Rechnernetze
Wintersemester 2022/2023

Kai Cikoglu
Sebastian Illges

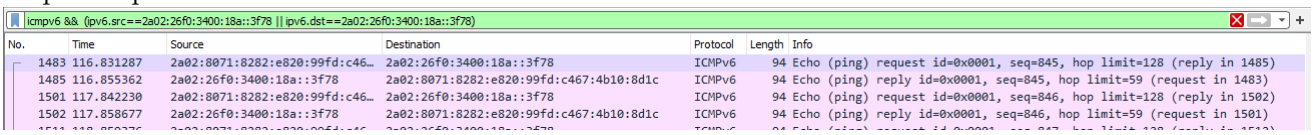
Ping Traceroute

Aufgabe 2

1. MacOS:
   command: `ping www.nsa.gov`
   Wireshark filter for request: `ip.src==172.20.140.65 && ipv6.dst==2a02:26f0:1700:1a6::3f78`
   Wireshark output: `70292 126.484571 172.20.140.65 23.79.130.30 ICMP 98 Echo (ping) request id=0x5988, seq=123/31488, ttl=64 (reply in 70308)`
   Example output:

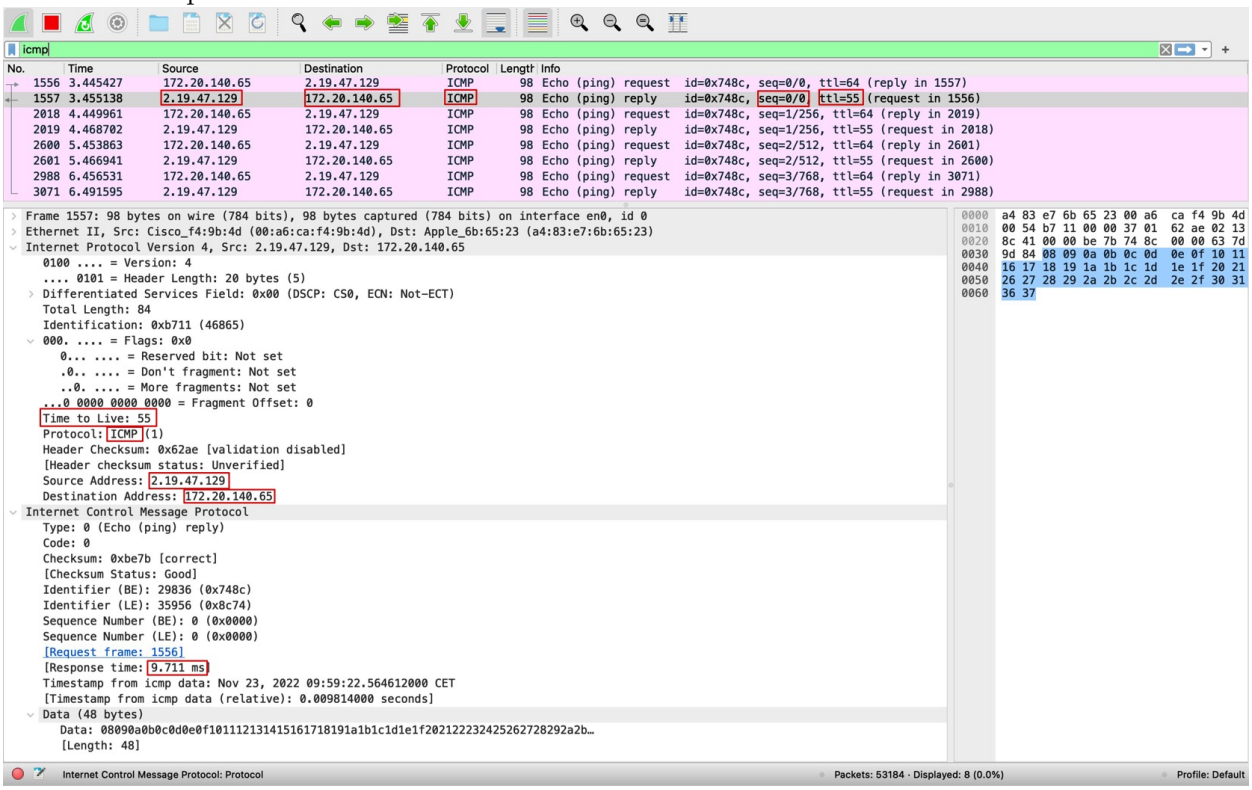
```
2444 9.210527    104.111.240.47   172.20.140.65    ICMP    98 Echo (ping) reply    id=0x4a8a, seq=4/1024, ttl=56 (request in 2443)
2613 10.201071   172.20.140.65    104.111.240.47   ICMP    98 Echo (ping) request  id=0x4a8a, seq=5/1280, ttl=64 (reply in 2614)
```

   Windows:
   command: `ping www.nsa.gov -t`
   Wireshark filter for request:
   `ipv6.dst==2a02:26f0:3400:18a::3f78`
   Wireshark filter for response:
   `ipv6.dst==2a02:26f0:3400:18a::3f78`
   Wireshark filter for both:
   `ipv6.src==2a02:26f0:3400:18a::3f78 || ipv6.dst==2a02:26f0:3400:18a::3f78` Example output:



2. `ICMP & ICMPv6` depending on the platform

3. MacOS:
   terminal output: `64 bytes from 2.19.47.129: icmp_seq=0 ttl=55 time=9.898 ms`
   Wireshark output:

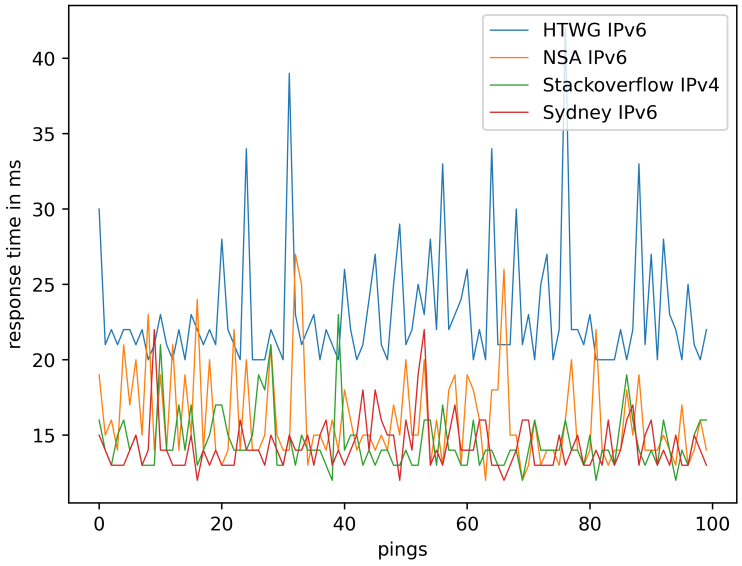


Windows:

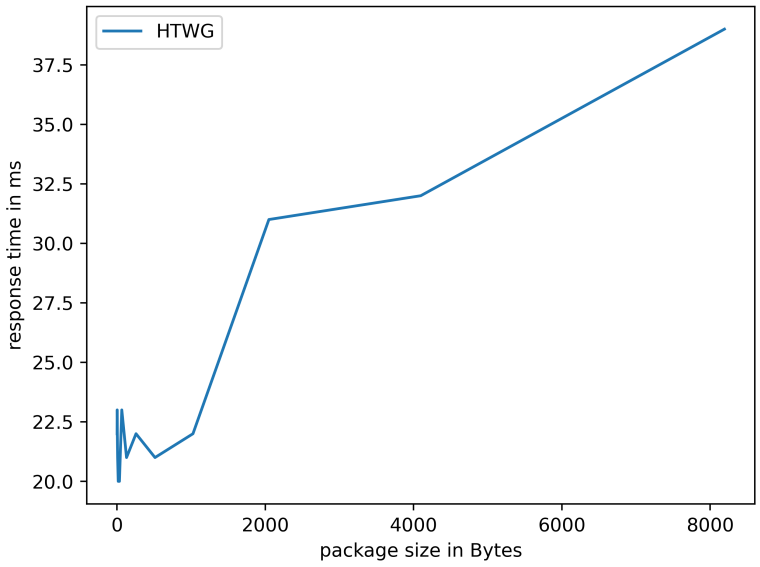
```
Ping-Statistik für 2a02:26f0:3400:18a::3f78:
    Pakete: Gesendet = 373, Empfangen = 369, Verloren = 4
    (1% Verlust),
Ca. Zeitangaben in Millisek.:
    Minimum = 12ms, Maximum = 31ms, Mittelwert = 14ms
```

4. `(icmp || icmpv6) && (ipv6.src==2a02:26f0:3400:18a::3f78 || ipv6.dst==2a02:26f0:3400:18a::3f78)`

5.



6.



Aufgabe 3

1. `C:\Users\sebas>tracert www.htwg-konstanz.de`

   ```
   Routenverfolgung zu cms.htwg-konstanz.de [2001:7c0:5f0:f020::20:17]
   über maximal 30 Hops:

     1    1 ms    1 ms    1 ms  2a02:8071:8282:e820:4a4e:fcff:feab:fa1
     2    9 ms    9 ms   11 ms  2a02:8071:8200::1
     3    8 ms    8 ms   10 ms  2a02:8071:80fe:34b2::1
     4   15 ms   19 ms   15 ms  de-str01c-rc1-lo0-0.v6.aorta.net [2001:730:2d00::5474:807d]
     5   21 ms   16 ms   15 ms  de-fra01b-rc2-lo0-0.v6.aorta.net [2001:730:2d00::5474:8065]
     6   19 ms   18 ms   20 ms  kar-rz-a99-hu0-2-0-0.belwue.net [2001:7c0:2:10c8::]
     7   20 ms   21 ms   20 ms  stu-nwz-a99-hu0-1-0-0.belwue.net [2001:7c0:2:10c1::]
     8   19 ms   21 ms   21 ms  stu-al30-1-hu0-0-1-0.belwue.net [2001:7c0:2:1104::1]
     9   26 ms   21 ms   20 ms  tue-wae-1-te0-0-0-15.belwue.net [2001:7c0:2:1064::1]
    10   27 ms   32 ms   28 ms  kon-bib-1-te0-0-0-11.belwue.net [2001:7c0:2:104a::1]
    11   22 ms   25 ms   25 ms  cmssrv6.htwg-konstanz.de [2001:7c0:5f0:f020::20:17]

   Ablaufverfolgung beendet.
   ```

