Domain Name System

Enterprise Digital Infrastructure – Assignment #2

This is a series of screenshots and commands in bash used to answer all questions. This is a "support" PDF to the main project report, in which there are no screenshots and it is shorter.

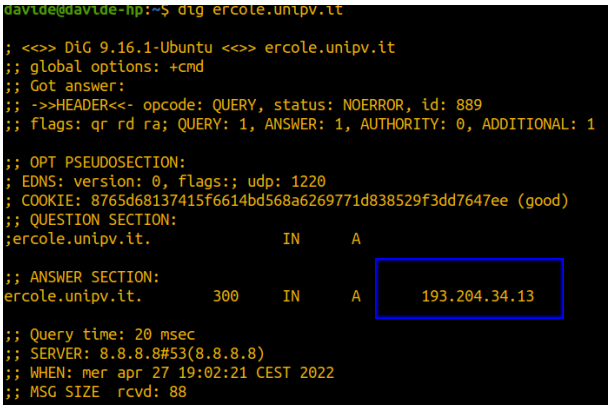
Active Experiments:

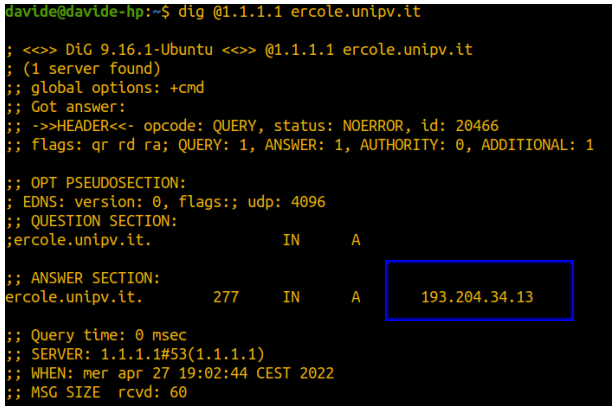
The *name server* by default, in the /etc/resolv.conf file is: 127.0.0.53

To change the name server, edit the file above. Change it with the IP address (8.8.8.8) of the Google public name server. The same experiments are performed using Cloudflare's public DNS name server (1.1.1.1) to see if there are any differences.

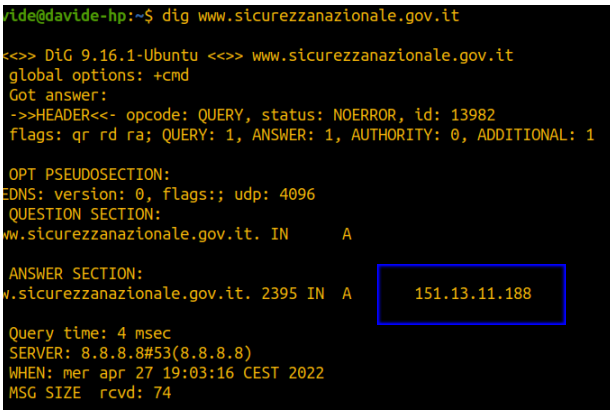
Question 1

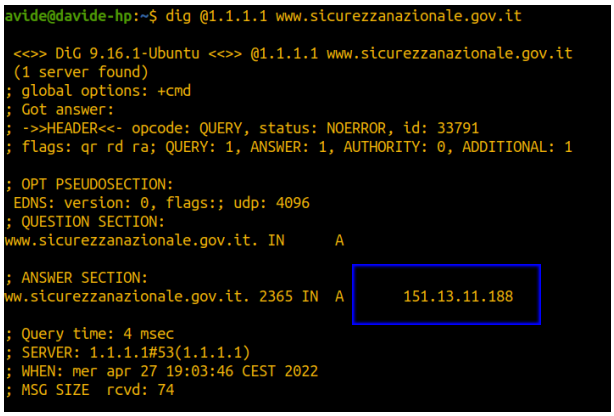
dig ercole.unipv.it
dig @1.1.1.1 ercole.unipv.it





dig www.sicurezzanazionale.gov.it
dig @1.1.1.1 www.sicurezzanazionale.gov.it

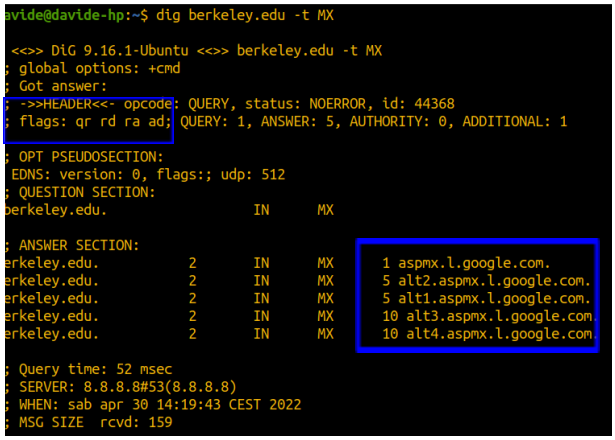


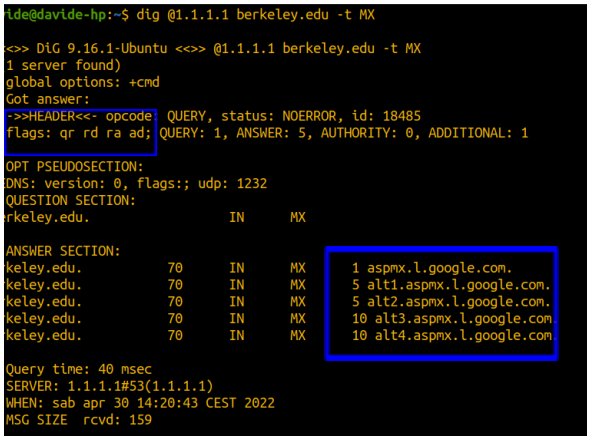


The answers are not authoritative, because they do not come from the authoritative name server of the targets and in fact, as you can see from the photos in the *flags* section, there is no abbreviation *aa*.

