NLNETLABS

Willem Toorop

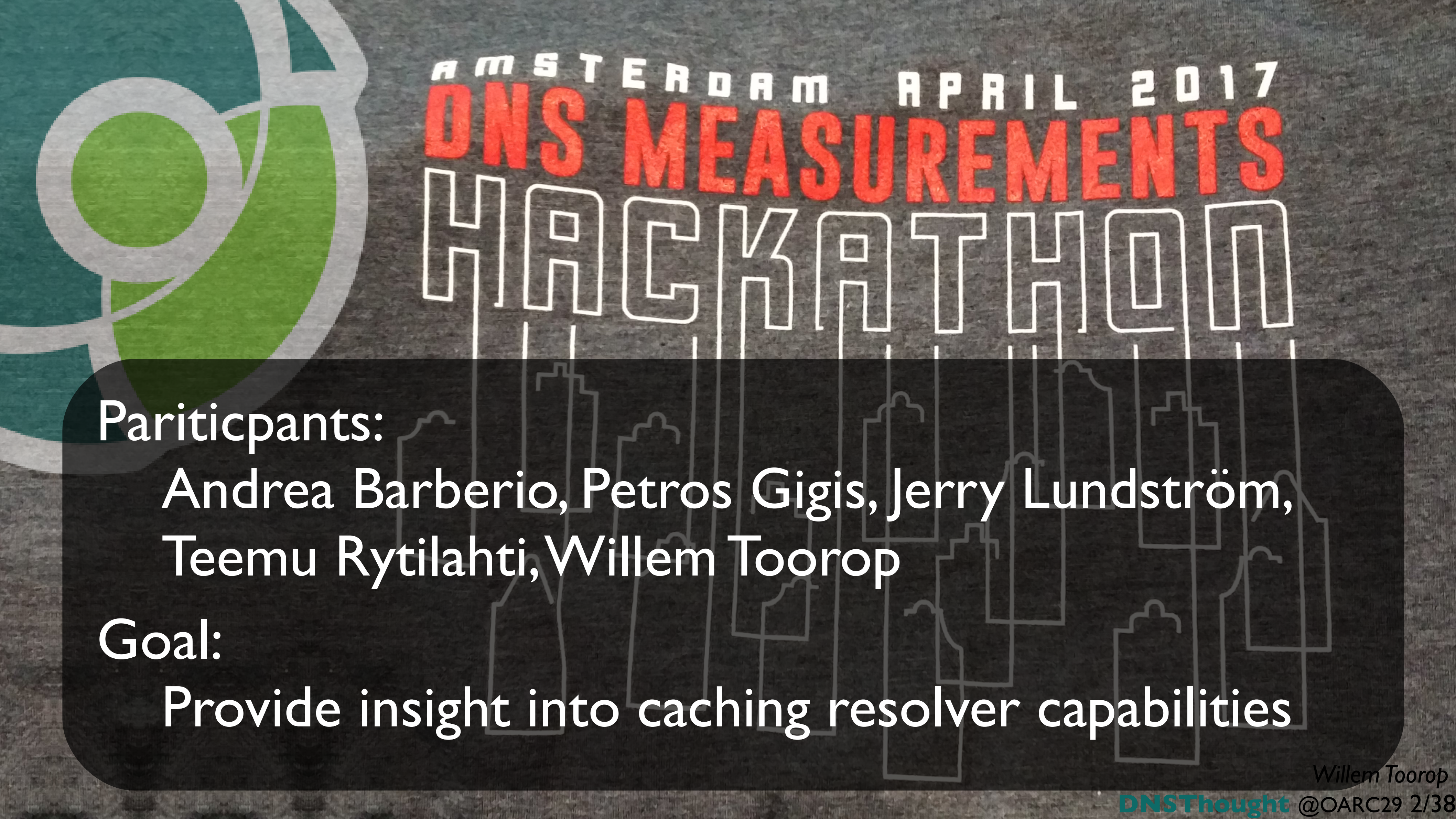
DNS-OARC 29

13 October 2018

Amsterdam

DNSThought

Everything you ever wanted to know about caching resolvers but were afraid to ask

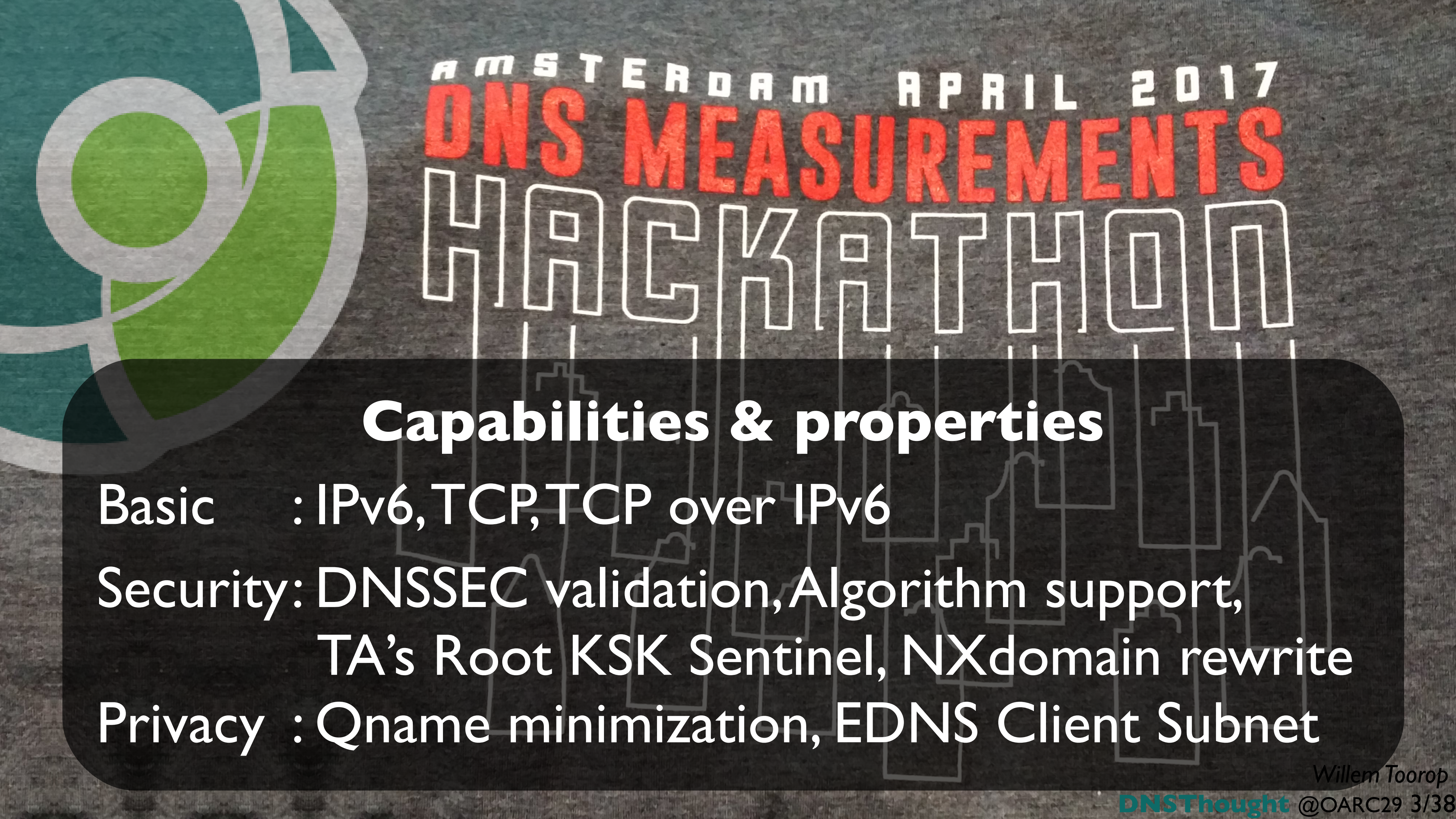


Pariticpants:

