Unbound

QNAME minimisation

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“Pervasive Monitoring Is an Attack”

- RFC7258
  - Pervasive monitoring is a technical attack that should be mitigated in the design of IETF protocols, where possible.

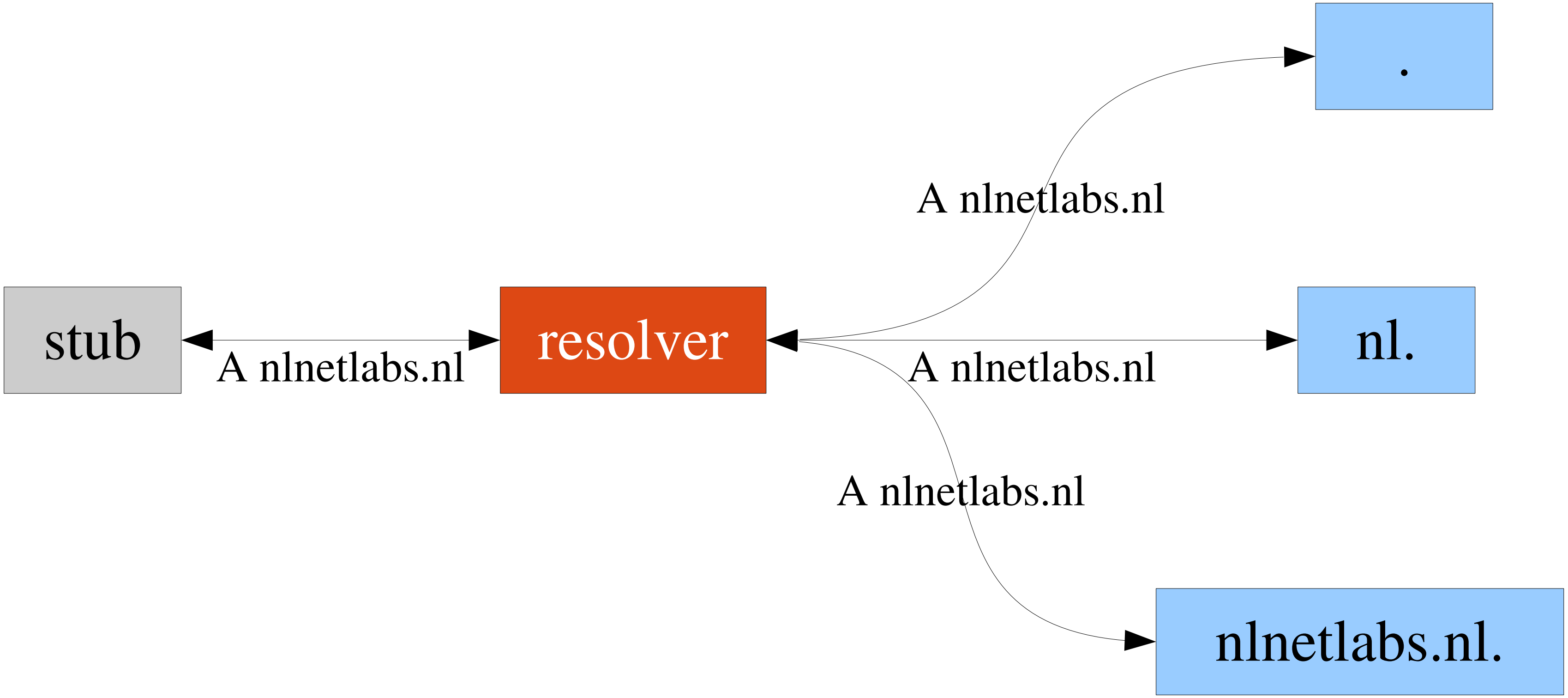
Privacy in DNS

- DNS data is public
- Transactions should not be public
  - MX nlnetlabs.nl.
  - `H(ralph)`._openpgpkey.nlnetlabs.nl

Privacy Threat Mitigations

- Privacy Considerations for Internet Protocols, RFC6973
  - 6.1 Data Minimization
    - “Reducing the amount of data exchanged reduces the amount of data that can be misused or leaked.”
  - 6.3 Security
    - “Confidentiality: Keeping data secret from unintended listeners.”

