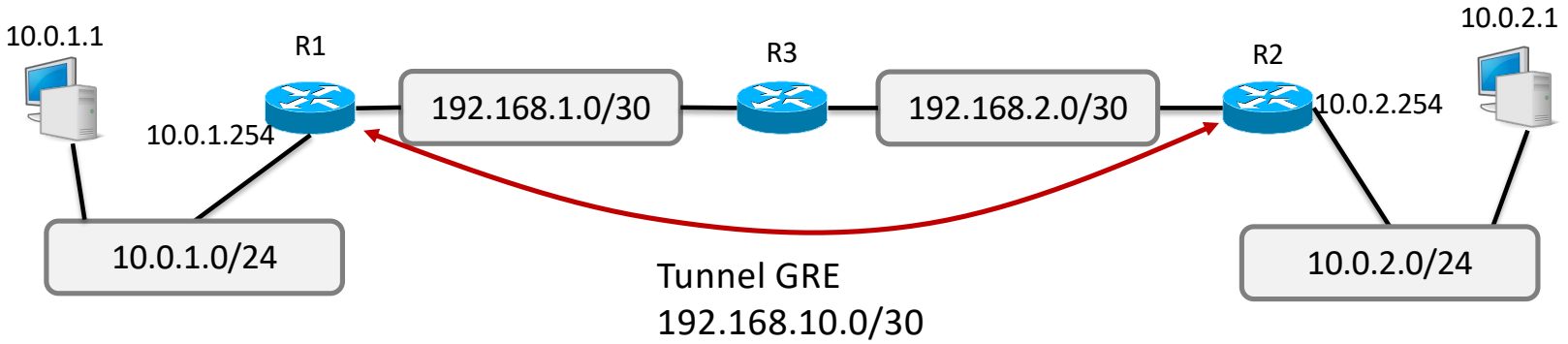
R2

| Destination | Gateway | Genmask | Flags | Metric | Ref | Use | Iface |
|---|---|---|---|---|---|---|---|
| 10.0.1.0 | 192.168.2.2 | 255.255.255.0 | UG | 0 | 0 | 0 | veth2 |
| 10.0.2.0 | 0.0.0.0 | 255.255.255.0 | U | 0 | 0 | 0 | eth-H2 |
| 192.168.1.0 | 192.168.2.2 | 255.255.255.252 | UG | 0 | 0 | 0 | veth2 |
| 192.168.2.0 | 0.0.0.0 | 255.255.255.252 | U | 0 | 0 | 0 | veth2 |