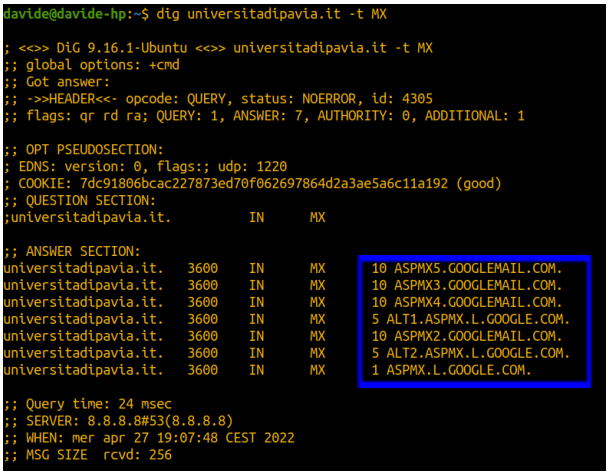
Question 2

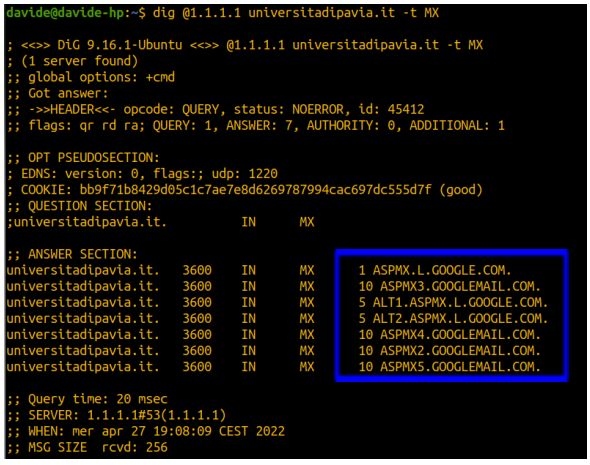
dig berkeley.edu -t MX
dig @1.1.1.1 berkeley.edu -t MX





dig universitadipavia.it -t MX
dig @1.1.1.1 universitadipavia.it -t MX



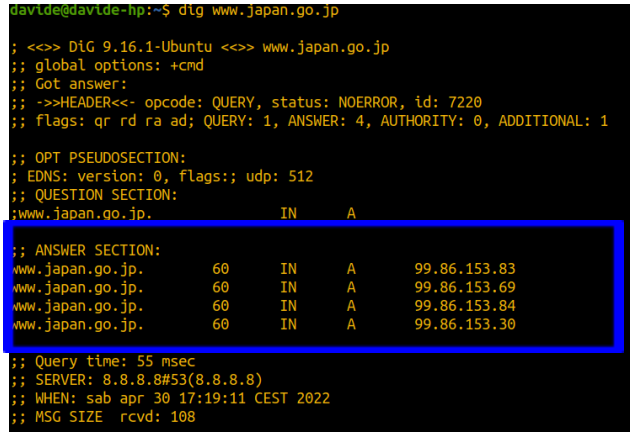


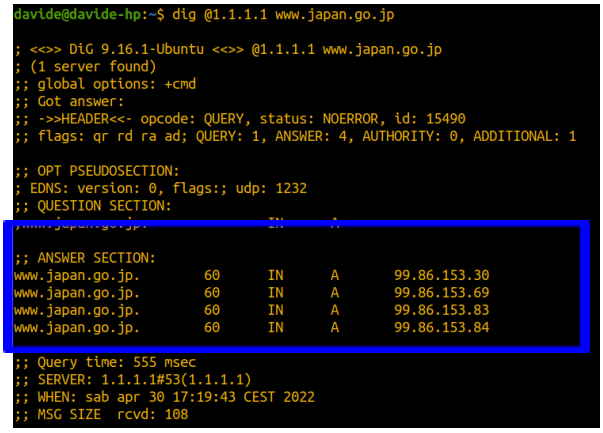
There are **five** servers that provide the mail service for *berkeley.edu,* while there are **seven** servers for *universitadipavia.it* . The servers used by the two universities are made available by Google and some of these (ALT1.ASPMX.L.GOOGLE.COM. - ALT2.ASPMX.L.GOOGLE.COM. - ASPMX.L.GOOGLE.COM.) are shared for the two universities. In fact, even checking with the *ping* / *dig* commands shows that the IP addresses match. Also note that the *berkeley.edu* domain uses DNSSEC to sign records.

Question 3

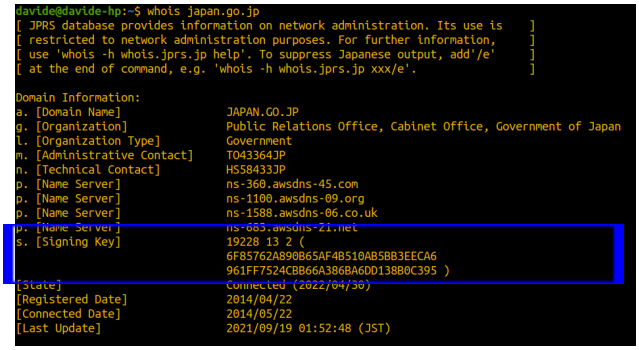
dig www.japan.go.jp
dig @1.1.1.1 www.japan.go.jp

The answers are not authoritative, because they do not come from the authoritative name server of the Government of Japan domain and in fact, as you can see from the photos in the *flags* section, there is no abbreviation *aa*. **Four** RRs are obtained: all of type A.





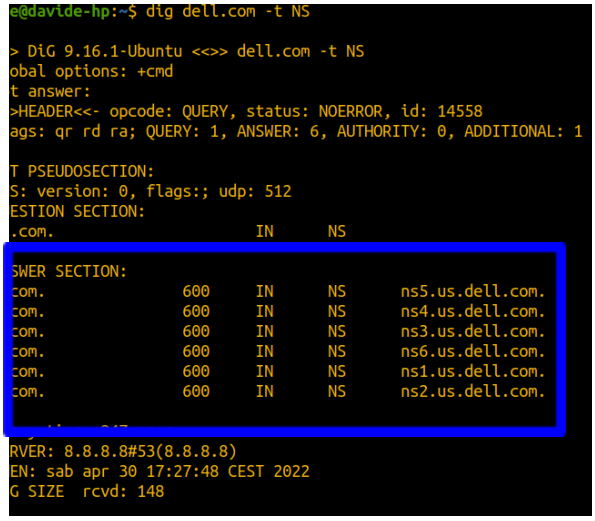
dig www.japan.go.jp +dnssec
whois www.japan.go.jp