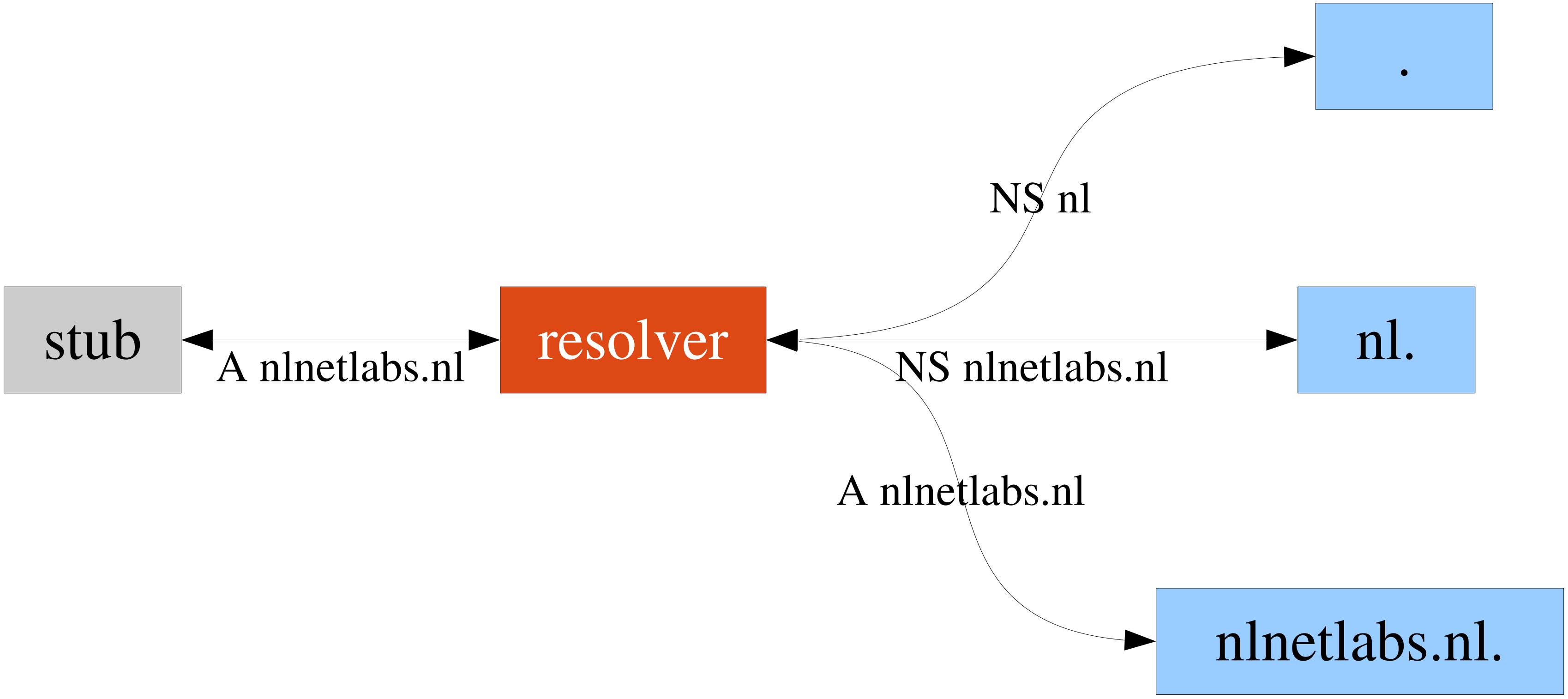
Resolving


stub
A nlnetlabs.nl
resolver
.
A nlnetlabs.nl
nl.
A nlnetlabs.nl
A nlnetlabs.nl
nlnetlabs.nl.