Andrea Barberio, Petros Gigis, Jerry Lundström,
Teemu Rytilahti, Willem Toorop

Goal:

Provide insight into caching resolver capabilities

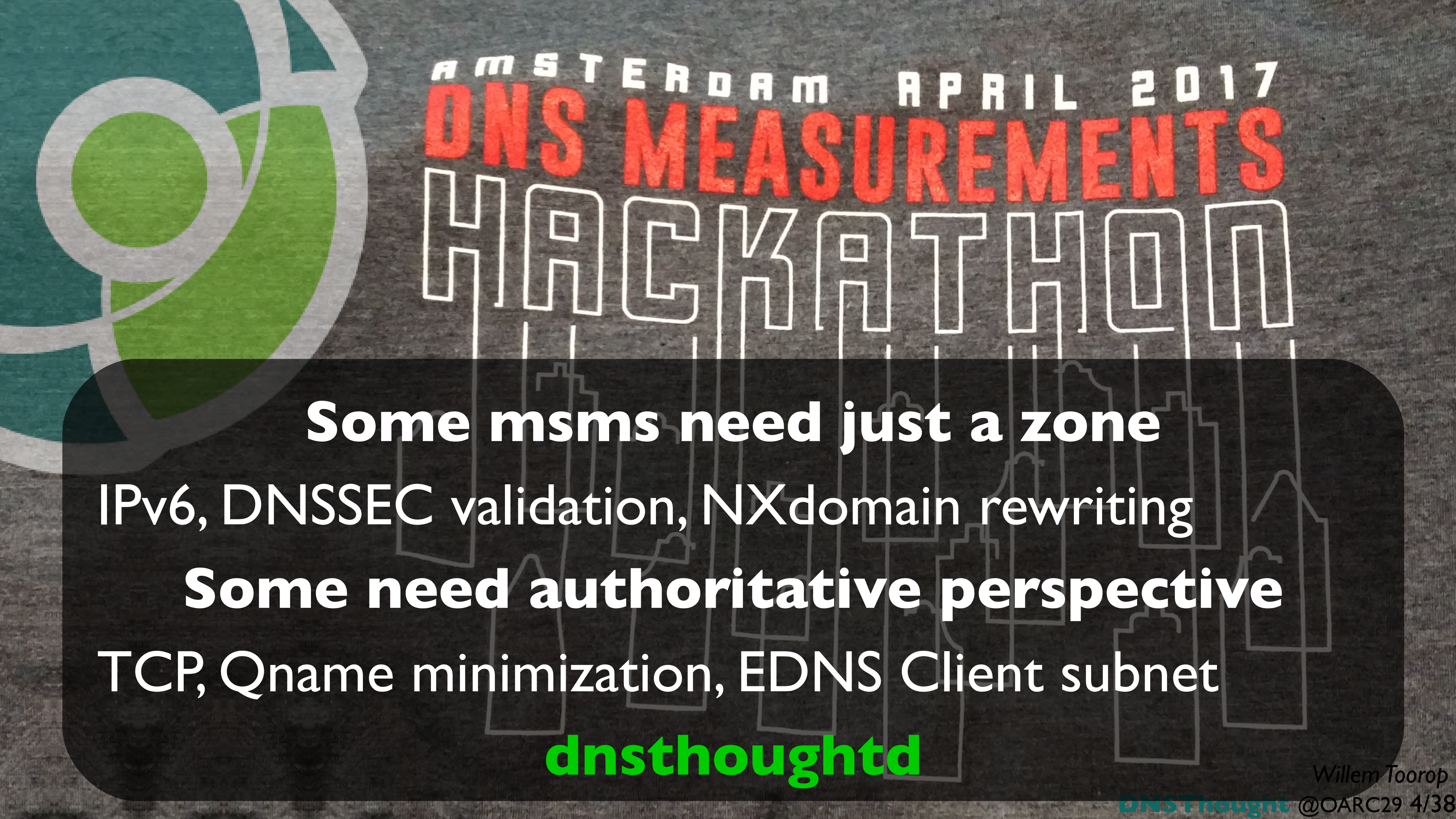


Capabilities & properties

Basic : IPv6, TCP, TCP over IPv6

Security: DNSSEC validation, Algorithm support,
TA's Root KSK Sentinel, NXdomain rewrite