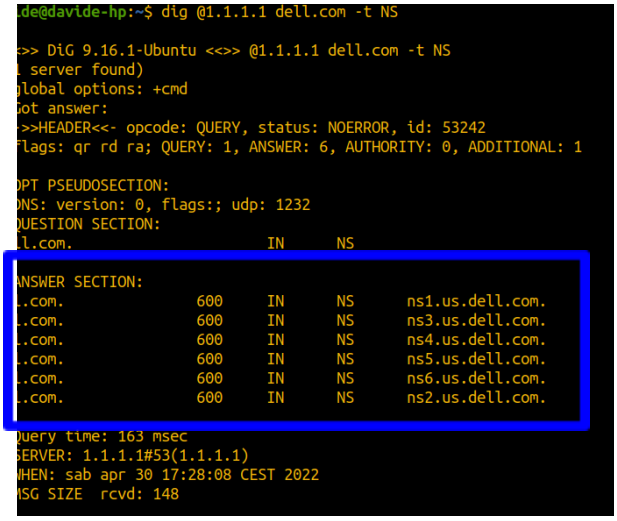


Querying through dig, adding the flag *+dnssec* it results that the domain uses DNSSEC. Also with the *whois* command shows that the DNSSEC signature field is not empty.

Question 4

dig dell.com -t NS
dig @1.1.1.1 dell.com -t NS

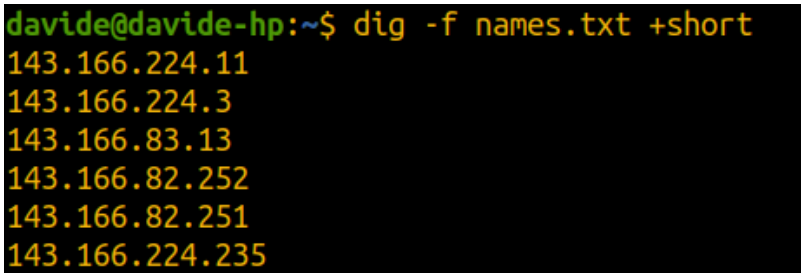




I execute a single query of type *ns* to obtain the domain names of the authoritative Name Servers of the Dell (USA) Company. There are **six** different name servers associated with them, which belong to the same domain: *us.dell.com*. I think that the name server called *<ns1.us.dell.com> (143.166.82.251)* is the primary one, because of its name.

In order to get these IP addresses I executed another query with the *dig* command and with the *-f* option.

dig -f names.txt



whois dell.com

```
davide@davide-hp:~$ whois dell.com
   Domain Name: DELL.COM
   Registry Domain ID: 1978972_DOMAIN_COM-VRSN
   Registrar WHOIS Server: whois.safenames.net
   Registrar URL: http://www.safenames.net
   Updated Date: 2018-04-16T21:36:51Z
   Creation Date: 1988-11-22T05:00:00Z
   Registry Expiry Date: 2024-11-21T05:00:00Z
   Registrar: SafeNames Ltd.
   Registrar IANA ID: 447
   Registrar Abuse Contact Email: abuse@safenames.net
   Registrar Abuse Contact Phone: +44.1908200022
   Domain Status: clientDeleteProhibited https://icann.org/epp#clientDeleteProhibited
   Domain Status: clientTransferProhibited https://icann.org/epp#clientTransferProhibited
   Domain Status: clientUpdateProhibited https://icann.org/epp#clientUpdateProhibited
   Domain Status: serverDeleteProhibited https://icann.org/epp#serverDeleteProhibited
   Domain Status: serverTransferProhibited https://icann.org/epp#serverTransferProhibited
   Domain Status: serverUpdateProhibited https://icann.org/epp#serverUpdateProhibited
   Name Server: NS1.US.DELL.COM
   Name Server: NS2.US.DELL.COM
   Name Server: NS3.US.DELL.COM
   Name Server: NS4.US.DELL.COM
   Name Server: NS5.US.DELL.COM
   Name Server: NS6.US.DELL.COM
   DNSSEC: unsigned
   URL of the ICANN Whois Inaccuracy Complaint Form: https://www.icann.org/wicf/
>>> Last update of whois database: 2022-04-30T15:33:56Z <<<
```

nslookup -type=soa dell.com

```
davide@davide-hp:~$ nslookup -type=soa dell.com
Server:         8.8.8.8
Address:        8.8.8.8#53

Non-authoritative answer:
dell.com
        origin = ns1.us.dell.com
        mail addr = hostmaster.dell.com
        serial = 629820137
        refresh = 900
        retry = 120
        expire = 604800
        minimum = 600

Authoritative answers can be found from:
```

The domain was registered by <*SafeNames Ltd*> on 22-11-1988 and will expire on 21-11-2024. Notice how the result of the *whois* command shows six name servers associated with the domain. The output of this command also supports the hypothesis that the primary name server is: *<ns1.us.dell.com> (143.166.82.251).* Using the *nslookup* command confirms the hypothesis that the primary name server is: *<ns1.us.dell.com>.*

Question 5

dig @143.166.82.251 samsung.com -t NS
dig @143.166.82.251 unipv.it -t NS

```
davide@davide-hp:~$ dig @143.166.82.251 samsung.com -t NS

; <<>> DiG 9.16.1-Ubuntu <<>> @143.166.82.251 samsung.com -t NS
; (1 server found)
;; global options: +cmd
;; Got answer:
; ->>HEADER<<- opcode: QUERY, status: REFUSED, id: 26088
; flags: qr rd; QUERY: 1, ANSWER: 0, AUTHORITY: 0, ADDITIONAL: 1
; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
; COOKIE: 9ba3ae07011e71f7f84ef75b626d58b944f4077ee421e346 (good)
;; QUESTION SECTION:
;samsung.com.                   IN      NS

;; Query time: 200 msec
;; SERVER: 143.166.82.251#53(143.166.82.251)
;; WHEN: sab apr 30 17:41:45 CEST 2022
;; MSG SIZE  rcvd: 68
```