2. Tool: `https://incolumitas.com/2022/07/31/Find-the-ASN-for-any-IP-Address/`

   1. `2a02:8071:8282:e820:4a4e:fcff:feab:fa1`:
      `"asn": 3209, "route": "2a02:8071::/32", "descr": "VODANET International IP-Backbone of Vodafone, DE", "country": "de", "org": "Vodafone GmbH", "domain": "www.vodafone.com"`
   2. `2a02:8071:8200::1`:
      `"asn": 3209, "route": "2a02:8071::/32", "descr": "VODANET International IP-Backbone of Vodafone, DE", "country": "de", "org": "Vodafone GmbH", "domain": "www.vodafone.com"`
   3. `2a02:8071:80fe:34b2::1`:
      `"asn": 3209, "route": "2a02:8071::/32", "descr": "VODANET International IP-Backbone of Vodafone, DE", "country": "de", "org": "Vodafone GmbH", "domain": "www.vodafone.com"`
   4. `2001:730:2d00::5474:807d`:
      `"asn": 6830, "route": "2001:730::/29", "descr": "LIBERTYGLOBAL Liberty Global formerly UPC Broadband Holding,", "country": "null", "org": "Liberty Global B.V.", "domain": "www.libertyglobal.com"`
   5. `2001:730:2d00::5474:8065`:
      `"asn": 6830, "route": "2001:730::/29", "descr": "LIBERTYGLOBAL Liberty Global formerly UPC Broadband Holding,", "country": "null", "org": "Liberty Global B.V.", "domain": "www.libertyglobal.com"`
   6. `2001:7c0:2:10c8::`:
      `"asn": 553, "route": "2001:7c0::/29", "descr": "BELWUE BelWue-Koordination, DE", "country": "de", "org": "Universitaet Stuttgart", "domain": "www.belwue.de"`
   7. `2001:7c0:2:10c1::`:
      `"asn": 553, "route": "2001:7c0::/29", "descr": "BELWUE BelWue-Koordination, DE", "country": "de", "org": "Universitaet Stuttgart", "domain": "www.belwue.de"`

8. 2001:7c0:2:1104::1:
   "asn": 553, "route": "2001:7c0::/29", "descr": "BELWUE BelWue-Koordination,
   DE", "country": "de", "org": "Universitaet Stuttgart", "domain": "www.belwue.de"
9. 2001:7c0:2:1064::1:
   "asn": 553, "route": "2001:7c0::/29", "descr": "BELWUE BelWue-Koordination,
   DE", "country": "de", "org": "Universitaet Stuttgart", "domain": "www.belwue.de"
10. 2001:7c0:2:104a::1:
    "asn": 553, "route": "2001:7c0::/29", "descr": "BELWUE BelWue-Koordination,
    DE", "country": "de", "org": "Universitaet Stuttgart", "domain": "www.belwue.de"
11. 2001:7c0:5f0:f020::20:17:
    "asn": 553, "route": "2001:7c0::/29", "descr": "BELWUE BelWue-Koordination,
    DE", "country": "de", "org": "Universitaet Stuttgart", "domain": "www.belwue.de"

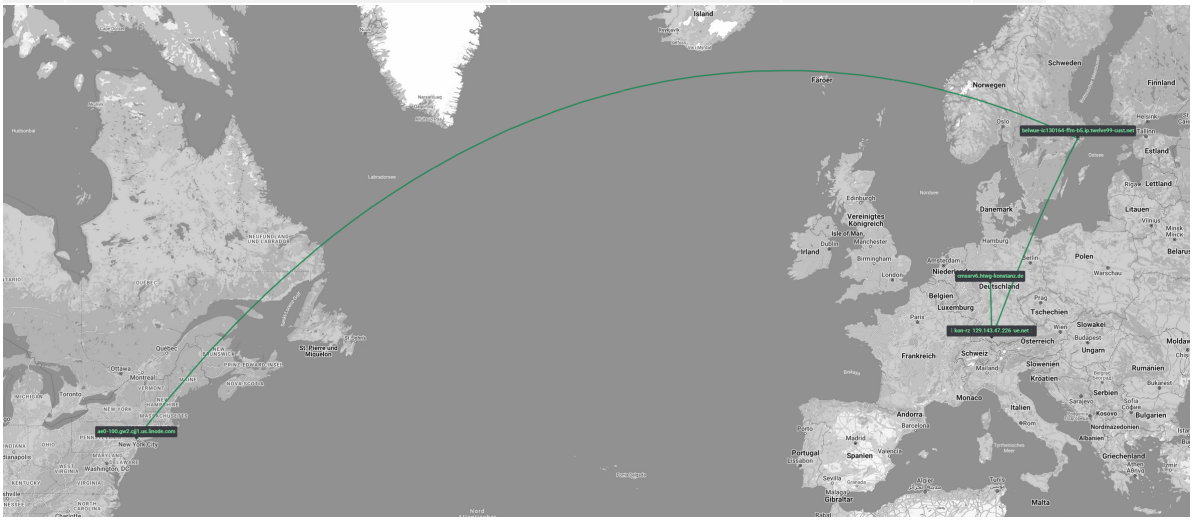
→ Die Route beinhaltet den Internetanbieter, in diesem Fall Vodafone, den Breitbandanbieter Liberty Global, sowie das Landeshochschulnetz BelWue bis zur HTWG Konstanz.