# Raggiungibilità

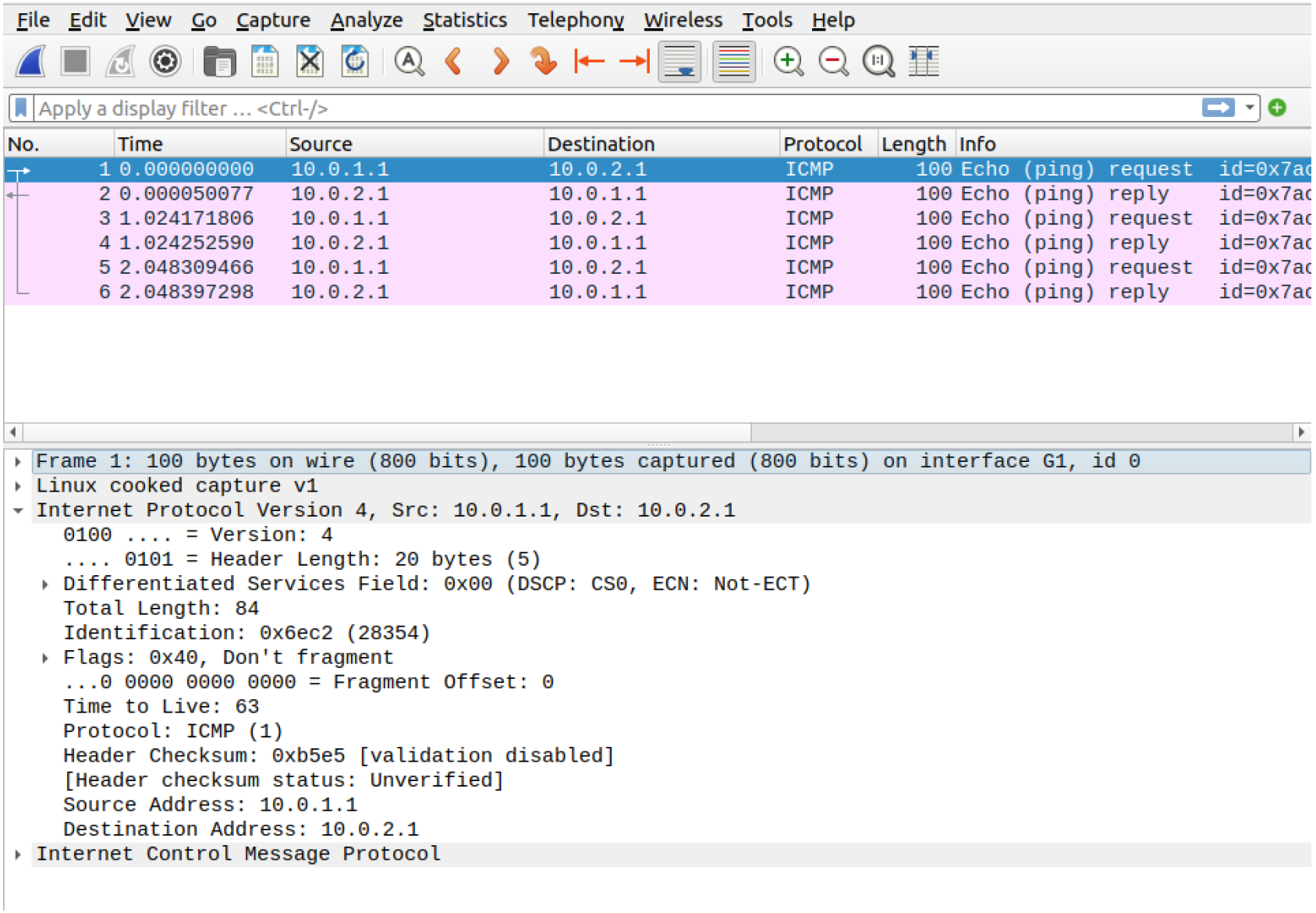
```
H1> ping -c 3 10.0.2.1

PING 10.0.2.1 (10.0.2.1) 56(84) bytes of data.
64 bytes from 10.0.2.1: icmp_seq=1 ttl=61 time=2.88 ms
64 bytes from 10.0.2.1: icmp_seq=2 ttl=61 time=0.097 ms
64 bytes from 10.0.2.1: icmp_seq=3 ttl=61 time=0.101 ms

--- 10.0.2.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2018ms
rtt min/avg/max/mdev = 0.097/1.026/2.880/1.310 ms

H1> traceroute -n 10.0.2.1

traceroute to 10.0.2.1 (10.0.2.1), 30 hops max, 60 byte packets
 1  10.0.1.254  0.087 ms  0.011 ms  0.007 ms
 2  192.168.1.2  0.039 ms  0.013 ms  0.010 ms
 3  192.168.2.1  0.019 ms  0.012 ms  0.011 ms
 4  10.0.2.1  0.021 ms  0.016 ms  0.017 ms
```