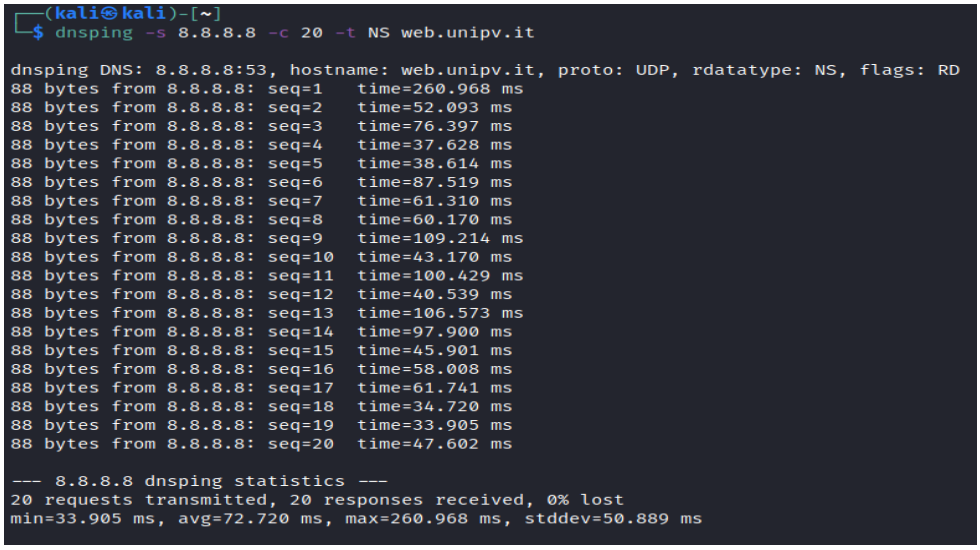
```
davide@davide-hp:~$ dig @143.166.82.251 unipv.it -t NS

; <<>> DiG 9.16.1-Ubuntu <<>> @143.166.82.251 unipv.it -t NS
; (1 server found)
; global options: +cmd
; Got answer:
; ->>HEADER<<- opcode: QUERY, status: REFUSED, id: 11669
; flags: qr rd; QUERY: 1, ANSWER: 0, AUTHORITY: 0, ADDITIONAL:
; WARNING: recursion requested but not available

; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
; COOKIE: ba92c2b613aa8523e4a17676626d58fb8116d650de3b1d28 (good)
; QUESTION SECTION:
unipv.it.                      IN      NS

; Query time: 239 msec
; SERVER: 143.166.82.251#53(143.166.82.251)
; WHEN: sab apr 30 17:42:51 CEST 2022
; MSG SIZE  rcvd: 65
```

Using the IP address of the primary name server of the American company Dell, both queries were rejected. Clearly this name server does not know and cannot resolve the given hostnames. In fact, querying this server with hostnames that are part of the domain, you can get an answer. Furthermore this name server is not a public name server, so it is legitimate that it does not make recursion queries to other name servers if requested from outside its domain.It is also not certain that this name server has enabled recursive queries.

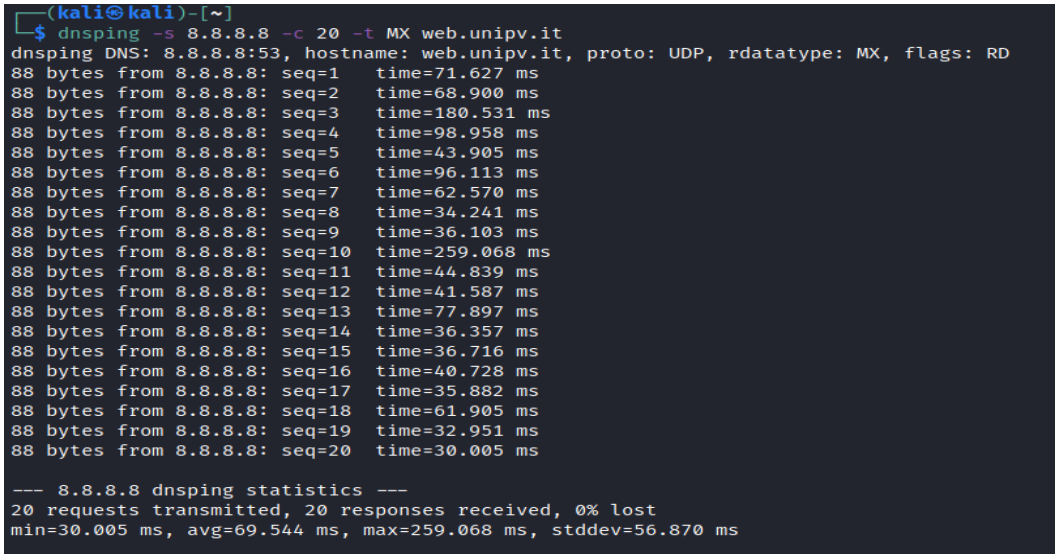
Performance/auditing experiments:

Question 1

dnsping -s 8.8.8.8 -c 20 -t NS web.unipv.it
dnsping -s 8.8.8.8 -c 20 -t MX web.unipv.it
dnsping -s 8.8.8.8 -c 20 -t AAAA web.unipv.it
dnsping -s 8.8.8.8 -c 20 web.unipv.it



The performance of the Google public name server is analyzed. The test was done by requesting 20 queries of type: NS / MX / AAAA / A, requested for the *unipv.it* domain. The results obtained are consistent with expectations. That is, in general, the RTT is higher when using a public name server than using the default one (assigned by the router). On the other