3. www.htwg-konstanz.de:

```
C:\Users\sebas>tracert www.htwg-konstanz.de
Routenverfolgung zu cms.htwg-konstanz.de [2001:7c0:5f0:f020::20:17]
über maximal 30 Hops:
  1    1 ms    1 ms    1 ms  2a02:8071:8282:e820:4a4e:fcff:feab:fa1
  2    9 ms    9 ms   11 ms  2a02:8071:8200::1
  3    8 ms    8 ms   10 ms  2a02:8071:80fe:34b2::1
  4   15 ms   19 ms   15 ms  de-str01c-rc1-lo0-0.v6.aorta.net [2001:730:2d00::5474:807d]
  5   21 ms   16 ms   15 ms  de-fra01b-rc2-lo0-0.v6.aorta.net [2001:730:2d00::5474:8065]
  6   19 ms   18 ms   20 ms  kar-rz-a99-hu0-2-0-0.belwue.net [2001:7c0:2:10c8::]
  7   20 ms   21 ms   20 ms  stu-nwz-a99-hu0-1-0-0.belwue.net [2001:7c0:2:10c1::]
  8   19 ms   21 ms   21 ms  stu-al30-1-hu0-0-1-0.belwue.net [2001:7c0:2:1104::1]
  9   26 ms   21 ms   20 ms  tue-wae-1-te0-0-0-15.belwue.net [2001:7c0:2:1064::1]
 10   27 ms   32 ms   28 ms  kon-bib-1-te0-0-0-11.belwue.net [2001:7c0:2:104a::1]
 11   22 ms   25 ms   25 ms  cmssrv6.htwg-konstanz.de [2001:7c0:5f0:f020::20:17]
Ablaufverfolgung beendet.
```

Hop	IP / Host Name	ISP	Netblock	Country	Loss	Response
1	172.17.0.1				0.0%	0.14ms
2	10.206.5.139				0.0%	0.38ms
3	10.206.35.8				0.0%	0.69ms
4	10.206.32.2				0.0%	2.79ms
5	lo0-0.gw1.cjj1.us.linode.com 173.255.239.101	LINODE-AP Linode, LLC, US	173.255.239.0/24		0.0%	3.64ms
6	ae0-100.gw2.cjj1.us.linode.com 173.255.239.9	LINODE-AP Linode, LLC, US	173.255.239.0/24		0.0%	1.61ms
7	ae31.r01.lga01.ien.netarch.akamai.com 23.203.156.16	AKAMAI-ASN1, NL	23.203.156.0/24		0.0%	2.26ms
8	nyk-b6-link.ip.twelve99.net 62.115.50.170	TWELVE99 Arelion, fka Telia Carrier, SE	62.115.0.0/16		0.0%	2.62ms
9	nyk-bb1-link.ip.twelve99.net 62.115.135.130	TWELVE99 Arelion, fka Telia Carrier, SE	62.115.0.0/16		0.0%	2.53ms
10	ldn-bb4-link.ip.twelve99.net 62.115.112.245	TWELVE99 Arelion, fka Telia Carrier, SE	62.115.0.0/16		50.0%	70.75ms
11	prs-bb2-link.ip.twelve99.net 62.115.133.239	TWELVE99 Arelion, fka Telia Carrier, SE	62.115.0.0/16		0.0%	80.34ms
12	ffm-bb2-link.ip.twelve99.net 62.115.114.99	TWELVE99 Arelion, fka Telia Carrier, SE	62.115.0.0/16		0.0%	85.96ms
13	ffm-b5-link.ip.twelve99.net 62.115.114.91	TWELVE99 Arelion, fka Telia Carrier, SE	62.115.0.0/16		0.0%	87.12ms
14	belwue-ic130164-ffm-b5.ip.twelve99-cust.net 213.248.88.26	TWELVE99 Arelion, fka Telia Carrier, SE	213.248.64.0/18		0.0%	89.31ms
15	stu-nwz-a99-hu0-3-0-2.belwue.net 129.143.57.126	BELWUE BelWue-Koordination, DE	129.143.0.0/16		0.0%	92.37ms
16	stu-al30-1-hu0-0-1-0.belwue.net 129.143.56.107	BELWUE BelWue-Koordination, DE	129.143.0.0/16		0.0%	92.76ms
17	tue-wae-1-te0-0-0-15.belwue.net 129.143.57.86	BELWUE BelWue-Koordination, DE	129.143.0.0/16		0.0%	94.59ms
18	kon-bib-1-te0-0-0-11.belwue.net 129.143.59.74	BELWUE BelWue-Koordination, DE	129.143.0.0/16		0.0%	96.27ms
19	kon-rz-1-te0-0-0-9.belwue.net 129.143.58.53	BELWUE BelWue-Koordination, DE	129.143.0.0/16		0.0%	95.79ms
20	129.143.47.226	BELWUE BelWue-Koordination, DE	129.143.0.0/16		0.0%	95.89ms
21	cmssrv6.htwg-konstanz.de 141.37.20.17	BELWUE BelWue-Koordination, DE	141.37.0.0/16		0.0%	95.45ms