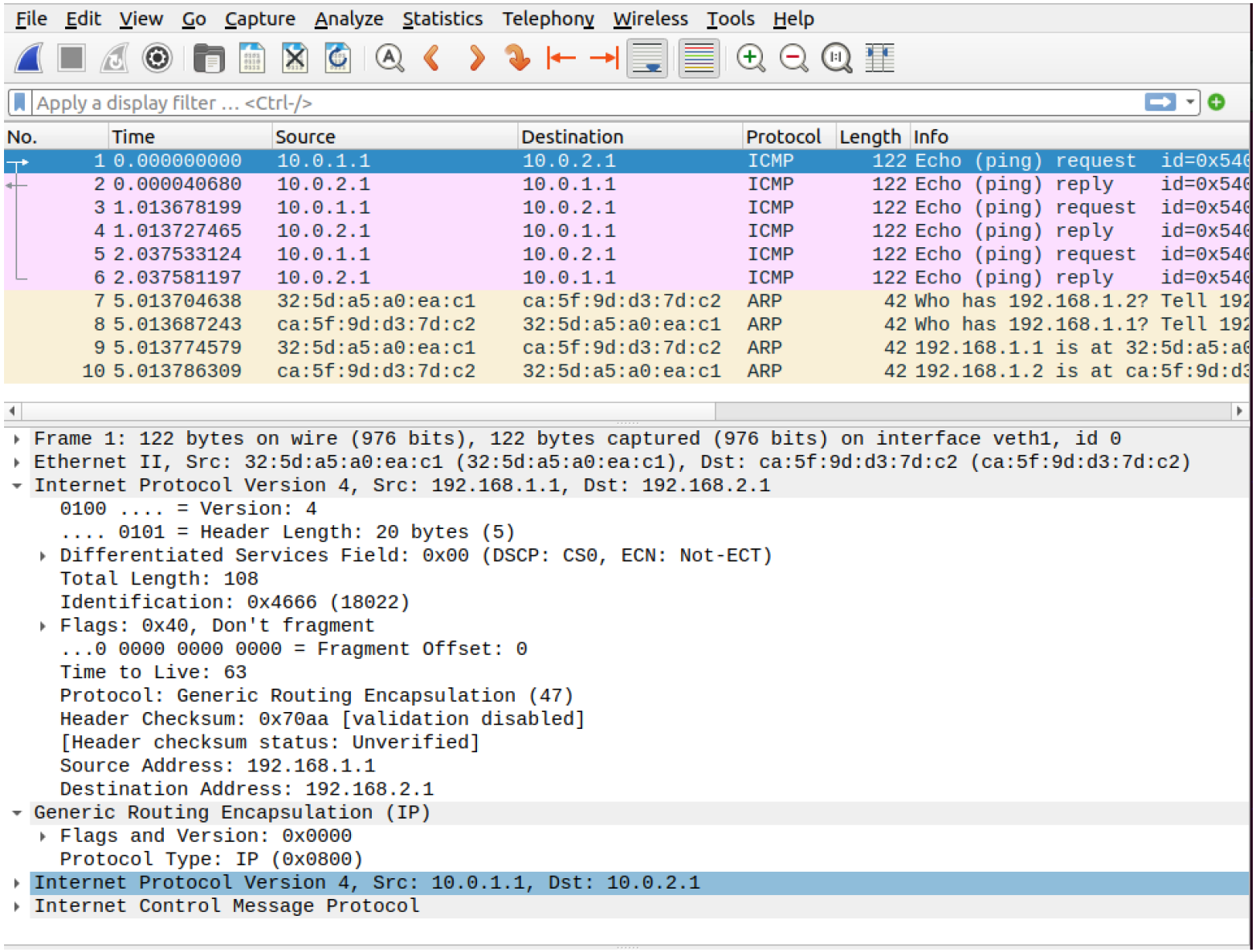
# GRE tunneling



# Raggiungibilità con GRE

```
H1> ping -c 3 10.0.2.1
PING 10.0.2.1 (10.0.2.1) 56(84) bytes of data.
64 bytes from 10.0.2.1: icmp_seq=1 ttl=62 time=0.153 ms
64 bytes from 10.0.2.1: icmp_seq=2 ttl=62 time=0.150 ms
64 bytes from 10.0.2.1: icmp_seq=3 ttl=62 time=0.141 ms

--- 10.0.2.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2025ms
rtt min/avg/max/mdev = 0.141/0.148/0.153/0.005 ms

H1> traceroute -n 10.0.2.1
traceroute to 10.0.2.1 (10.0.2.1), 30 hops max, 60 byte packets
 1  10.0.1.254  0.066 ms  0.011 ms  0.006 ms
 2  192.168.10.2  0.073 ms  0.023 ms  0.017 ms
 3  10.0.2.1  0.028 ms  0.020 ms  0.021 ms
```


File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
1 0.000000000 10.0.1.1 10.0.2.1 ICMP 100 Echo (ping) request id=0x7ac
2 0.000050077 10.0.2.1 10.0.1.1 ICMP 100 Echo (ping) reply id=0x7ac
3 1.024171806 10.0.1.1 10.0.2.1 ICMP 100 Echo (ping) request id=0x7ac
4 1.024252590 10.0.2.1 10.0.1.1 ICMP 100 Echo (ping) reply id=0x7ac
5 2.048309466 10.0.1.1 10.0.2.1 ICMP 100 Echo (ping) request id=0x7ac
6 2.048397298 10.0.2.1 10.0.1.1 ICMP 100 Echo (ping) reply id=0x7ac
Frame 1: 100 bytes on wire (800 bits), 100 bytes captured (800 bits) on interface G1, id 0
Linux cooked capture v1
Internet Protocol Version 4, Src: 10.0.1.1, Dst: 10.0.2.1
0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
Total Length: 84
Identification: 0x6ec2 (28354)
Flags: 0x40, Don't fragment
...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 63
Protocol: ICMP (1)
Header Checksum: 0xb5e5 [validation disabled]
[Header checksum status: Unverified]
Source Address: 10.0.1.1
Destination Address: 10.0.2.1
Internet Control Message Protocol