hand, the high standard error value obtained was less expected. There are RTT values around 30ms but also values that touch 300ms.

```
┌──(kali㉿kali)-[~]
└─$ dnsping -s 8.8.8.8 -c 20 -t AAAA web.unipv.it
dnsping DNS: 8.8.8.8:53, hostname: web.unipv.it, proto: UDP, rdatatype: AAAA, flags: RD
88 bytes from 8.8.8.8: seq=1   time=44.709 ms
88 bytes from 8.8.8.8: seq=2   time=59.880 ms
88 bytes from 8.8.8.8: seq=3   time=39.068 ms
88 bytes from 8.8.8.8: seq=4   time=35.699 ms
88 bytes from 8.8.8.8: seq=5   time=38.337 ms
88 bytes from 8.8.8.8: seq=6   time=59.174 ms
88 bytes from 8.8.8.8: seq=7   time=56.820 ms
88 bytes from 8.8.8.8: seq=8   time=130.194 ms
88 bytes from 8.8.8.8: seq=9   time=39.596 ms
88 bytes from 8.8.8.8: seq=10  time=106.441 ms
88 bytes from 8.8.8.8: seq=11  time=35.736 ms
88 bytes from 8.8.8.8: seq=12  time=30.004 ms
88 bytes from 8.8.8.8: seq=13  time=54.974 ms
88 bytes from 8.8.8.8: seq=14  time=43.486 ms
88 bytes from 8.8.8.8: seq=15  time=40.955 ms
88 bytes from 8.8.8.8: seq=16  time=30.954 ms
88 bytes from 8.8.8.8: seq=17  time=42.070 ms
88 bytes from 8.8.8.8: seq=18  time=108.630 ms
88 bytes from 8.8.8.8: seq=19  time=46.479 ms
88 bytes from 8.8.8.8: seq=20  time=28.378 ms

--- 8.8.8.8 dnsping statistics ---
20 requests transmitted, 20 responses received, 0% lost
min=28.378 ms, avg=53.579 ms, max=130.194 ms, stddev=28.359 ms
```

```
┌──(kali㉿kali)-[~]
└─$ dnsping -s 8.8.8.8 -c 20  web.unipv.it
dnsping DNS: 8.8.8.8:53, hostname: web.unipv.it, proto: UDP, rdatatype: A, flags: RD
57 bytes from 8.8.8.8: seq=1   time=53.257 ms
57 bytes from 8.8.8.8: seq=2   time=35.287 ms
57 bytes from 8.8.8.8: seq=3   time=34.154 ms
57 bytes from 8.8.8.8: seq=4   time=36.882 ms
57 bytes from 8.8.8.8: seq=5   time=38.851 ms
57 bytes from 8.8.8.8: seq=6   time=80.256 ms
57 bytes from 8.8.8.8: seq=7   time=60.045 ms
57 bytes from 8.8.8.8: seq=8   time=34.366 ms
57 bytes from 8.8.8.8: seq=9   time=26.901 ms
57 bytes from 8.8.8.8: seq=10  time=296.235 ms
57 bytes from 8.8.8.8: seq=11  time=34.971 ms
57 bytes from 8.8.8.8: seq=12  time=33.513 ms
57 bytes from 8.8.8.8: seq=13  time=33.207 ms
57 bytes from 8.8.8.8: seq=14  time=34.363 ms
57 bytes from 8.8.8.8: seq=15  time=30.973 ms
57 bytes from 8.8.8.8: seq=16  time=38.910 ms
57 bytes from 8.8.8.8: seq=17  time=32.718 ms
57 bytes from 8.8.8.8: seq=18  time=91.684 ms
57 bytes from 8.8.8.8: seq=19  time=28.738 ms
57 bytes from 8.8.8.8: seq=20  time=31.056 ms

--- 8.8.8.8 dnsping statistics ---
20 requests transmitted, 20 responses received, 0% lost
min=26.901 ms, avg=54.318 ms, max=296.235 ms, stddev=59.464 ms
```

It is possible to see that the response time changes by varying the type of query. In general, type A queries (in this case smaller size) take less time. All the other three types tested have very similar times.

Finally it must be said that the results obtained were taken in a single moment, therefore their validity is limited. The analysis should be repeated several times to collect data closer to reality.

Question 2

dnseval -f list-NS -t NS -c 20 berkeley.edu
dnseval -f list-NS -t MX -c 20 berkeley.edu
dnseval -f list-NS -t A -c 20 berkeley.edu

The public name servers that I have chosen to test for this part are the following, note that the geographical location is also shown, useful for considerations:

139.134.2.190	Australia
8.8.8.8	USA
64.6.64.6	USA
62.149.128.2	Italy
200.221.11.101	Brazil
82.103.129.72	Denmark

For each name server 50 queries were made, of type A / MX / NS. The hostnames used are the following:

- web.unipv.it
- australia.gov.au
- fbi.gov
- verizion.com
- berkeley.edu

```
┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t A -c 50 web.unipv.it
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                    response
139.134.2.190    351.433     320.234     980.675     92.084      %0       283        QR -- -- RD RA -- --     NOERROR
8.8.8.8          43.744      25.964      82.025      10.509      %0       215        QR -- -- RD RA -- --     NOERROR
64.6.64.6        60.542      46.290      156.426     23.257      %0       297        QR -- -- RD RA -- --     NOERROR
62.149.128.2     50.720      37.128      81.172      7.757       %0       297        QR -- -- RD RA -- --     NOERROR
200.221.11.101   265.851     238.248     523.538     53.170      %0       288        QR -- -- RD RA -- --     NOERROR
82.103.129.72    80.144      64.013      138.715     19.143      %4       298        QR -- -- RD RA -- --     NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t MX -c 50 web.unipv.it
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                    response
139.134.2.190    340.975     319.217     776.955     63.351      %0       N/A        QR -- -- RD RA -- --     NOERROR
8.8.8.8          41.475      26.503      83.560      16.104      %0       N/A        QR -- -- RD RA -- --     NOERROR
64.6.64.6        55.979      47.276      104.691     11.753      %0       N/A        QR -- -- RD RA -- --     NOERROR
62.149.128.2     48.818      36.179      74.393      7.580       %0       N/A        QR -- -- RD RA -- --     NOERROR
200.221.11.101   260.720     236.250     488.346     46.561      %0       N/A        QR -- -- RD RA -- --     NOERROR
82.103.129.72    80.090      65.580      178.483     25.262      %4       N/A        QR -- -- RD RA -- --     NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t NS -c 50 web.unipv.it
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                    response
139.134.2.190    352.343     320.147     1151.736    115.657     %0       N/A        QR -- -- RD RA -- --     NOERROR
8.8.8.8          33.132      26.123      52.916      6.739       %0       N/A        QR -- -- RD RA -- --     NOERROR
64.6.64.6        62.573      48.002      102.244     13.858      %0       N/A        QR -- -- RD RA -- --     NOERROR
62.149.128.2     68.476      42.894      96.840      6.172       %0       N/A        QR -- -- RD RA -- --     NOERROR
200.221.11.101   261.646     237.926     487.588     47.068      %0       N/A        QR -- -- RD RA -- --     NOERROR
82.103.129.72    77.645      64.718      125.200     14.703      %4       N/A        QR -- -- RD RA -- --     NOERROR
```

```
┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t A -c 50 australia.gov.au
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                 response
139.134.2.190    337.268     321.707     432.806     17.523      %0       3583       QR -- -- RD RA -- --  NOERROR
8.8.8.8          55.019      26.850      264.366     34.752      %0       3598       QR -- -- RD RA -- --  NOERROR
64.6.64.6        83.629      46.669      883.306     122.698     %0       3597       QR -- -- RD RA -- --  NOERROR
62.149.128.2     50.477      35.523      100.734     11.494      %0       3597       QR -- -- RD RA -- --  NOERROR
200.221.11.101   263.424     241.763     455.845     39.966      %0       3587       QR -- -- RD RA -- --  NOERROR
82.103.129.72    86.279      63.704      255.181     40.967      %4       3598       QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t MX -c 50 australia.gov.au
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                 response
139.134.2.190    335.895     322.281     457.078     18.391      %0       N/A        QR -- -- RD RA -- --  NOERROR
8.8.8.8          39.191      27.047      96.121      17.107      %0       N/A        QR -- -- RD RA -- --  NOERROR
64.6.64.6        59.917      46.876      121.888     15.727      %0       N/A        QR -- -- RD RA -- --  NOERROR
62.149.128.2     50.212      39.258      86.043      9.057       %0       N/A        QR -- -- RD RA -- --  NOERROR
200.221.11.101   262.575     237.056     384.329     25.270      %0       N/A        QR -- -- RD RA -- --  NOERROR
82.103.129.72    75.694      62.940      117.577     12.007      %4       N/A        QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t NS -c 50 australia.gov.au
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                 response
139.134.2.190    342.082     322.152     474.109     24.608      %0       383        QR -- -- RD RA -- --  NOERROR
8.8.8.8          43.323      25.634      251.538     38.765      %0       21598      QR -- -- RD RA -- --  NOERROR
64.6.64.6        64.219      48.578      120.578     15.689      %0       43197      QR -- -- RD RA -- --  NOERROR
62.149.128.2     50.779      37.000      100.428     9.484       %0       86397      QR -- -- RD RA -- --  NOERROR
200.221.11.101   260.006     240.718     383.699     25.714      %0       172787     QR -- -- RD RA -- --  NOERROR
82.103.129.72    76.083      62.476      118.820     11.855      %4       172799     QR -- -- RD RA -- --  NOERROR
```

```
┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t A -c 50 verizon.com
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                 response
139.134.2.190    341.315     323.724     376.713     15.113      %0       584        QR -- -- RD RA -- --  NOERROR
8.8.8.8          34.649      26.479      56.069      7.771       %0       599        QR -- -- RD RA -- --  NOERROR
64.6.64.6        63.127      47.939      111.278     12.558      %0       596        QR -- -- RD RA -- --  NOERROR
62.149.128.2     49.751      36.722      71.012      7.692       %0       28         QR -- -- RD RA -- --  NOERROR
200.221.11.101   265.615     237.345     505.879     41.733      %0       392        QR -- -- RD RA -- --  NOERROR
82.103.129.72    77.044      62.333      99.916      10.200      %4       599        QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t MX -c 50 verizon.com
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                 response
139.134.2.190    336.752     321.575     364.995     7.045       %0       583        QR -- -- RD RA -- --  NOERROR
8.8.8.8          35.242      26.433      52.073      8.215       %0       598        QR -- -- RD RA -- --  NOERROR
64.6.64.6        56.134      47.083      75.776      6.936       %0       597        QR -- -- RD RA -- --  NOERROR
62.149.128.2     48.124      35.717      69.232      7.141       %0       598        QR -- -- RD RA -- --  NOERROR
200.221.11.101   263.750     239.816     367.576     25.364      %0       586        QR -- -- RD RA -- --  NOERROR
82.103.129.72    75.738      63.094      99.627      9.658       %4       599        QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t NS -c 50 verizon.com
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl        flags                 response
139.134.2.190    333.806     322.217     404.946     12.977      %0       3477       QR -- -- RD RA -- --  NOERROR
8.8.8.8          37.881      27.269      54.840      7.809       %0       3598       QR -- -- RD RA -- --  NOERROR
64.6.64.6        58.405      47.422      76.099      7.231       %0       3597       QR -- -- RD RA -- --  NOERROR
62.149.128.2     49.266      36.825      75.099      6.628       %0       27         QR -- -- RD RA -- --  NOERROR
200.221.11.101   261.187     239.912     395.400     26.167      %0       3588       QR -- -- RD RA -- --  NOERROR
82.103.129.72    78.698      62.736      102.599     11.484      %4       3598       QR -- -- RD RA -- --  NOERROR
```

```
┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t A -c 50 fbi.gov
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl       flags                 response
139.134.2.190    341.843     322.144     453.433     19.758      %0       103       QR -- -- RD RA -- --  NOERROR
8.8.8.8          36.708      26.300      100.999     14.166      %0       118       QR -- -- RD RA -- --  NOERROR
64.6.64.6        61.643      47.939      135.366     19.081      %0       117       QR -- -- RD RA -- --  NOERROR
62.149.128.2     50.339      37.427      88.788      8.501       %0       117       QR -- -- RD RA -- --  NOERROR
200.221.11.101   266.316     237.988     578.547     61.102      %0       108       QR -- -- RD RA -- --  NOERROR
82.103.129.72    83.932      62.511      289.117     49.165      %4       298       QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t MX -c 50 fbi.gov
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl       flags                 response
139.134.2.190    351.317     320.628     463.002     25.923      %0       103       QR -- -- RD RA -- --  NOERROR
8.8.8.8          37.455      26.285      112.407     16.124      %0       118       QR -- -- RD RA -- --  NOERROR
64.6.64.6        59.165      47.410      115.770     14.611      %0       117       QR -- -- RD RA -- --  NOERROR
62.149.128.2     51.687      36.216      95.287      12.259      %0       117       QR -- -- RD RA -- --  NOERROR
200.221.11.101   262.047     238.140     392.278     27.725      %0       108       QR -- -- RD RA -- --  NOERROR
82.103.129.72    77.620      65.013      106.063     9.947       %4       298       QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t NS -c 50 fbi.gov
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl       flags                 response
139.134.2.190    349.118     321.899     467.521     24.852      %0       583       QR -- -- RD RA -- --  NOERROR
8.8.8.8          37.580      26.208      90.518      13.383      %0       598       QR -- -- RD RA -- --  NOERROR
64.6.64.6        62.997      47.579      94.493      10.468      %0       597       QR -- -- RD RA -- --  NOERROR
62.149.128.2     49.473      35.921      75.332      7.165       %0       598       QR -- -- RD RA -- --  NOERROR
200.221.11.101   261.617     237.910     386.371     25.788      %0       588       QR -- -- RD RA -- --  NOERROR
82.103.129.72    77.796      62.433      112.103     14.052      %4       598       QR -- -- RD RA -- --  NOERROR
```

```
┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t A -c 50 berkeley.edu
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl       flags                 response
139.134.2.190    341.917     320.577     531.408     31.473      %0       283       QR -- -- RD RA -- --  NOERROR
8.8.8.8          53.854      26.931      210.883     55.019      %0       297       QR -- -- RD RA -- --  NOERROR
64.6.64.6        170.412     56.613      226.749     79.987      %14      300       QR -- -- RD RA -- --  NOERROR
62.149.128.2     55.127      36.870      219.798     35.041      %0       297       QR -- -- RD RA -- --  NOERROR
200.221.11.101   264.086     243.127     472.822     40.475      %0       287       QR -- -- RD RA -- --  NOERROR
82.103.129.72    81.738      64.098      246.089     39.251      %4       298       QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t MX -c 50 berkeley.edu
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl       flags                 response
139.134.2.190    340.099     320.144     521.034     28.701      %0       255       QR -- -- RD RA -- --  NOERROR
8.8.8.8          50.577      25.681      225.595     52.782      %0       269       QR -- -- RD RA -- --  NOERROR
64.6.64.6        72.448      47.431      233.063     44.951      %0       267       QR -- -- RD RA -- --  NOERROR
62.149.128.2     54.267      37.106      225.481     35.112      %0       268       QR -- -- RD RA -- --  NOERROR
200.221.11.101   269.396     239.262     534.875     54.773      %0       259       QR -- -- RD RA -- --  NOERROR
82.103.129.72    86.138      66.975      250.121     39.299      %4       298       QR -- -- RD RA -- --  NOERROR

┌──(kali㉿kali)-[~]
└─$ dnseval -f list-NS -t NS -c 50 berkeley.edu
server           avg(ms)     min(ms)     max(ms)     stddev(ms)  lost(%)  ttl       flags                 response
139.134.2.190    334.899     320.741     353.020     6.839       %0       9298      QR -- -- RD RA -- --  NOERROR
8.8.8.8          50.562      26.498      210.708     51.678      %0       10798     QR -- -- RD RA -- --  NOERROR
64.6.64.6        57.410      46.990      85.677      7.301       %0       8935      QR -- -- RD RA -- --  NOERROR
62.149.128.2     48.539      37.362      60.955      5.627       %0       9300      QR -- -- RD RA -- --  NOERROR
200.221.11.101   255.562     245.607     272.766     6.038       %0       9288      QR -- -- RD RA -- --  NOERROR
82.103.129.72    80.869      63.424      244.517     38.902      %4       10799     QR -- -- RD RA -- --  NOERROR
```