Privacy : Qname minimization, EDNS Client Subnet



Some msms need just a zone

IPv6, DNSSEC validation, NXdomain rewriting

Some need authoritative perspective

TCP, Qname minimization, EDNS Client subnet

dnsthoughtd

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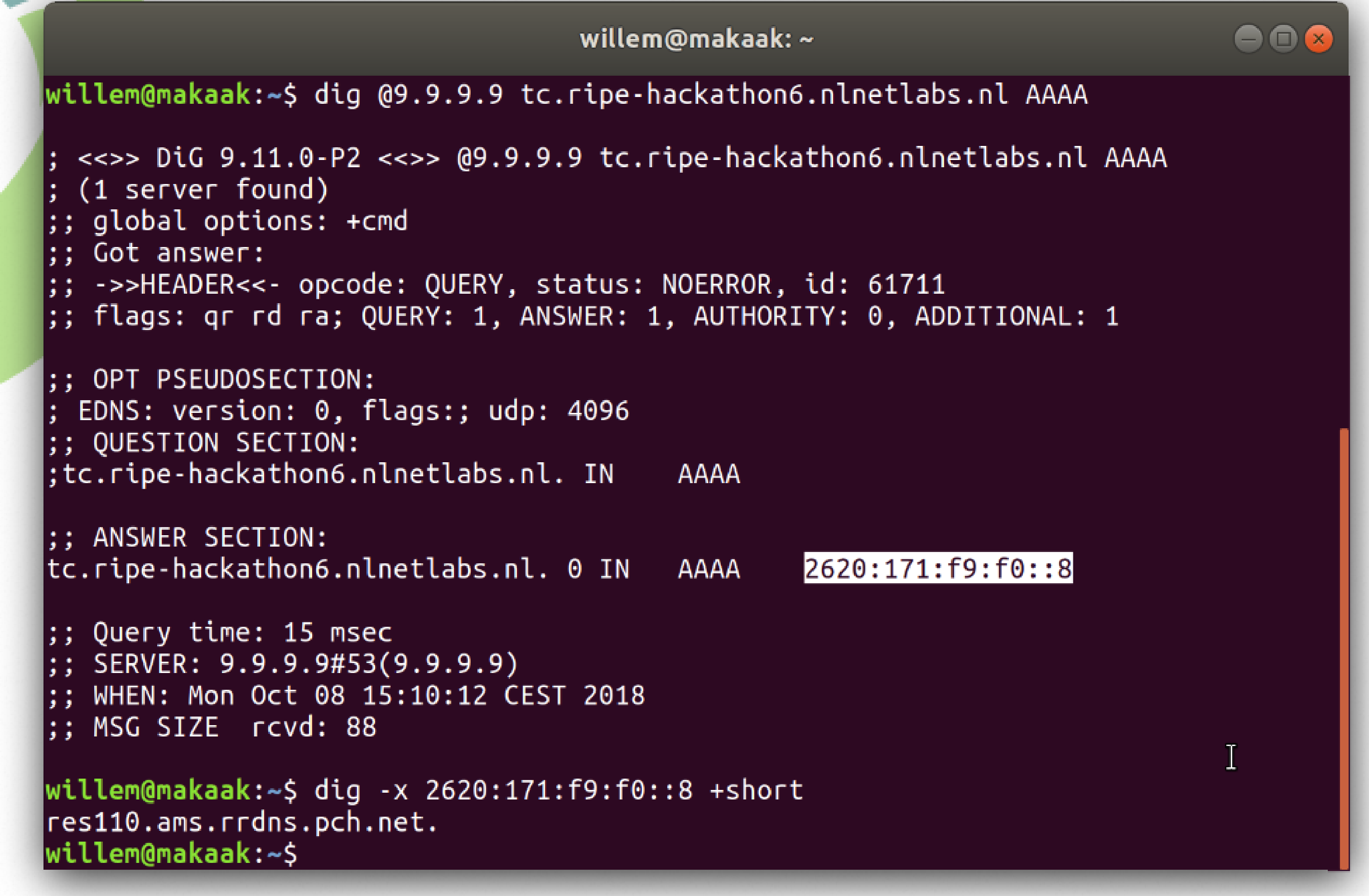
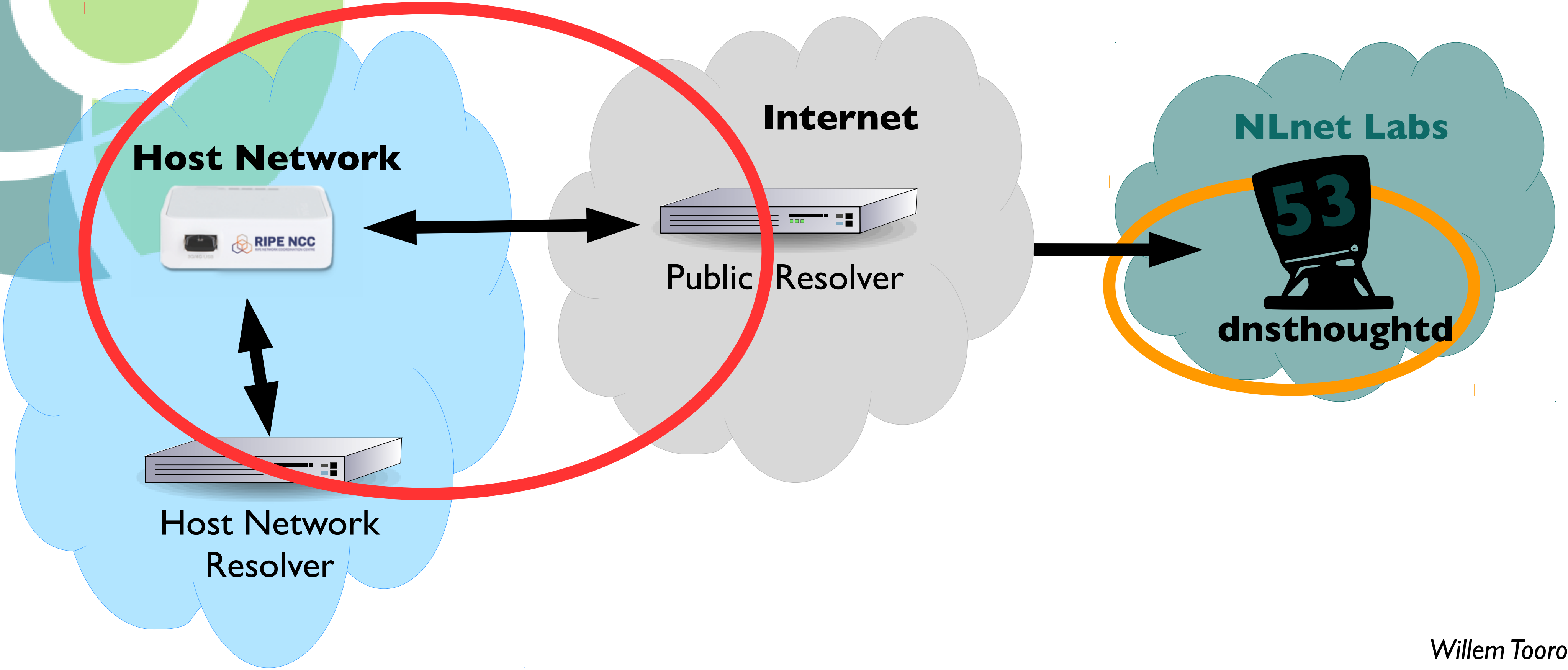


willem@makaak: ~

```
willem@makaak:~$ dig @9.9.9.9 tc.ripe-hackathon6.nlnetlabs.nl AAAA

; <<>> DiG 9.11.0-P2 <<>> @9.9.9.9 tc.ripe-hackathon6.nlnetlabs.nl AAAA
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 61711
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;tc.ripe-hackathon6.nlnetlabs.nl. IN    AAAA

;; ANSWER SECTION:
tc.ripe-hackathon6.nlnetlabs.nl. 0 IN   AAAA    2620:171:f9:f0::8

;; Query time: 15 msec
;; SERVER: 9.9.9.9#53(9.9.9.9)
;; WHEN: Mon Oct 08 15:10:12 CEST 2018
;; MSG SIZE  rcvd: 88

willem@makaak:~$ dig -x 2620:171:f9:f0::8 +short
res110.ams.rrdns.pch.net.
willem@makaak:~$
```

The RIPE Atlas perspective



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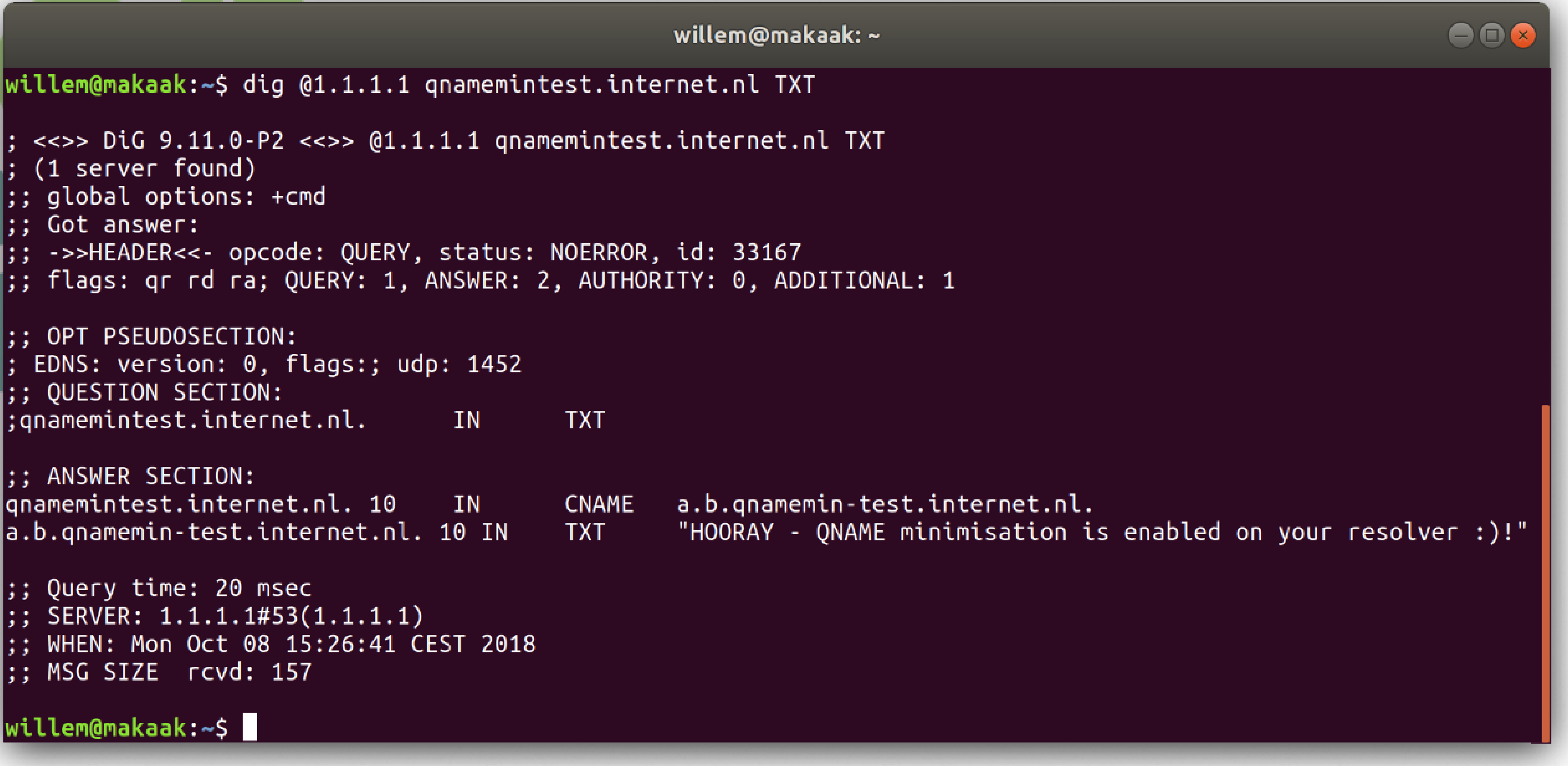
The RIPE Atlas perspective