Hop	IP	Hostname	Pings [ms]	avg [ms]
1	2a02:02e0:03fe:10ad:0000:0000:0000:0001	2a02:2e0:3fe:10ad::1	0,63 / 0,65 / 0,53	0,60
2	2a02:02e0:03fe:0000:000c:0000:0000:0100	2a02:2e0:3fe:0:c::100	0,65 / 0,53 / 0,48	0,55
3	-	-	-	-
4	-	-	-	-
5	2001:07f8:0000:0000:0000:0229:0000:0002	frankfurt-tc-1-10ge-0-2-0-6.belwue.net	1,18 / 1,25 / 1,25	1,23
6	2001:07c0:0002:10c8:0000:0000:0000:0000	kar-rz-a99-hu0-2-0-0.belwue.net	3,52 / 3,40 / 3,39	3,44
7	2001:07c0:0002:10c1:0000:0000:0000:0000	stu-nwz-a99-hu0-1-0-0.belwue.net	5,59 / 5,42 / 5,37	5,46
8	2001:07c0:0002:1104:0000:0000:0000:0001	stu-al30-1-hu0-0-1-0.belwue.net	5,39 / 5,49 / 5,53	5,47
9	2001:07c0:0002:10b2:0000:0000:0000:0001	tue-wae-1-te0-0-0-17.belwue.net	6,55 / 6,72 / 6,52	6,60
10	2001:07c0:0002:104a:0000:0000:0000:0001	kon-bib-1-te0-0-0-11.belwue.net	8,42 / 8,49 / 8,42	8,44
11	2001:07c0:05f0:f020:0000:0000:0020:0017	cmssrv6.htwg-konstanz.de	8,22 / 8,07 / 7,98	8,09
12	2001:07c0:05f0:f020:0000:0000:0020:0017	cmssrv6.htwg-konstanz.de	7,98	7,98



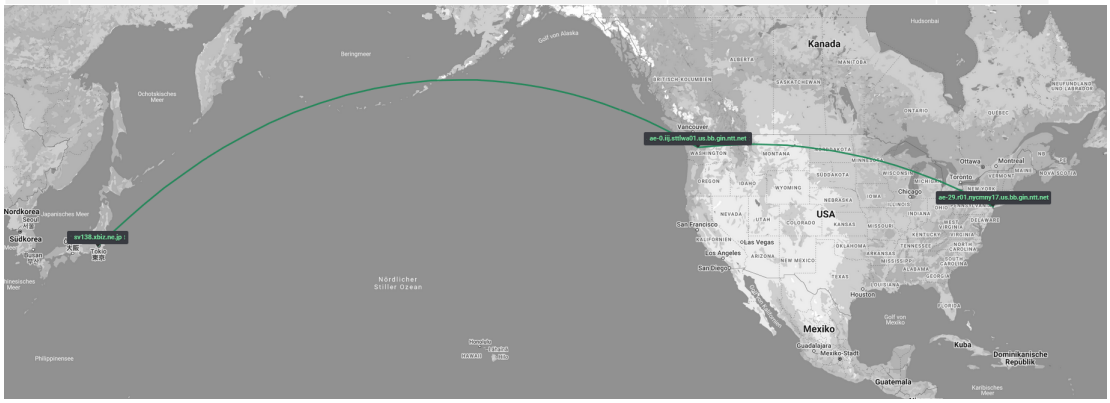
→ Identisch sind hier nur die Weiterleitung über das Landeshochschultnetz BelWue, da sich Internetanbieter, Router, sowie Ort unterscheiden.

www.ntt.co.jp:

```
C:\Users\sebas>tracert www.ntt.co.jp
Routenverfolgung zu www.ntt.co.jp [183.181.99.39]
über maximal 30 Hops:
  1    1 ms    1 ms    1 ms  kabelbox.local [192.168.0.1]
  2   10 ms   11 ms    9 ms  ip-037-209-084-001.um11.pools.vodafone-ip.de [37.209.84.1]
  3    8 ms    7 ms    7 ms  ip-081-210-144-106.um21.pools.vodafone-ip.de [81.210.144.1
  4   17 ms   18 ms   18 ms  de-str01c-rc1-ae-39-0.aorta.net [84.116.191.213]
  5   19 ms   17 ms   17 ms  de-fra01b-rc2-ae-4-0.aorta.net [84.116.140.201]
  6   16 ms   15 ms   15 ms  de-bfe18a-rt01-lag-1.aorta.net [84.116.190.34]
  7   16 ms   15 ms   16 ms  ae8-100-tcr1.fnt.cw.net [195.2.26.93]
  8   29 ms   29 ms   28 ms  ae34-pcr1.fnt.cw.net [195.2.31.38]
  9   29 ms   30 ms   36 ms  ae36-xcr1.ltw.cw.net [195.2.2.73]
 10   31 ms   26 ms   28 ms  iij-gw.ltw.cw.net [195.2.14.2]
 11  183 ms  177 ms  179 ms  sjc002bb00.IIJ.Net [58.138.83.178]
 12  235 ms  259 ms  234 ms  tky001bb01.IIJ.Net [58.138.88.85]
 13  236 ms  237 ms  237 ms  tky001ip56.IIJ.Net [58.138.101.34]
 14  236 ms  237 ms  238 ms  210.130.134.98
 15  247 ms  244 ms  245 ms  103.3.0.3
 16  271 ms  263 ms  263 ms  103.3.0.17
 17  273 ms  257 ms  248 ms  103.3.0.29
 18  254 ms  251 ms  246 ms  sv138.xbiz.ne.jp [183.181.99.39]
Ablaufverfolgung beendet.
```