QNAME minimisation

- DNS Query Name Minimisation to Improve Privacy, RFC7816:
  - “The request is done with:
    - the QTYPE NS,
    - the QNAME which is the original QNAME, stripped to just one label more than the zone for which the server is authoritative.”

Resolving with QNAME minimisation



QNAME minimisation in Unbound

- Version 1.5.7
- Default off
- Enable in config:

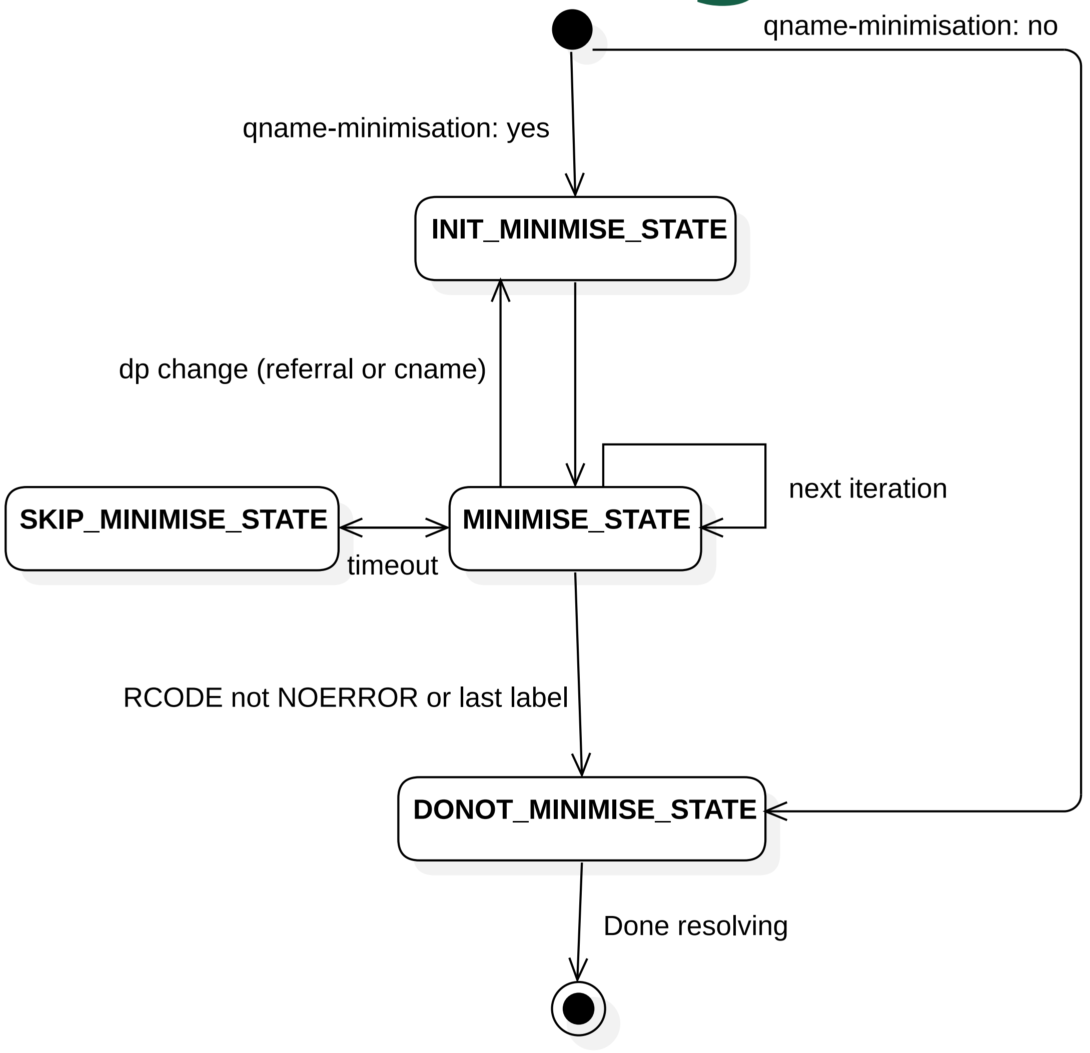
```
server:
  qname-minimisation: yes
```