	Probe ASN	Resolver ASN	Authoritative ASN
Internal	**X**	**=**	**X**
Forwarding	**X**	**X**	**Z**
	X	**Y**	**Z**
External	**X**	**Z**	**Z**

Qname minimization



```
willem@makaak:~$ dig @1.1.1.1 qnamemintest.internet.nl TXT

; <<>> DiG 9.11.0-P2 <<>> @1.1.1.1 qnamemintest.internet.nl TXT
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 33167
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1452
;; QUESTION SECTION:
;qnamemintest.internet.nl.      IN      TXT

;; ANSWER SECTION:
qnamemintest.internet.nl. 10    IN      CNAME   a.b.qnamemin-test.internet.nl.
a.b.qnamemin-test.internet.nl. 10 IN    TXT     "HOORAY - QNAME minimisation is enabled on your resolver :)!"

;; Query time: 20 msec
;; SERVER: 1.1.1.1#53(1.1.1.1)
;; WHEN: Mon Oct 08 15:26:41 CEST 2018
;; MSG SIZE  rcvd: 157

willem@makaak:~$ 
```

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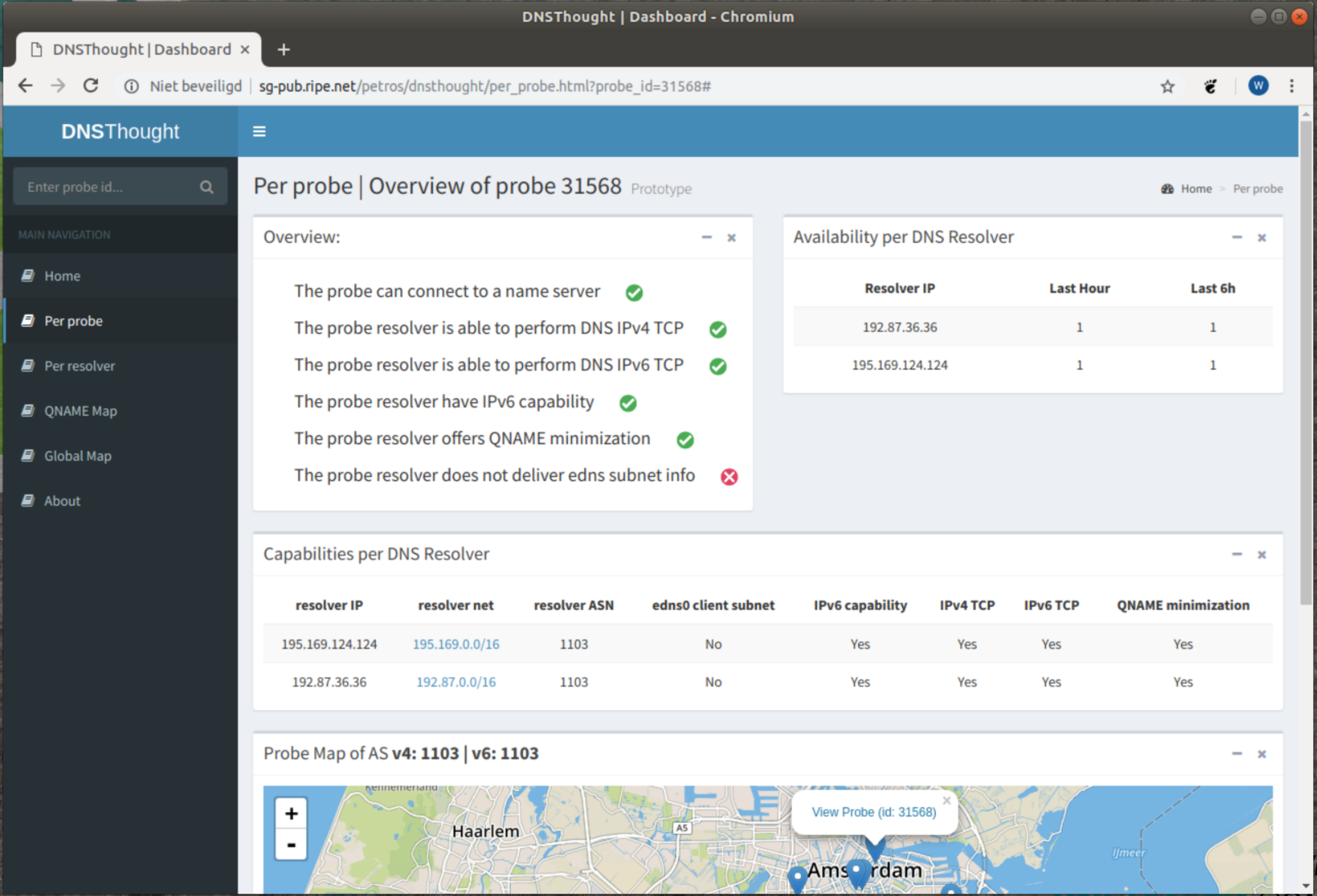
Measurements for all probes every hour

query	msm ID
`<prb_id>.<time>.ripe-hackathon6.nlnetlabs.nl AAAA`	8310366
`<prb_id>.<time>.tc.ripe-hackathon4.nlnetlabs.nl A`	8310360
`<prb_id>.<time>.tc.ripe-hackathon6.nlnetlabs.nl AAAA`	8310364
`qnamemintest.internet.nl TXT`	8310250
`nxdomain.ripe-hackathon2.nlnetlabs.nl A`	8311777
`whoami.akamai.net A`	8310245
`o-o.myaddr.l.google.com TXT`	8310237
`secure.ripe-hackathon2.nlnetlabs.nl A`	8311760
`bogus.ripe-hackathon2.nlnetlabs.nl A`	8311763

Thank you Emile Aben! ♥



Per probe | Overview of probe 31568 Prototype

Overview:

- The probe can connect to a name server ✓
- The probe resolver is able to perform DNS IPv4 TCP ✓
- The probe resolver is able to perform DNS IPv6 TCP ✓
- The probe resolver have IPv6 capability ✓
- The probe resolver offers QNAME minimization ✓
- The probe resolver does not deliver edns subnet info ✗