File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
1 0.000000000 10.0.1.1 10.0.2.1 ICMP 122 Echo (ping) request id=0x540
2 0.000040680 10.0.2.1 10.0.1.1 ICMP 122 Echo (ping) reply id=0x540
3 1.013678199 10.0.1.1 10.0.2.1 ICMP 122 Echo (ping) request id=0x540
4 1.013727465 10.0.2.1 10.0.1.1 ICMP 122 Echo (ping) reply id=0x540
5 2.037533124 10.0.1.1 10.0.2.1 ICMP 122 Echo (ping) request id=0x540
6 2.037581197 10.0.2.1 10.0.1.1 ICMP 122 Echo (ping) reply id=0x540
7 5.013704638 32:5d:a5:a0:ea:c1 ca:5f:9d:d3:7d:c2 ARP 42 Who has 192.168.1.2? Tell 192
8 5.013687243 ca:5f:9d:d3:7d:c2 32:5d:a5:a0:ea:c1 ARP 42 Who has 192.168.1.1? Tell 192
9 5.013774579 32:5d:a5:a0:ea:c1 ca:5f:9d:d3:7d:c2 ARP 42 192.168.1.1 is at 32:5d:a5:a0
10 5.013786309 ca:5f:9d:d3:7d:c2 32:5d:a5:a0:ea:c1 ARP 42 192.168.1.2 is at ca:5f:9d:d3
Frame 1: 122 bytes on wire (976 bits), 122 bytes captured (976 bits) on interface veth1, id 0
Ethernet II, Src: 32:5d:a5:a0:ea:c1 (32:5d:a5:a0:ea:c1), Dst: ca:5f:9d:d3:7d:c2 (ca:5f:9d:d3:7d:c2)
Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.2.1
0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
Total Length: 108
Identification: 0x4666 (18022)
Flags: 0x40, Don't fragment
...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 63
Protocol: Generic Routing Encapsulation (47)
Header Checksum: 0x70aa [validation disabled]
[Header checksum status: Unverified]
Source Address: 192.168.1.1
Destination Address: 192.168.2.1
Generic Routing Encapsulation (IP)
Flags and Version: 0x0000
Protocol Type: IP (0x0800)
Internet Protocol Version 4, Src: 10.0.1.1, Dst: 10.0.2.1
Internet Control Message Protocol

# R1 dopo il GRE

```
R1> route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.1.0        0.0.0.0         255.255.255.0   U     0      0        0 eth-H1
10.0.2.0        192.168.10.2    255.255.255.0   UG    0      0        0 G1
192.168.1.0     0.0.0.0         255.255.255.252 U     0      0        0 veth1
192.168.2.0     192.168.1.2     255.255.255.252 UG    0      0        0 veth1
192.168.10.0    0.0.0.0         255.255.255.252 U     0      0        0 G1
```

```
R1> route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.1.0        0.0.0.0         255.255.255.0   U     0      0        0 eth-H1
10.0.2.0        192.168.1.2     255.255.255.0   UG    0      0        0 veth1
192.168.1.0     0.0.0.0         255.255.255.252 U     0      0        0 veth1
192.168.2.0     192.168.1.2     255.255.255.252 UG    0      0        0 veth1
```

# R2 dopo il GRE

```
R2> route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.1.0        192.168.10.1    255.255.255.0   UG    0      0        0 G1
10.0.2.0        0.0.0.0         255.255.255.0   U     0      0        0 eth-H2
192.168.1.0     192.168.2.2     255.255.255.252 UG    0      0        0 veth2
192.168.2.0     0.0.0.0         255.255.255.252 U     0      0        0 veth2
192.168.10.0    0.0.0.0         255.255.255.252 U     0      0        0 G1

R2> route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.1.0        192.168.2.2     255.255.255.0   UG    0      0        0 veth2
10.0.2.0        0.0.0.0         255.255.255.0   U     0      0        0 eth-H2
192.168.1.0     192.168.2.2     255.255.255.252 UG    0      0        0 veth2
192.168.2.0     0.0.0.0         255.255.255.252 U     0      0        0 veth2
```