Resolve AAAA nlnetlabs.nl

```
./unbound -dd  2>&1 | grep send
```

```
info: sending query: nl. NS IN
debug: sending to target: <.> 2001:500:2d::d#53
info: sending query: nlnetlabs.nl. NS IN
debug: sending to target: <nl.> 194.171.17.10#53
info: sending query: nlnetlabs.nl. AAAA IN
debug: sending to target: <nlnetlabs.nl.>
2a04:b900::8:0:0:60#53
```

State diagram



When to stop?

- Continue iterating until all labels from original QNAME are in minimised QNAME?
  - DoS
- Until the nameserver indicates requested domain doesn't exist (NXDOMAIN) or on error?

wildcard.whitehouse.gov.edgekey.net

info: sending **query: edgekey.net. NS** IN

debug: sending to **target: <net.>** 192.5.6.30#53

info: sending **query: gov.edgekey.net. NS** IN

debug: sending to **target: <edgekey.net.>** 95.100.168.65#53

NXDOMAIN

Other wrong RCODEs

```
$ dig ns www.limburg.nl | grep status
;; ->>HEADER<<- opcode: QUERY,
status: SERVFAIL, id: 14956
```

-Also: REFUSED on QTYPE=NS

When to stop resolving?

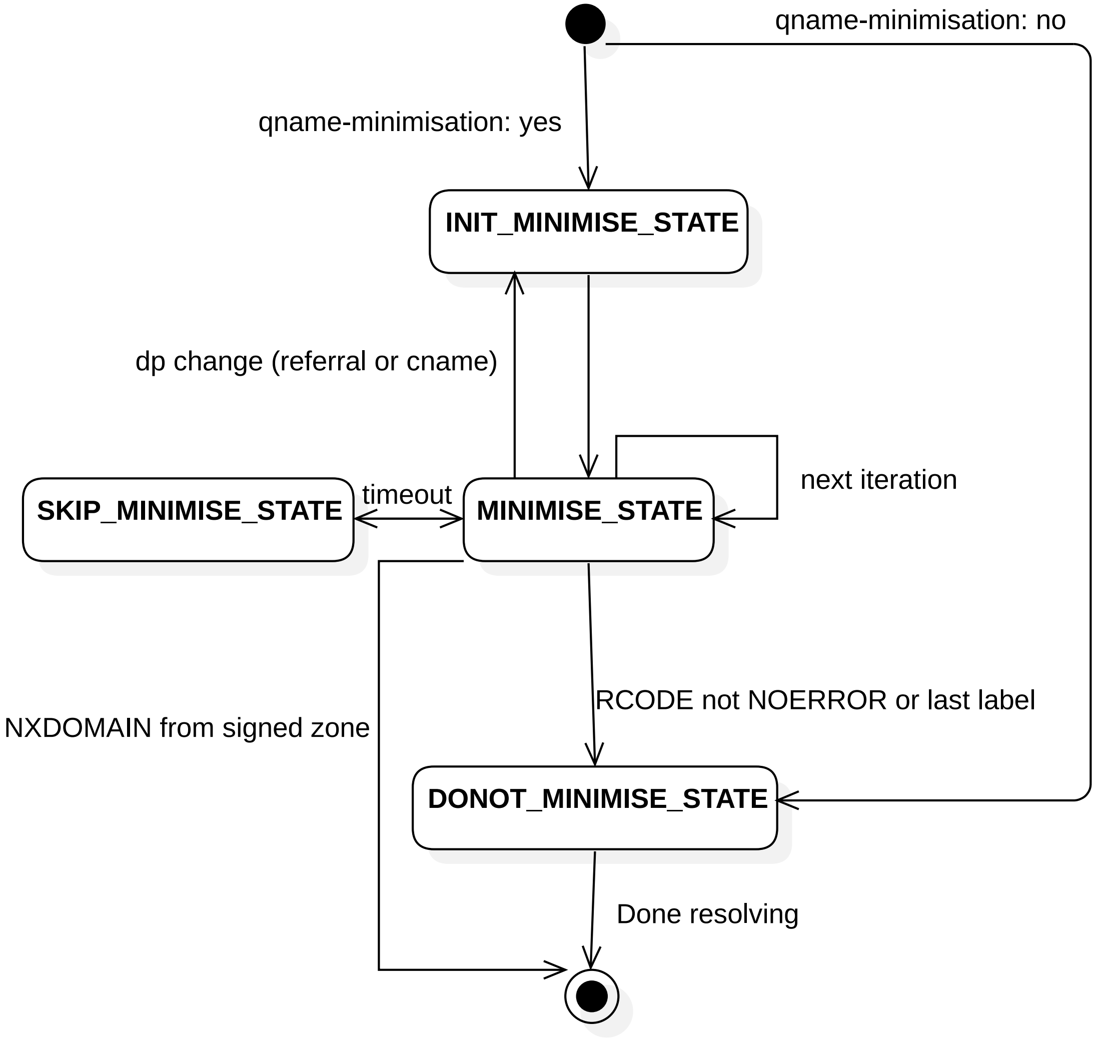
- We can't ignore the RCODE and continue resolving
- We can't trust the RCODE and stop resolving
- Stop minimisation when RCODE is not NOERROR
  - DONOT_MINIMISE_STATE: send full QNAME and original QTYPE
- Not conform RFC