Hop	IP / Host Name	ISP	Netblock	Country	Loss	Response
1	172.17.0.1				0.0%	0.38ms
2	10.206.5.139				0.0%	0.54ms
3	10.206.35.8				0.0%	0.55ms
4	10.206.32.2				0.0%	1.23ms
5	lo0-0.gw2.cjj1.us.linode.com 173.255.239.102	LINODE-AP Linode, LLC, US	173.255.239.0/24		0.0%	0.76ms
6	ae31.r01.lga01.ien.netarch.akamai.com 23.203.156.16	AKAMAI-ASN1, NL	23.203.156.0/24		0.0%	2.44ms
7	ae-29.r01.nycmny17.us.bb.gin.ntt.net 140.174.21.217	NTT-LTD-2914, US	140.174.0.0/16		0.0%	3.55ms
8	ae-13.r20.nwrknj03.us.bb.gin.ntt.net 129.250.4.40	NTT-LTD-2914, US	129.250.0.0/16		50.0%	3.45ms
9	ae-4.r24.sttlwa01.us.bb.gin.ntt.net 129.250.6.177	NTT-LTD-2914, US	129.250.0.0/16		0.0%	62.85ms
10	ae-0.a03.sttlwa01.us.bb.gin.ntt.net 129.250.2.99	NTT-LTD-2914, US	129.250.0.0/16		0.0%	60.74ms
11	ae-0.iij.sttlwa01.us.bb.gin.ntt.net 131.103.116.22	NTT-LTD-2914, US	131.103.0.0/16		0.0%	83.43ms
12	tky001bb00.IIJ.Net 58.138.88.129	IIJ Internet Initiative Japan Inc., JP	58.138.0.0/17		0.0%	160.28ms
13	tky001ip56.IIJ.Net 58.138.101.26	IIJ Internet Initiative Japan Inc., JP	58.138.0.0/17		0.0%	158.03ms
14	210.130.134.98	IIJ Internet Initiative Japan Inc., JP	210.130.0.0/16		0.0%	159.16ms
15	103.3.0.3	XSERVER Xserver Inc., JP	103.3.0.0/22		0.0%	166.84ms
16	103.3.0.17	XSERVER Xserver Inc., JP	103.3.0.0/22		0.0%	183.35ms
17	103.3.0.29	XSERVER Xserver Inc., JP	103.3.0.0/22		0.0%	166.34ms
18	sv138.xbiz.ne.jp 183.181.99.39	XSERVER Xserver Inc., JP	183.181.98.0/23		0.0%	166.26ms

Hop	IP	Hostname	Pings [ms]	avg [ms]
1	212.19.45.33	212.19.45.33	0,59 / 0,31 / 0,38	0,43
2	212.19.61.10	212.19.61.10	0,41 / 0,51 / 0,46	0,46
3	82.98.102.62	82.98.102.62	0,80 / 0,93 / 0,79	0,84
4	82.98.102.4	82.98.102.4	0,88 / 0,87 / 0,77	0,84
5	212.162.24.57	edge4.Frankfurt1.Level3.net	0,56 / 2,16 / 0,56	1,09
6	4.69.217.18	ae2.3605.edge2.Tokyo4.level3.net	230,78 / 230,03 / 229,96	230,25
7	113.29.1.138	ARTERIA-NET.edge2.Tokyo4.Level3.net	234,03 / 246,87 / 234,13	238,34
8	163.139.130.218	163.139.130.218	233,99 / 233,97 / 234,97	234,31
9	222.230.187.206	222.230.187.206	229,73 / 229,82 / 229,81	229,79
10	103.3.0.5	103.3.0.5	253,24 / 253,24 / 253,08	253,19
11	103.3.0.23	103.3.0.23	262,24 / 305,68 / 261,42	276,45
12	103.3.0.35	103.3.0.35	236,78 / 236,81 / 236,76	236,78
13	183.181.99.39	sv138.xbiz.ne.jp	249,83 / 249,91 / 249,83	249,86
14	183.181.99.39	-	249,83	249,83
15	183.181.99.39	-	249,87	249,87
16	183.181.99.39	-	249,85	249,85



→ Hier unterscheiden sich die Routes sehr stark. Das liegt vermutlich daran, dass abhängig vom Ort des tracer Routers der kürzeste Weg verwendet wird.

www.google.com:

```
C:\Users\sebas>tracert www.google.com
Routenverfolgung zu www.google.com [2a00:1450:4001:811::2004]
über maximal 30 Hops:
  1   <1 ms    1 ms    1 ms  2a02:8071:8282:e820:4a4e:fcff:feab:fa1
  2   11 ms    9 ms   20 ms  2a02:8071:8200::1
  3   10 ms    8 ms   21 ms  2a02:8071:80fe:34b2::1
  4   16 ms   18 ms   39 ms  de-str01c-rc1-lo0-0.v6.aorta.net [2001:730:2d00::5474:807d]
  5   16 ms   19 ms   15 ms  de-fra04d-rc1-lo0-0.v6.aorta.net [2001:730:2d00::5474:8015]
  6   22 ms   22 ms   22 ms  2a00:1450:814f::1
  7   23 ms   22 ms   23 ms  2001:4860:0:1::40ae
  8   23 ms   23 ms   22 ms  2001:4860:0:1::11ff
  9   27 ms   22 ms   20 ms  fra15s10-in-x04.1e100.net [2a00:1450:4001:811::2004]
Ablaufverfolgung beendet.
```