# R3 prima e dopo

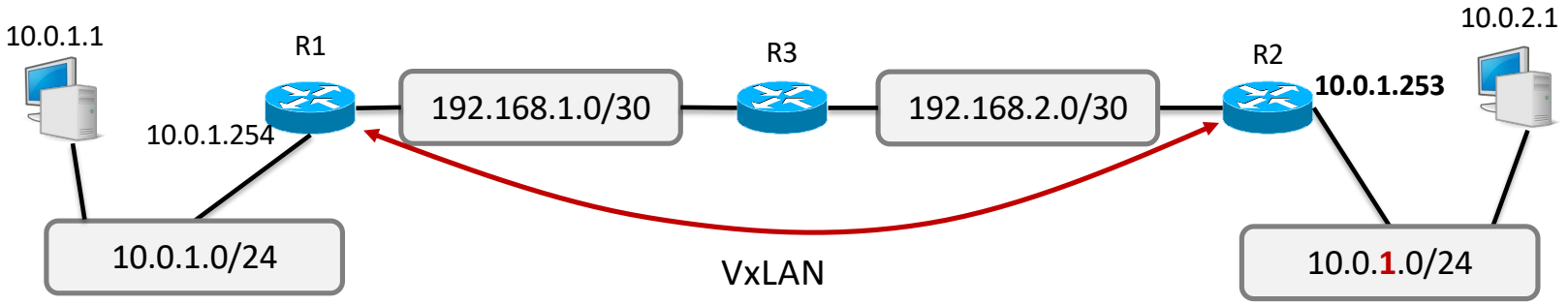
Prima del GRE

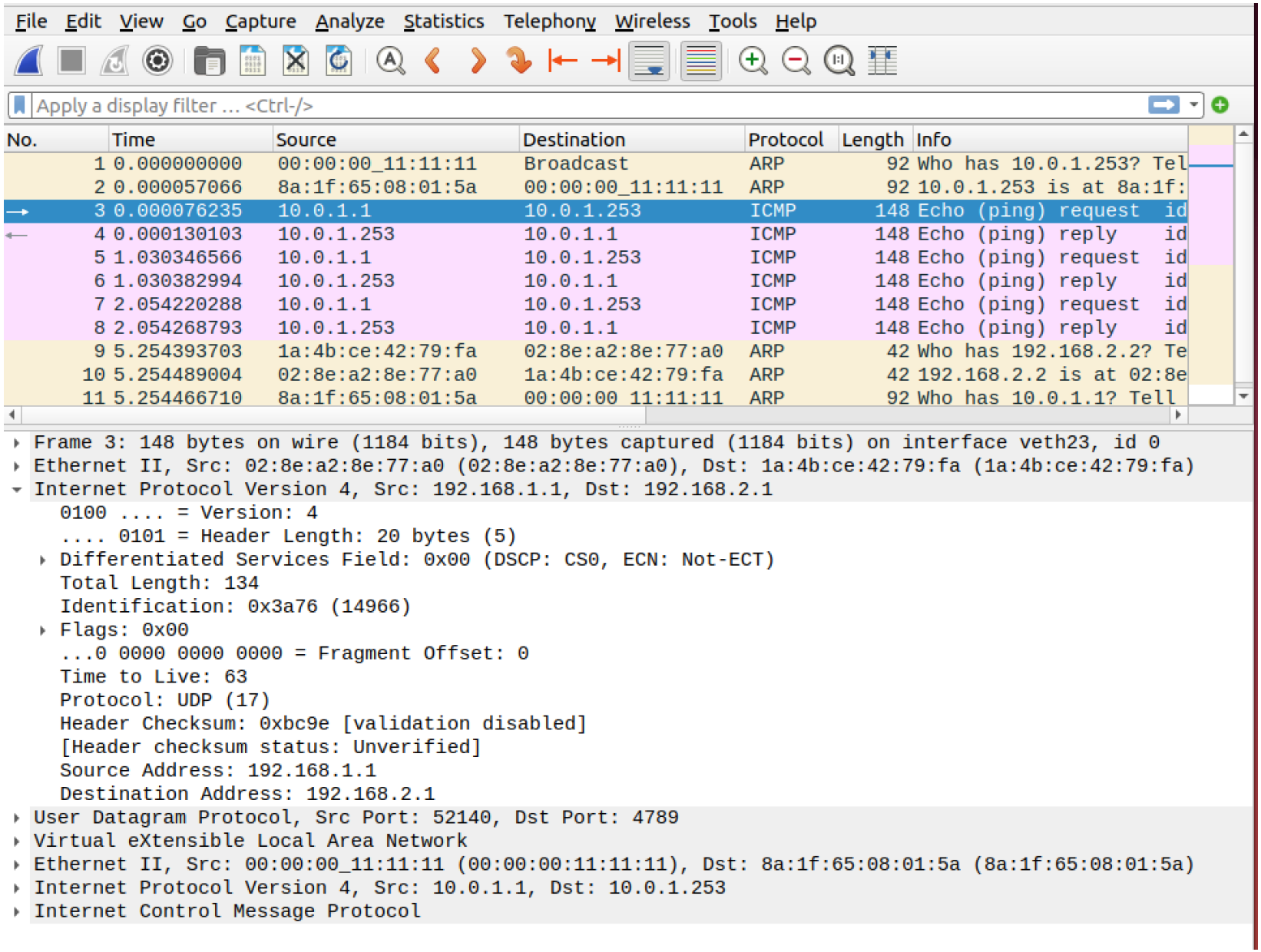
```
R3> route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.1.0        192.168.1.1     255.255.255.0   UG    0      0        0 veth13
10.0.2.0        192.168.2.1     255.255.255.0   UG    0      0        0 veth23
192.168.1.0     0.0.0.0         255.255.255.252 U     0      0        0 veth13
192.168.2.0     0.0.0.0         255.255.255.252 U     0      0        0 veth23
```