Impact fall-back

- Stop on NXDOMAIN decreases privacy
  - Queries become visible
  - Active attacks possible but detectable

Signed zones fall-back

New in Unbound 1.5.9



qname-minimisation: no

qname-minimisation: yes

INIT_MINIMISE_STATE

dp change (referral or cname)

SKIP_MINIMISE_STATE

timeout

MINIMISE_STATE

next iteration

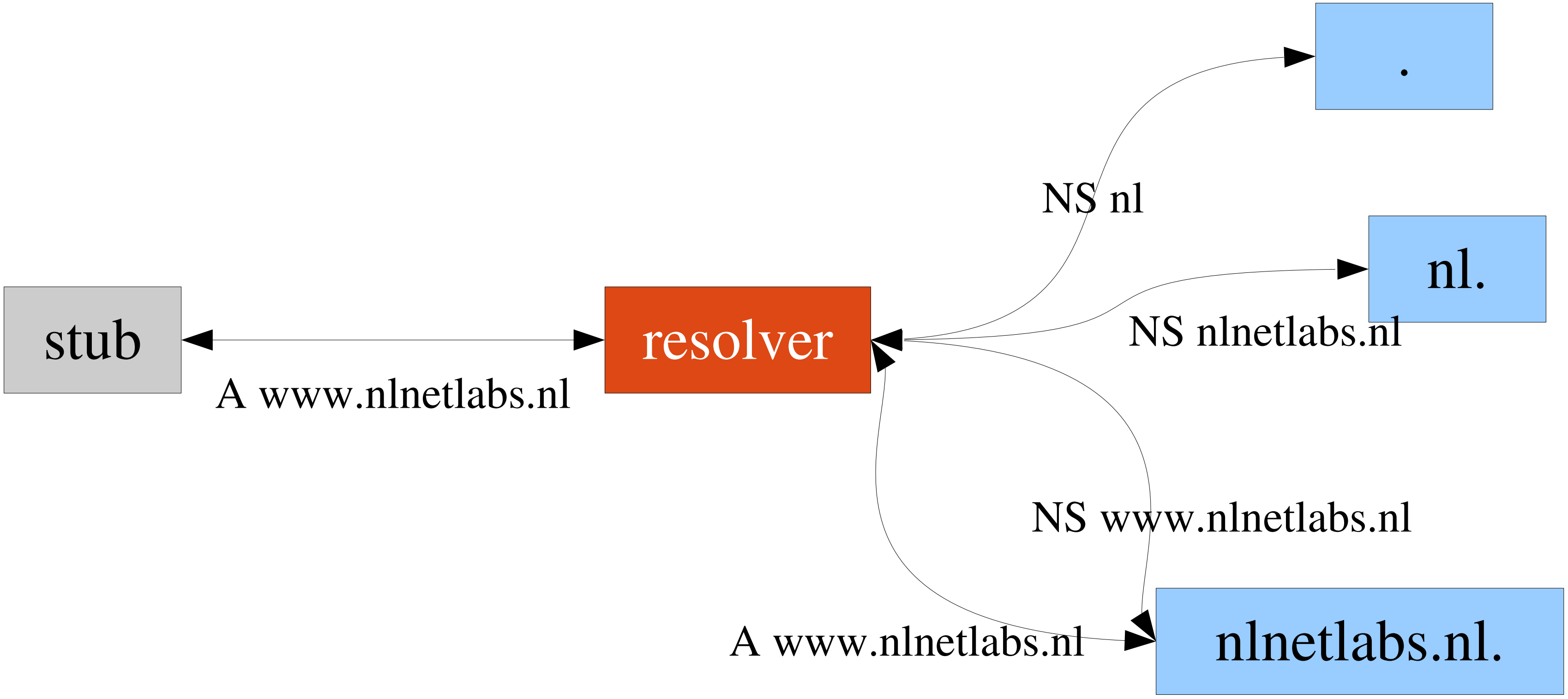
NXDOMAIN from signed zone

RCODE not NOERROR or last label

DONOT_MINIMISE_STATE

Done resolving

Number of queries



Number of queries - 2

- Without QNAME minimisation
  - Number of zones
- With QNAME minimisation
  - Total number of labels
    - original QNAME, delegations, CNAME, ...
  - + number of resolved delegations
  - +1 (original QTYPE query)
    - Except when QTYPE is DS or QTYPE is NS and QNAME not zone apex

Number of queries - 3

- AAAA www.ietf.org
  - 3 labels, 3 zones
  - NS:
    - ns1.ams1.afilias-nst.info.
      - 4 labels, 3 zones
      - +1 query for QTYPE=AAAA
  - CNAME:
    - www.ietf.org.cdn.cloudflare-dnssec.net.
      - 6 labels, 3 zones
      - +1 query for QTYPE=AAAA

9 vs 15 queries

Reverse IPv6

- nlnetlabs.nl reverse IPv6: 0.1.0.0.0.0.0.0.0.0.0.1.0.0.0.0.0.0. 0.0.0.0.0.0.0.9.b.4.0.a.2.ip6.arpa.