What the data shows is that the times obtained vary greatly depending on the name server used, as might be expected. It is clear that performance is greatly influenced by the geographic location of the name server, in fact for the same query a name server in Australia takes up to six times the time of a name server in Italy. With the same name server, I expected a big time difference based on the type of query requested. In reality the results obtained go against this expectation, there are small variations in times.

Question 3

The public name servers that I have chosen to test for this part are the following, note that the geographical location is also shown, useful for considerations:

139.134.2.190	Australia
8.8.8.8	USA
64.6.64.6	USA
200.221.11.101	Brazil
82.103.129.72	Denmark

sudo dnstraceroute -x -a -s 139.134.2.190 unipv.it

The results thus obtained are consistent with those expected. There are some things in common with all name servers used, for example in hops 5/6/7 routers obscure responses to this type of traffic. This being a common behavior with every query run, I can imagine that it is related to my ISP. The same consideration can be made for all 10 first hops, they are all in common. Regardless of the name server used. In particular, all the queries are in my ISP's network at least up to hop 11, some of these even up to hop 13. Hop number 11 varies each time, but is always within the ISP's network.

```
┌──(kali㉿kali)-[~]
└─$ sudo dnstraceroute -x -a -s 139.134.2.190 unipv.it
dnstraceroute DNS: 139.134.2.190:53, hostname: unipv.it, rdatatype: A
1       10.0.2.2 (10.0.2.2) 1.026 ms
2       _gateway (192.168.75.166) 8.501 ms
3       192.168.60.82 (192.168.60.82) 40.402 ms
4       192.168.60.82 (192.168.60.82) 31.579 ms
5        *
6        *
7        *
8       10.178.86.49 (10.178.86.49) 81.799 ms
9       83.224.40.186 (83.224.40.186) 38.711 ms
10      83.224.40.185 (83.224.40.185) 56.547 ms
11      ae3-100-xcr1.mlb.cw.net (195.59.1.85) [AS1273 CW Vodafone Group PLC, EU] 34.511 ms
12      ae9-tcr1.pat.cw.net (195.2.9.89) [AS1273 CW Vodafone Group PLC, EU] 55.039 ms
13      ae.29-xcr1.hex.cw.net (195.2.9.94) [AS1273 CW Vodafone Group PLC, EU] 55.797 ms
14      ae9-xcr1.lnt.cw.net (195.2.24.161) [AS1273 CW Vodafone Group PLC, EU] 48.968 ms
15      195.66.224.177 (195.66.224.177) 57.191 ms
16      i-1001.ulhc-core02.telstraglobal.net (202.84.178.70) [AS4637 ASN-TELSTRA-GLOBAL Telstra Global, HK] 73.708 ms
17      202.84.249.82 (202.84.249.82) [AS4637 ASN-TELSTRA-GLOBAL Telstra Global, HK] 189.057 ms
18      202.84.249.81 (202.84.249.81) [AS4637 ASN-TELSTRA-GLOBAL Telstra Global, HK] 189.542 ms
19      202.84.249.81 (202.84.249.81) [AS4637 ASN-TELSTRA-GLOBAL Telstra Global, HK] 328.251 ms
20      i-37.sydo-core03.telstraglobal.net (202.84.247.46) [AS4637 ASN-TELSTRA-GLOBAL Telstra Global, HK] 330.275 ms
21      bundle-ether3.oxf-gw11.sydney.telstra.net (203.50.13.97) [AS1221 ASN-TELSTRA Telstra Corporation Ltd, AU] 331.119 ms
22      bundle-ether1.chw-core10.sydney.telstra.net (203.50.6.92) [AS1221 ASN-TELSTRA Telstra Corporation Ltd, AU] 330.707 ms
23      Bundle-Ether1.civ-core30.canberra.telstra.net (203.50.6.112) [AS1221 ASN-TELSTRA Telstra Corporation Ltd, AU] 328.426 ms
24      Bundle-Ether1.civ-dlr20.canberra.telstra.net (203.50.8.9) [AS1221 ASN-TELSTRA Telstra Corporation Ltd, AU] 339.105 ms
25      139.134.2.190 (139.134.2.190) [AS1221 ASN-TELSTRA Telstra Corporation Ltd, AU] 1275.103 ms
```