Availability per DNS Resolver

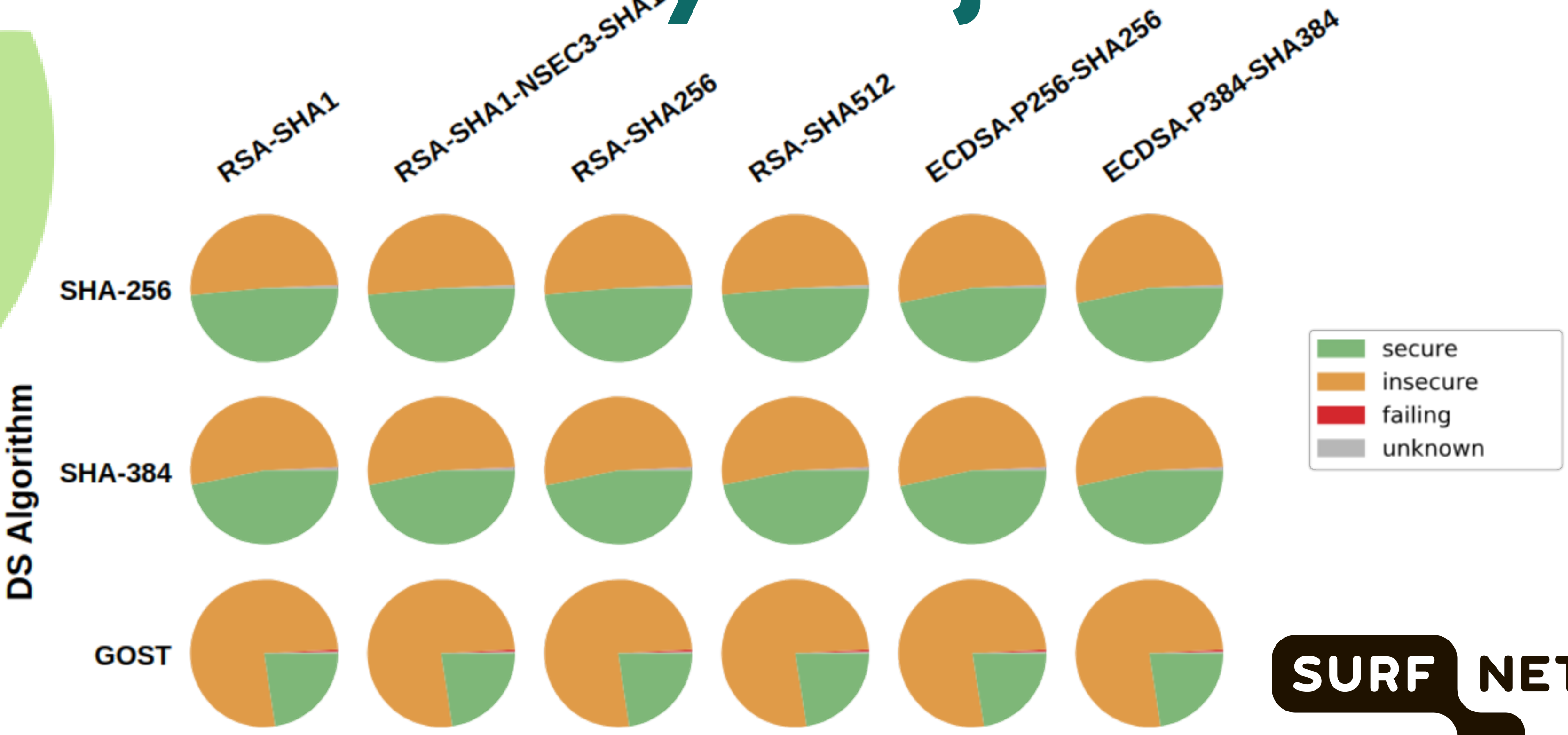
Resolver IP	Last Hour	Last 6h
192.87.36.36	1	1
195.169.124.124	1	1

Capabilities per DNS Resolver

resolver IP	resolver net	resolver ASN	edns0 client subnet	IPv6 capability	IPv4 TCP	IPv6 TCP	QNAME minimization
195.169.124.124	195.169.0.0/16	1103	No	Yes	Yes	Yes	Yes
192.87.36.36	192.87.0.0/16	1103	No	Yes	Yes	Yes	Yes

Probe Map of AS **v4: 1103 | v6: 1103**

Root Canary Project



- Participation with Roland van Rijswijk - Deij
- Measurements started 20 June 2017

More measurements

- Moritz Muller joined too
- Root KSK Sentinel msms since 19 July 2018

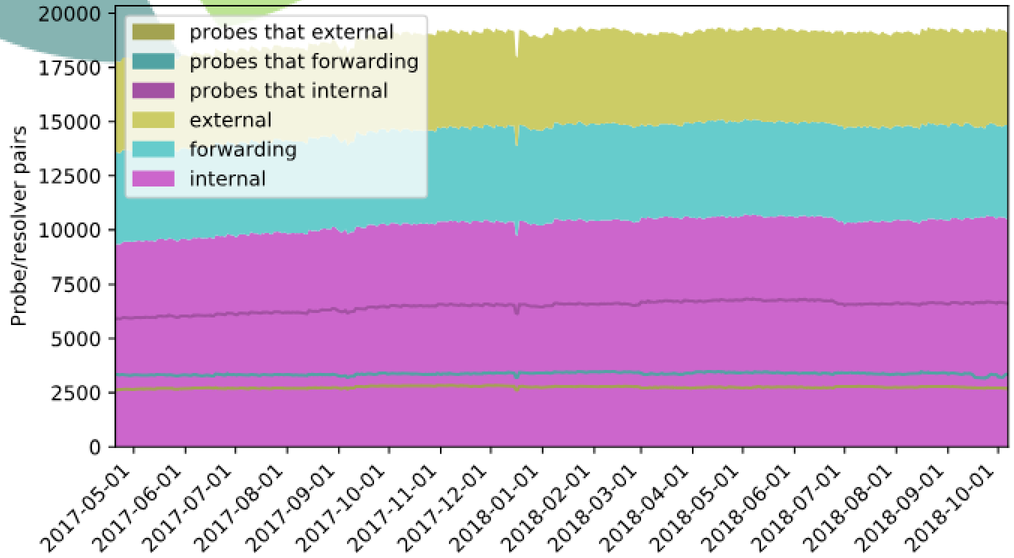
query	msm ID
`root-key-sentinel-not-ta-19036.d2a8n3.rootcanary.net A`	15283670
`root-key-sentinel-not-ta-20326.d2a8n3.rootcanary.net A`	15283671

With validating resolvers we have three situations:
1. Key 20326 has not been picked up (yet)
2. Key 20326 is a valid TA, and key 19036 is still a valid TA
3. Key 20326 is a valid TA, and key 19036 is removed
For these situations (1, 2,3), measurements for:
- (not-ta-19036 is-ta-20326) results in   1: (S S), 2: (S A), 3: (A A)
- (is-ta-19036 is-ta-20326) results in   1: (A S), 2: (A A), 3: (S A)
- (not-ta-19036 not-ta-20326) results in   1: (S A), 2: (S S), 3: (A S)
- (is-ta-19036 not-ta-20326) results in   1: (A A), 2: (A S), 3: (S S)