Hop	IP / Host Name	ISP	Netblock	Country	Loss	Response
1	172.17.0.1				0.0%	0.19ms
2	10.206.5.139				0.0%	0.32ms
3	10.206.35.7				0.0%	0.51ms
4	10.206.32.1				0.0%	4.09ms
5	lo0-0.gw2.cjj1.us.linode.com 173.255.239.102	LINODE-AP Linode, LLC, US	173.255.239.0/24		0.0%	0.74ms
6	ae31.r01.lga01.ien.netarch.akamai.com 23.203.156.16	AKAMAI-ASN1, NL	23.203.156.0/24		0.0%	3.03ms
7	a23-203-156-153.deploy.static.akamaitechnologies.com 23.203.156.153	AKAMAI-ASN1, NL	23.203.156.0/24		0.0%	2.44ms
8	142.251.78.59	GOOGLE, US	142.250.0.0/15		0.0%	3.10ms
9	209.85.253.143	GOOGLE, US	209.85.128.0/17		0.0%	2.81ms
10	lga25s81-in-f4.1e100.net 142.251.40.164	GOOGLE, US	142.251.40.0/24		0.0%	3.34ms

Hop	IP	Hostname	Pings [ms]	a [r
1	2a02:02e0:03fe:10ad:0000:0000:0000:0001	2a02:2e0:3fe:10ad::1	0,75 / 0,51 / 0,66	0,
2	2a02:02e0:03fe:0000:000c:0000:0000:0100	2a02:2e0:3fe:0:c::100	0,69 / 0,54 / 0,58	0,
3	2a02:02e0:0012:0031:0000:0000:0000:0001	2a02:2e0:12:31::1	1,08 / 0,91	0,
4	-	-	-	-
5	2001:07f8:0000:0000:0000:3b41:0000:0002	ipv6.de-cix.fra.de.as15169.google.com	0,81 / 0,84 / 0,82	0,
6	2001:4860:0000:0000:0000:0012:0000:b406	2001:4860::12:0:b406	1,90 / 1,86	1,
7	2001:4860:0000:0001:0000:0000:0000:5007	2001:4860:0:1::5007	0,79 / 0,74 / 0,74	0,
8	2a00:1450:4001:0828:0000:0000:0000:2004	fra24s05-in-x04.1e100.net	0,99 / 0,98 / 0,98	0,
9	2a00:1450:4001:0828:0000:0000:0000:2004	fra24s05-in-x04.1e100.net	1,01	1,

→ Auch hier unterscheiden sich die Routes. Das liegt vermutlich daran, dass abhängig vom Ort des tracer Routers der kürzeste Weg verwendet wird.

Aufgabe 4

1. Tracerout über Interxion Frankfurt (`core1.fra1.he.net`), Equinix SY1, Sydney (`core2.syd1.he.net`) nach Equinix SL1, Seoul (`core1.sel2.he.net`):

core1.fra1.he.net> traceroute ipv6 2a02:8071:8282:e820:b968:cc7b:c65b:2706 source 2001:470:0:2a::1 numeric

Target	2a02:8071:8282:e820:b968:cc7b:c65b:2706
Hop Start	1
Hop End	30

Hop	Packet 1	Packet 2	Packet 3	Hostname
1	1 ms	1 ms	1 ms	**ve950.core2.fra1.he.net** (2001:470:0:512::2)
2	*	*	*	?
3	*	1 ms	*	**vodanet-as3209.port-channel9.core3.fra1.he.net** (2001:470:0:53f::2)
4	7 ms	7 ms	7 ms	2a02:908::48:1
5	7 ms	7 ms	7 ms	2a02:8071:80ff:34b2::2
6	17 ms	19 ms	38 ms	2a02:8071:8200::1899
7	*	*	*	?
8	*	*	*	?
9	*	*	*	?
10	*	*	*	?
11	*	*	*	?
12	*	*	*	?
13	*	*	*	?
14	*	*	*	?
15	*	*	*	?
16	*	*	*	?
17	*	*	*	?
18	*	*	*	?
19	*	*	*	?
20	*	*	*	?
21	*	*	*	?
22	*	*	*	?
23	*	*	*	?
24	*	*	*	?
25	*	*	*	?
26	*	*	*	?
27	*	*	*	?
28	*	*	*	?
29	*	*	*	?
30	*	*	*	?

Entry cached for another 58 seconds. 2022-11-27 12:16:57 UTC

core2.syd1.he.net> traceroute ipv6 2a02:8071:8282:e820:b968:cc7b:c65b:2706 source 2001:470:0:50b::1

Target	2a02:8071:8282:e820:b968:cc7b:c65b:2706
Hop Start	1
Hop End	30

Hop	Packet 1	Packet 2	Packet 3	Hostname
1	26.836 ms	27.249 ms	27.586 ms	**e0-48.core1.akl1.he.net** (2001:470:0:454::2)
2	27.602 ms	27.799 ms	28.251 ms	**e0-32.core1.akl2.he.net** (2001:470:0:59a::1)
3	155.224 ms	155.492 ms	155.785 ms	**e0-34.core1.pdx3.he.net** (2001:470:0:553::1)
12	291.999 ms	292.090 ms	292.229 ms	2001:7f8:1::a500:3209:2
13	307.328 ms	307.814 ms	307.835 ms	2a02:908::48:1
14	307.341 ms	307.820 ms	302.739 ms	2a02:8071:80ff:34b2::2
15	317.196 ms	321.231 ms	321.118 ms	2a02:8071:8200::1899