  - 4 zones
  - 34 labels

- Unbound 1.5.7 “solution”: increase IPv6 address by 8 labels every iteration. Start with ip6.arpa.

Other large zones

- DNSBL, Wildcards(!!)
- Unbound 1.5.9:
  - Limit QNAME minimisation iterations to 10
  - Always append one label for the first 4 queries
  - Example, QNAME with 18 labels, appended labels per iteration:
    - 1,1,1,1,2,2,2,2,3,3

Benefits

- Cache intermediate domain names
  - More specific NXDOMAIN cache
    - draft-vixie-dnsext-resimprove
    - draft-ietf-dnsop-nxdomain-cut
  - Improves privacy and performance
    - No need to perform lookup
    - No need to expose data

```
server:
   qname-minimisation: yes
   harden-below-nxdomain: yes
```

Benefits cont.

- Example queries:
  - Q1: b.nonexistent.
  - Q2: a.b.nonexistent.
  - Q3: c.nonexistent.
- With QNAME minimisation: Q3 NXDOMAIN from cache

Test

```
$ drill txt qnamemintest.internet.nl
```

```
"HOORAY - QNAME minimisation is
enabled on your resolver :)!"
```

```
"NO - QNAME minimisation is NOT
enabled on your resolver :(."
```

More to be done

- Only minimising data received by authoritative nameservers
- Not on resolvers!
- Not hiding data on the wire!
  - DPRIVE (stub to resolver)

Questions?