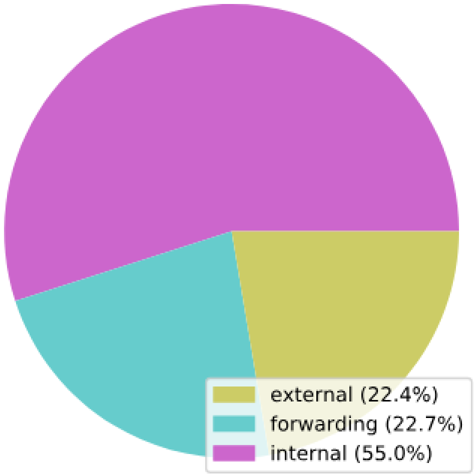
1½ years of measurements

Internal, Forwarding & External

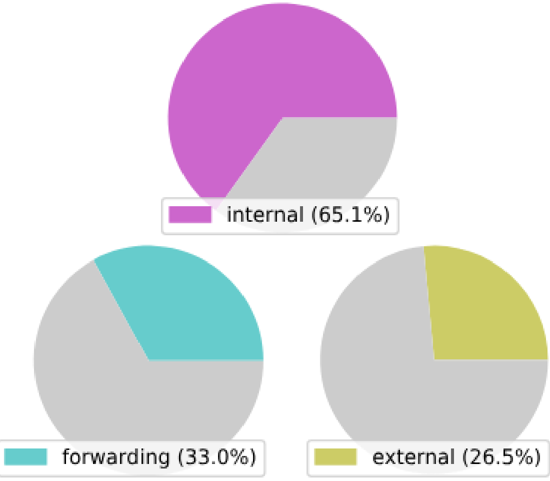
https://dnsthought.nlnetlabs.nl/#int_fwd_ext