Entry cached for another 59 seconds. 2022-11-27 12:16:57 UTC

core1.sel2.he.net> traceroute ipv6 2a02:8071:8282:e820:b968:cc7b:c65b:2706 source 2001:470:0:5da::1

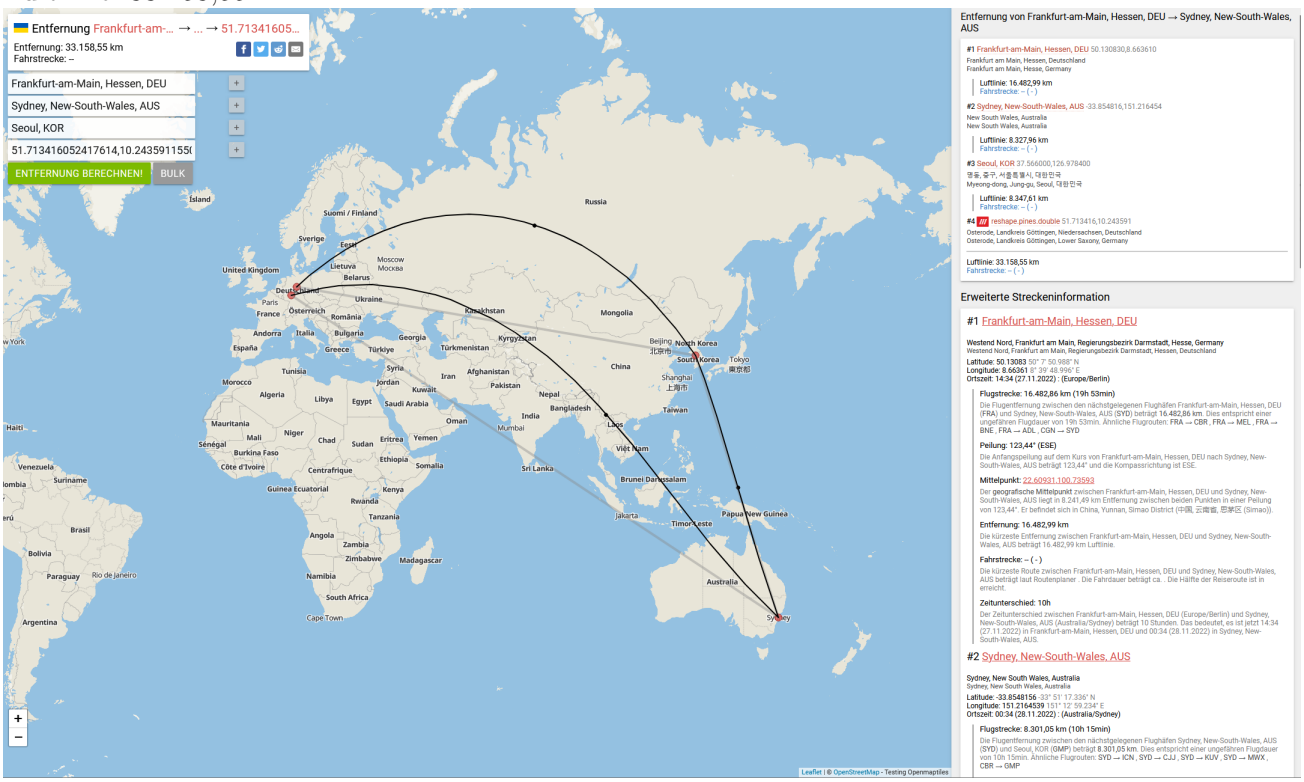
Target	2a02:8071:8282:e820:b968:cc7b:c65b:2706
Hop Start	1
Hop End	30

Hop	Packet 1	Packet 2	Packet 3	Hostname
1	2.313 ms	2.689 ms	*	**port-channel3.core2.sel1.he.net** (2001:470:0:609::1)
8	221.464 ms	221.611 ms	221.858 ms	**vodanet-as3209.port-channel9.core3.fra1.he.net** (2001:470:0:53f::2)
9	231.668 ms	232.078 ms	232.523 ms	2a02:908::48:1
10	232.787 ms	233.099 ms	233.217 ms	2a02:8071:80ff:34b2::2
11	244.713 ms	249.015 ms	244.794 ms	2a02:8071:8200::1899

Entry cached for another 60 seconds. 2022-11-27 12:16:57 UTC

2. $(7ms + 7ms + 17ms) + (26.836ms + 27.602ms + 155.224ms + 291.999ms + 307.328ms + 307.341ms + 317.196ms) + (2.313ms + 221.464ms + 231.668ms + 232.787ms + 244.713ms) = \underline{2397.471ms}$

3. Luftlinie: 33.158,55 km



Theoretische Ausbreitungsverzögerung:
$t_{prop} = \frac{33158{,}55km}{300.000\frac{km}{s}} = 0,111s$
Differenz bissle groß wa?
→ Das sollte teilweise daran liegen, dass 1. die Leitungslänge sehr von der Luftlinie abweicht, 2. die Datenübertragung nicht mit Lichtgeschwindigkeit erfolgt, sowie 3. diese Leitungen einer hohen Auslastung ausgesetzt sind.