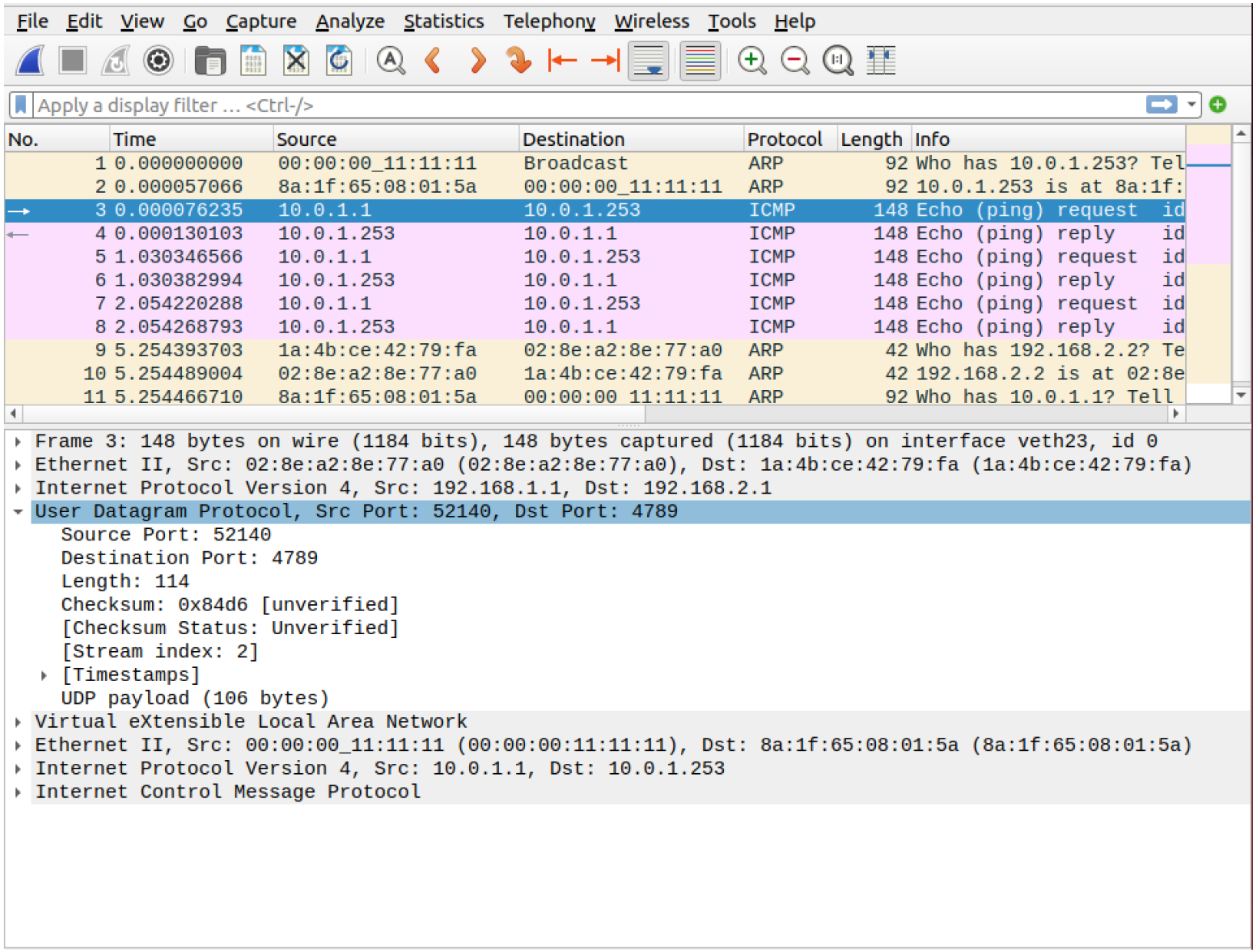
Dopo il GRE

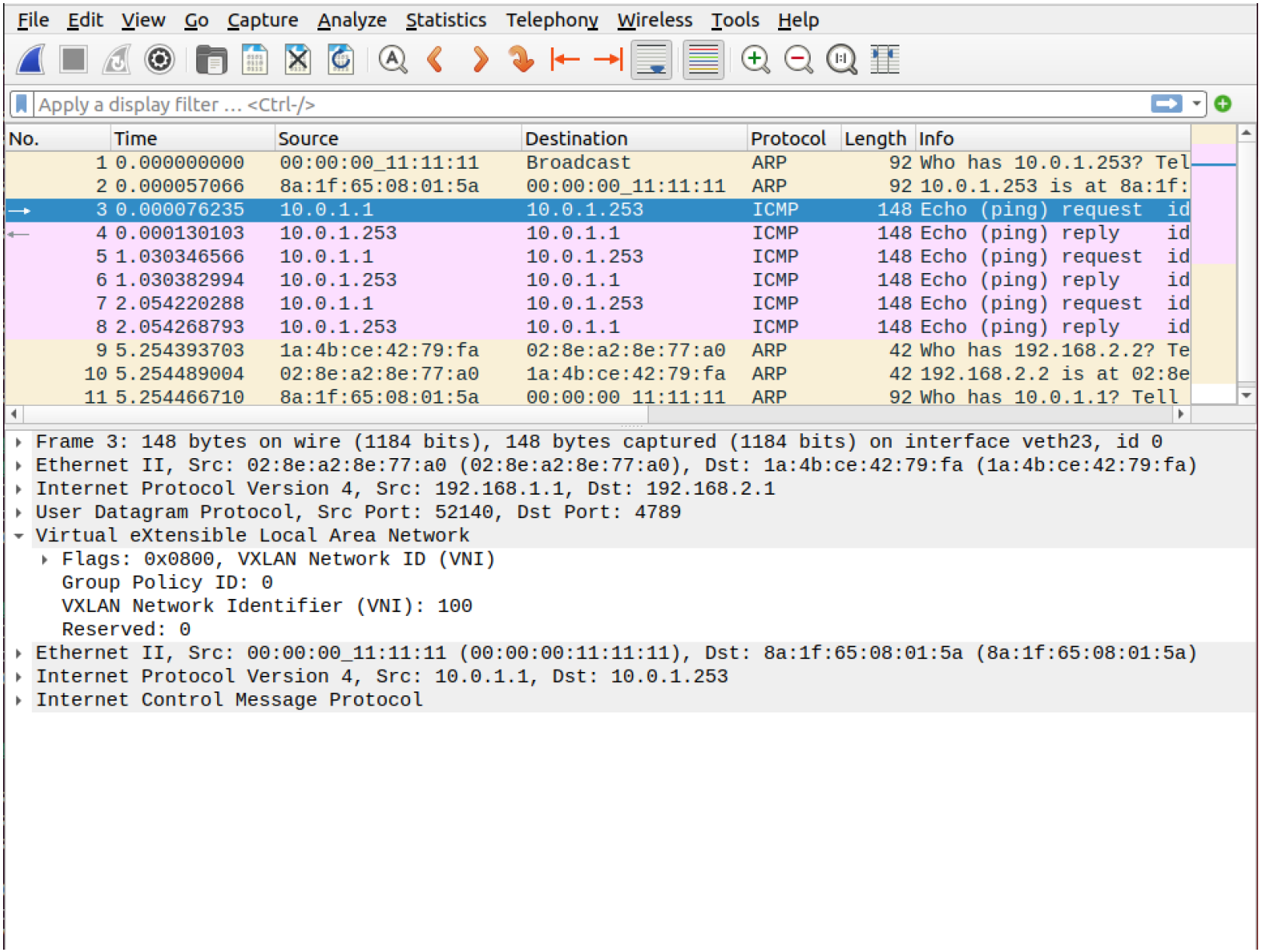
```
R3> route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.1.0        192.168.1.1     255.255.255.0   UG    0      0        0 veth13
10.0.2.0        192.168.2.1     255.255.255.0   UG    0      0        0 veth23
192.168.1.0     0.0.0.0         255.255.255.252 U     0      0        0 veth13
192.168.2.0     0.0.0.0         255.255.255.252 U     0      0        0 veth23
```

# VxLAN tunneling




File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
1 0.000000000 00:00:00_11:11:11 Broadcast ARP 92 Who has 10.0.1.253? Tel
2 0.000057066 8a:1f:65:08:01:5a 00:00:00_11:11:11 ARP 92 10.0.1.253 is at 8a:1f:
3 0.000076235 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
4 0.000130103 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
5 1.030346566 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
6 1.030382994 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
7 2.054220288 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
8 2.054268793 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