with 19082 resolvers

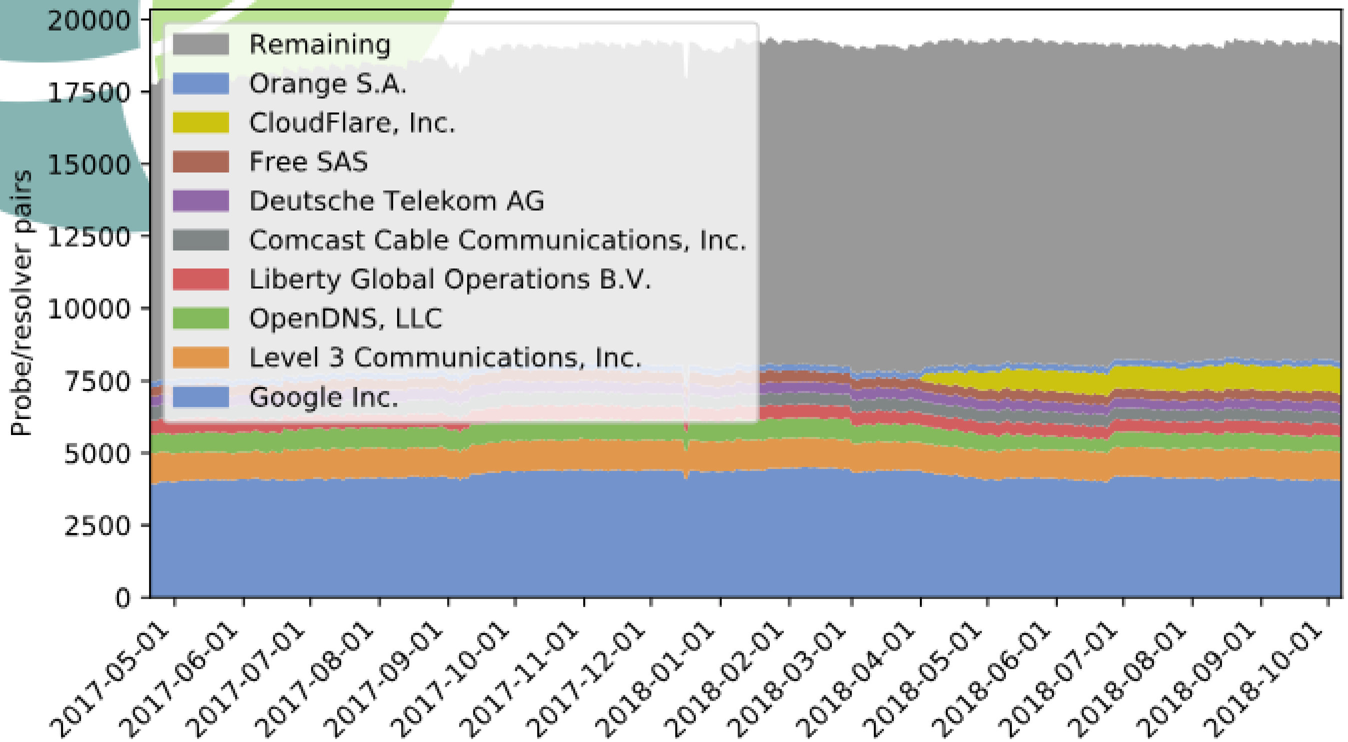


with 10155 probes

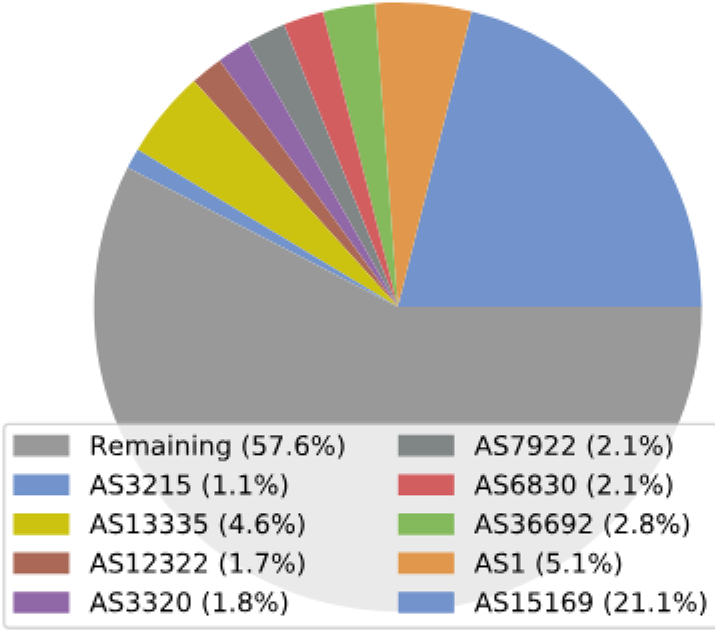


1½ years of measurements
Top 10 ASNs seen @ authoritative

https://dnsthought.nlnetlabs.nl/#top_auth_asns



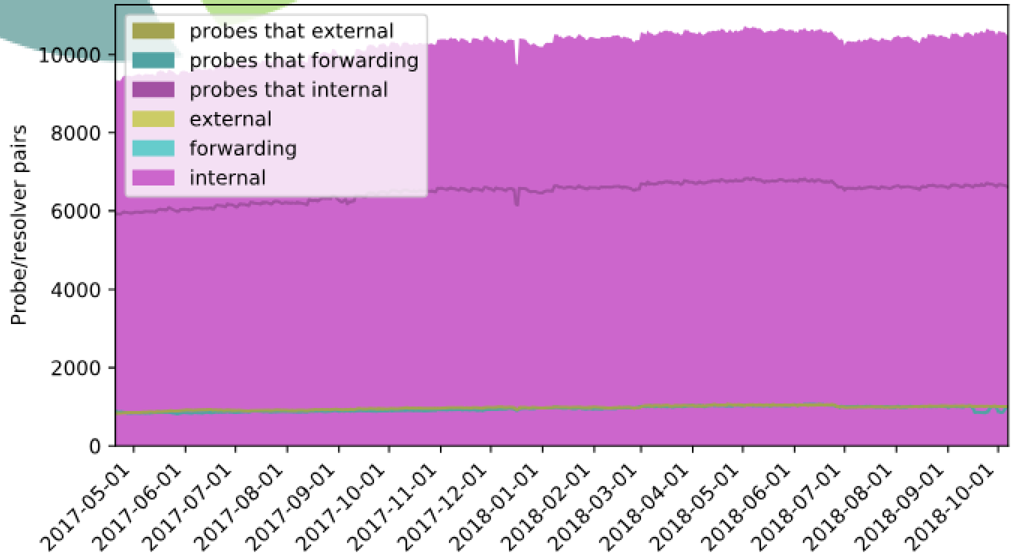
with 19082 resolvers



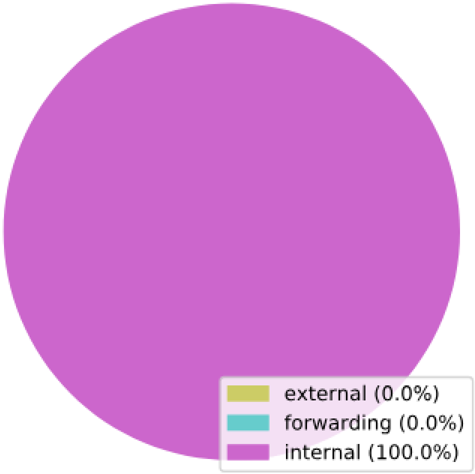
Internal

have the same ASN as the probe (internal)

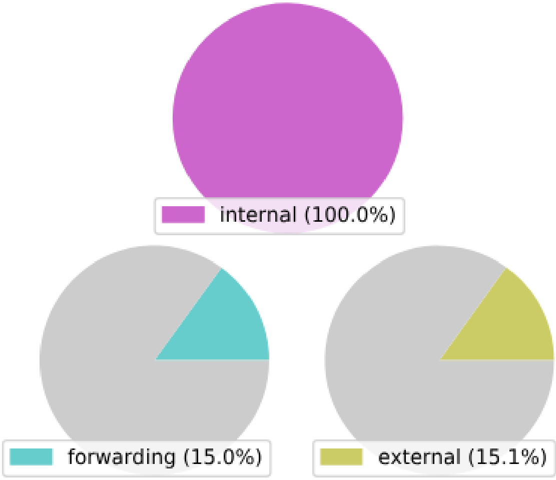
https://dnsthought.nlnetlabs.nl/is_internal/#int_fwd_ext



with 10490 resolvers



with 6611 probes



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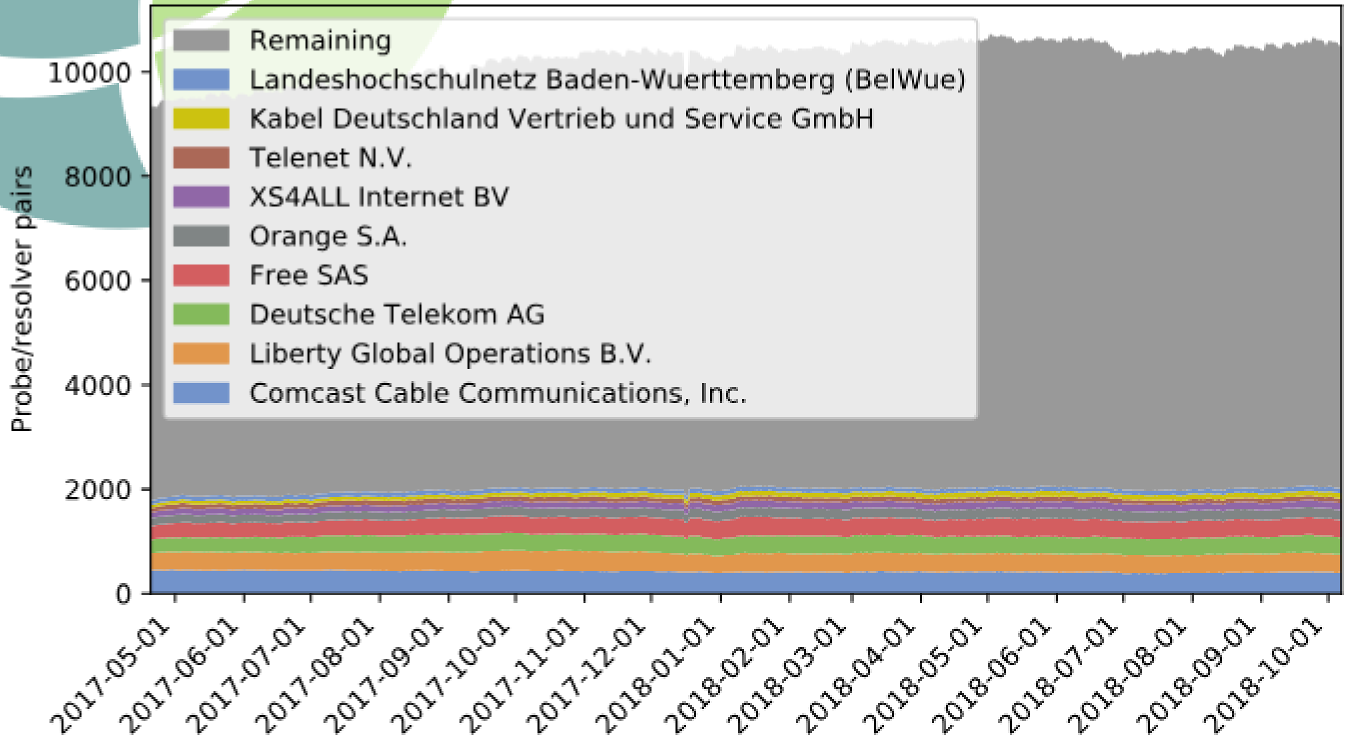
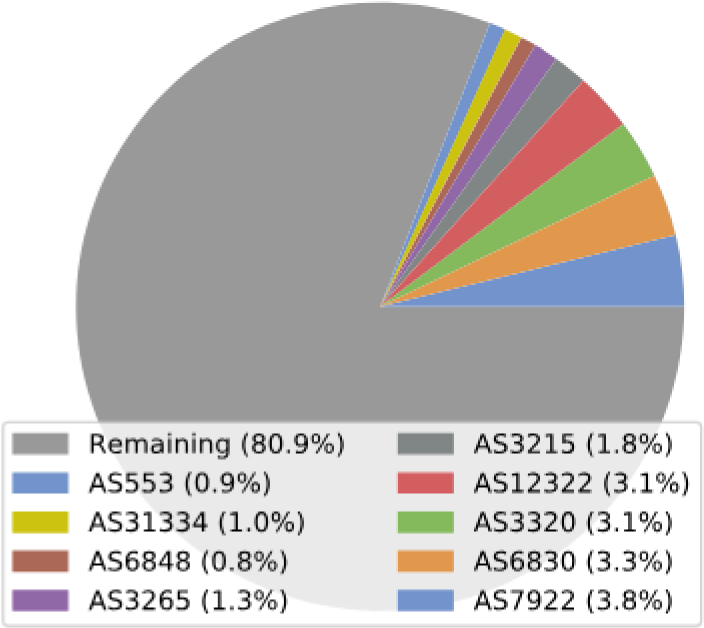
have the same ASN as the probe (internal)
https://dnsthought.nlnetlabs.nl/is_internal/#top_auth_asns