Starting with hop 12 the behavior changes significantly depending on the specified server. Sometimes this is an exchange point, while other times it's still a router within my ISP's network.

```
┌──(kali㉿kali)-[~]
└─$ sudo dnstraceroute -x -a -s 8.8.8.8 unipv.it
dnstraceroute DNS: 8.8.8.8:53, hostname: unipv.it, rdatatype: A
1       10.0.2.2 (10.0.2.2) 1.330 ms
2       _gateway (192.168.75.166) 3.767 ms
3       192.168.60.82 (192.168.60.82) 243.534 ms
4       192.168.60.82 (192.168.60.82) 79.703 ms
5        *
6       192.168.0.69 (192.168.0.69) 30.718 ms
7        *
8       10.178.86.49 (10.178.86.49) 81.967 ms
9       83.224.40.186 (83.224.40.186) 40.947 ms
10      83.224.40.185 (83.224.40.185) 34.057 ms
11      83.224.46.233 (83.224.46.233) 33.164 ms
12      216.239.49.41 (216.239.49.41) [AS15169 GOOGLE, US] 42.086 ms
13      142.251.235.179 (142.251.235.179) [AS15169 GOOGLE, US] 31.324 ms
14      dns.google (8.8.8.8) [AS15169 GOOGLE, US] 44.644 ms
```

```
┌──(kali㉿kali)-[~]
└─$ sudo dnstraceroute -x -a -s 64.6.64.6 unipv.it
dnstraceroute DNS: 64.6.64.6:53, hostname: unipv.it, rdatatype: A
1       10.0.2.2 (10.0.2.2) 1.066 ms
2       _gateway (192.168.75.166) 6.236 ms
3       192.168.60.82 (192.168.60.82) 253.313 ms
4       192.168.60.82 (192.168.60.82) 31.297 ms
5        *
6       192.168.0.69 (192.168.0.69) 43.074 ms
7        *
8       10.178.86.49 (10.178.86.49) 70.373 ms
9       83.224.40.186 (83.224.40.186) 43.933 ms
10      83.224.40.185 (83.224.40.185) 42.353 ms
11      185.210.48.137 (185.210.48.137) 62.430 ms
12      lag17.fr4.mrs1.llnw.net (87.248.216.248) [AS22822 LLNW, US] 47.501 ms
13      p1-4.fr3.mrs1.llnw.net (178.79.236.9) [AS22822 LLNW, US] 52.344 ms
14      lag19.fr3.toj1.llnw.net (87.248.220.11) [AS22822 LLNW, US] 52.951 ms
15      uldns.p1-8-10g.fr3.toj1.llnw.net (95.140.224.29) [AS22822 LLNW, US] 65.003 ms
16      rec1pubns1.ultradns.net (64.6.64.6) [AS397213 ULTRADNS, US] 111.655 ms
```

```
┌──(kali㉿kali)-[~]
└─$ sudo dnstraceroute -x -a -s 200.221.11.101 unipv.it
dnstraceroute DNS: 200.221.11.101:53, hostname: unipv.it, rdatatype: A
1       10.0.2.2 (10.0.2.2) 1.321 ms
2       _gateway (192.168.75.166) 7.429 ms
3       192.168.60.82 (192.168.60.82) 306.411 ms
4       192.168.60.82 (192.168.60.82) 62.099 ms
5        *
6        *
7        *
8       10.178.86.49 (10.178.86.49) 34.584 ms
9       83.224.40.186 (83.224.40.186) 53.655 ms
10      83.224.40.185 (83.224.40.185) 70.188 ms
11      ae3-100-xcr1.mlb.cw.net (195.59.1.85) [AS1273 CW Vodafone Group PLC, EU] 62.389 ms
12      ae23-xcr1.mrx.cw.net (195.2.31.118) [AS1273 CW Vodafone Group PLC, EU] 38.171 ms
13      as6762-gw-xcr1.mrx.cw.net (195.2.29.182) [AS1273 CW Vodafone Group PLC, EU] 41.718 ms
14       *
15      tim-brasil.sanpaolo8.spa.seabone.net (195.22.219.33) [AS6762 SEABONE-NET TELECOM ITALIA SPARKLE S.p.A., IT] 289.857 ms
16      26.252.40.189.isp.timbrasil.com.br (189.40.252.26) [AS26615 TIM SA, BR] 250.672 ms
17       *
18      186.234.29.38 (186.234.29.38) [AS7162 Universo Online S.A., BR] 251.799 ms
19      200-147-26-38.static.uol.com.br (200.147.26.38) [AS7162 Universo Online S.A., BR] 425.232 ms
20      ravel.uol.com.br (200.221.11.101) [AS7162 Universo Online S.A., BR] 272.105 ms

═══ Expert Hints ═══
 [*] No expert hint available for this trace
```