9 5.254393703 1a:4b:ce:42:79:fa 02:8e:a2:8e:77:a0 ARP 42 Who has 192.168.2.2? Te
10 5.254489004 02:8e:a2:8e:77:a0 1a:4b:ce:42:79:fa ARP 42 192.168.2.2 is at 02:8e
11 5.254466710 8a:1f:65:08:01:5a 00:00:00 11:11:11 ARP 92 Who has 10.0.1.1? Tell
Frame 3: 148 bytes on wire (1184 bits), 148 bytes captured (1184 bits) on interface veth23, id 0
Ethernet II, Src: 02:8e:a2:8e:77:a0 (02:8e:a2:8e:77:a0), Dst: 1a:4b:ce:42:79:fa (1a:4b:ce:42:79:fa)
Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.2.1
0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
Total Length: 134
Identification: 0x3a76 (14966)
Flags: 0x00
...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 63
Protocol: UDP (17)
Header Checksum: 0xbc9e [validation disabled]
[Header checksum status: Unverified]
Source Address: 192.168.1.1
Destination Address: 192.168.2.1
User Datagram Protocol, Src Port: 52140, Dst Port: 4789
Virtual eXtensible Local Area Network
Ethernet II, Src: 00:00:00_11:11:11 (00:00:00:11:11:11), Dst: 8a:1f:65:08:01:5a (8a:1f:65:08:01:5a)
Internet Protocol Version 4, Src: 10.0.1.1, Dst: 10.0.1.253
Internet Control Message Protocol


File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
1 0.000000000 00:00:00_11:11:11 Broadcast ARP 92 Who has 10.0.1.253? Tel
2 0.000057066 8a:1f:65:08:01:5a 00:00:00_11:11:11 ARP 92 10.0.1.253 is at 8a:1f:
3 0.000076235 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
4 0.000130103 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
5 1.030346566 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
6 1.030382994 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
7 2.054220288 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
8 2.054268793 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
9 5.254393703 1a:4b:ce:42:79:fa 02:8e:a2:8e:77:a0 ARP 42 Who has 192.168.2.2? Te
10 5.254489004 02:8e:a2:8e:77:a0 1a:4b:ce:42:79:fa ARP 42 192.168.2.2 is at 02:8e
11 5.254466710 8a:1f:65:08:01:5a 00:00:00 11:11:11 ARP 92 Who has 10.0.1.1? Tell
Frame 3: 148 bytes on wire (1184 bits), 148 bytes captured (1184 bits) on interface veth23, id 0
Ethernet II, Src: 02:8e:a2:8e:77:a0 (02:8e:a2:8e:77:a0), Dst: 1a:4b:ce:42:79:fa (1a:4b:ce:42:79:fa)
Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.2.1
User Datagram Protocol, Src Port: 52140, Dst Port: 4789
Source Port: 52140
Destination Port: 4789
Length: 114
Checksum: 0x84d6 [unverified]
[Checksum Status: Unverified]
[Stream index: 2]
[Timestamps]
UDP payload (106 bytes)
Virtual eXtensible Local Area Network
Ethernet II, Src: 00:00:00_11:11:11 (00:00:00:11:11:11), Dst: 8a:1f:65:08:01:5a (8a:1f:65:08:01:5a)
Internet Protocol Version 4, Src: 10.0.1.1, Dst: 10.0.1.253
Internet Control Message Protocol


File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
1 0.000000000 00:00:00_11:11:11 Broadcast ARP 92 Who has 10.0.1.253? Tel
2 0.000057066 8a:1f:65:08:01:5a 00:00:00_11:11:11 ARP 92 10.0.1.253 is at 8a:1f:
3 0.000076235 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
4 0.000130103 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
5 1.030346566 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
6 1.030382994 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
7 2.054220288 10.0.1.1 10.0.1.253 ICMP 148 Echo (ping) request id
8 2.054268793 10.0.1.253 10.0.1.1 ICMP 148 Echo (ping) reply id
9 5.254393703 1a:4b:ce:42:79:fa 02:8e:a2:8e:77:a0 ARP 42 Who has 192.168.2.2? Te
10 5.254489004 02:8e:a2:8e:77:a0 1a:4b:ce:42:79:fa ARP 42 192.168.2.2 is at 02:8e
11 5.254466710 8a:1f:65:08:01:5a 00:00:00 11:11:11 ARP 92 Who has 10.0.1.1? Tell
Frame 3: 148 bytes on wire (1184 bits), 148 bytes captured (1184 bits) on interface veth23, id 0
Ethernet II, Src: 02:8e:a2:8e:77:a0 (02:8e:a2:8e:77:a0), Dst: 1a:4b:ce:42:79:fa (1a:4b:ce:42:79:fa)
Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.2.1
User Datagram Protocol, Src Port: 52140, Dst Port: 4789
Virtual eXtensible Local Area Network
Flags: 0x0800, VXLAN Network ID (VNI)
Group Policy ID: 0
VXLAN Network Identifier (VNI): 100
Reserved: 0
Ethernet II, Src: 00:00:00_11:11:11 (00:00:00:11:11:11), Dst: 8a:1f:65:08:01:5a (8a:1f:65:08:01:5a)
Internet Protocol Version 4, Src: 10.0.1.1, Dst: 10.0.1.253
Internet Control Message Protocol