Internal

Top 10 ASNs seen @ authoritative

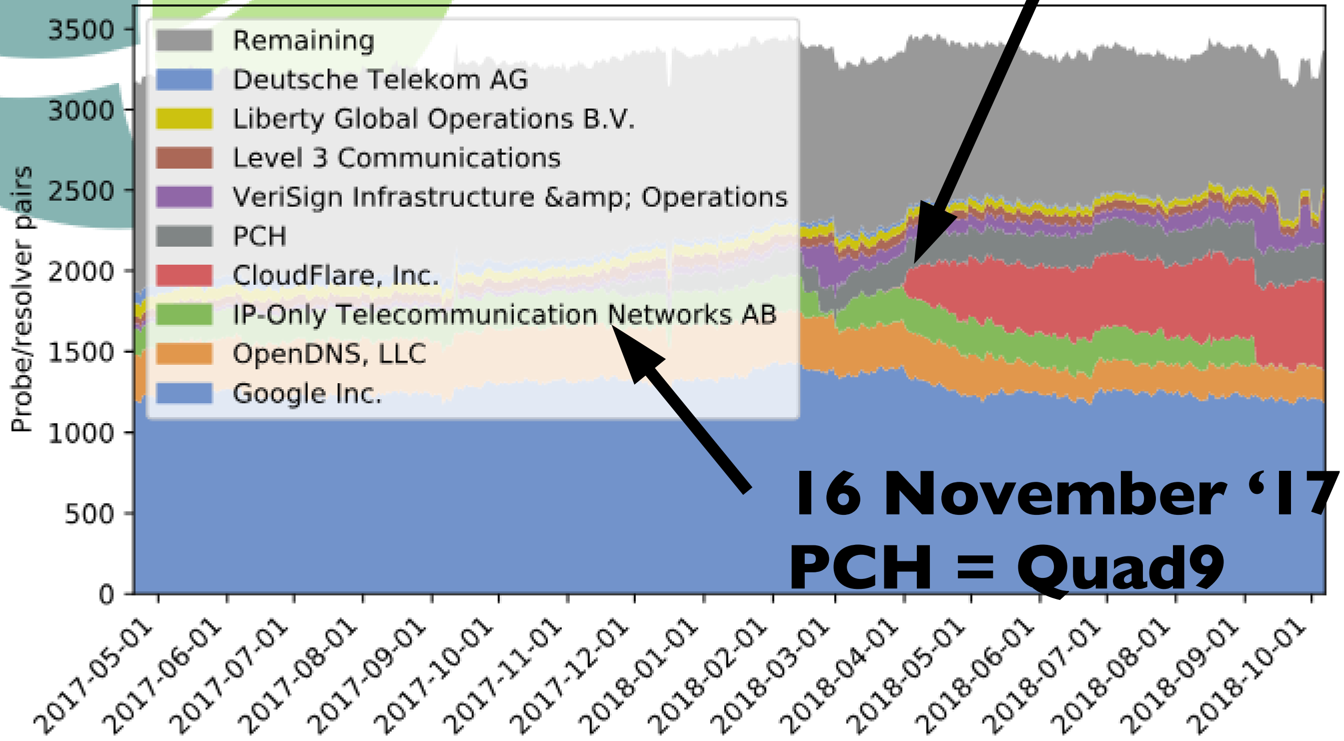


with 10490 resolvers



forwarding to a resolver with a different ASN
https://dnsthought.nlnetlabs.nl/is_forwarding/#top_auth_asns

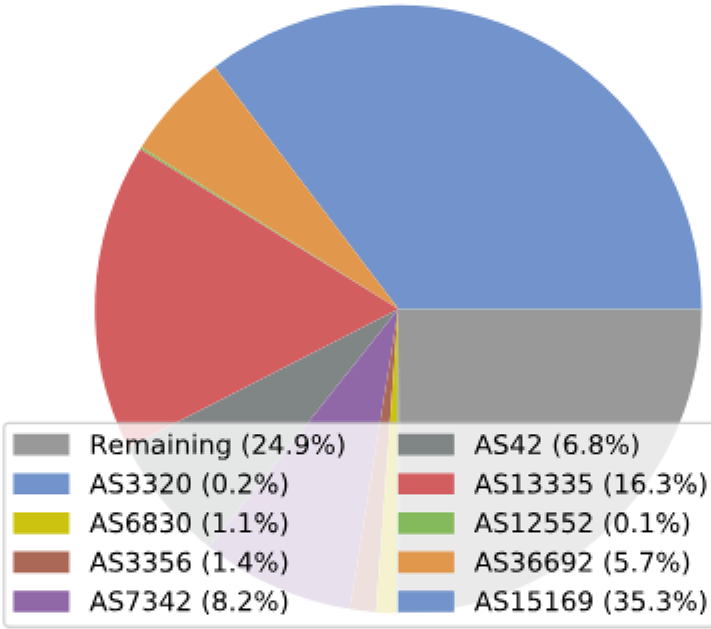
Forwarding
Top 10 ASNs seen @ authoritative



1st April 2018

16 November '17
PCH = Quad9

with 3351 resolvers



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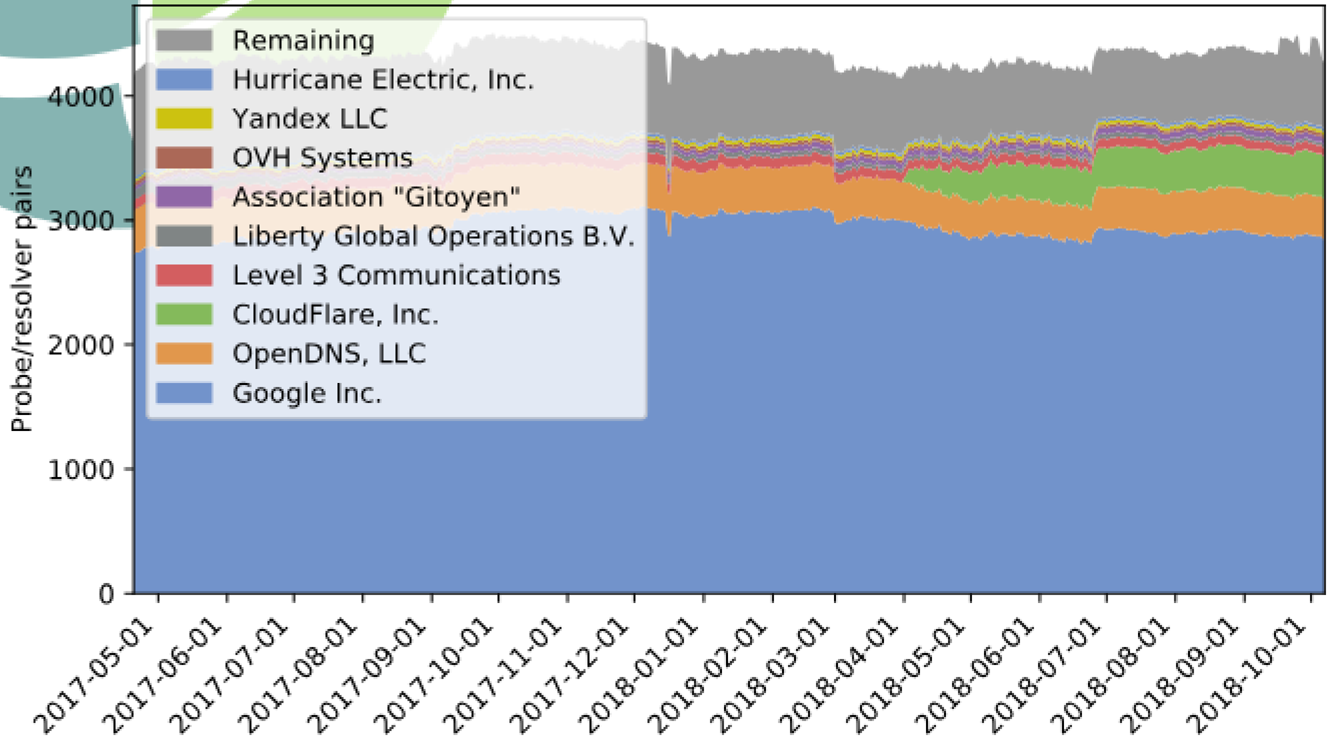
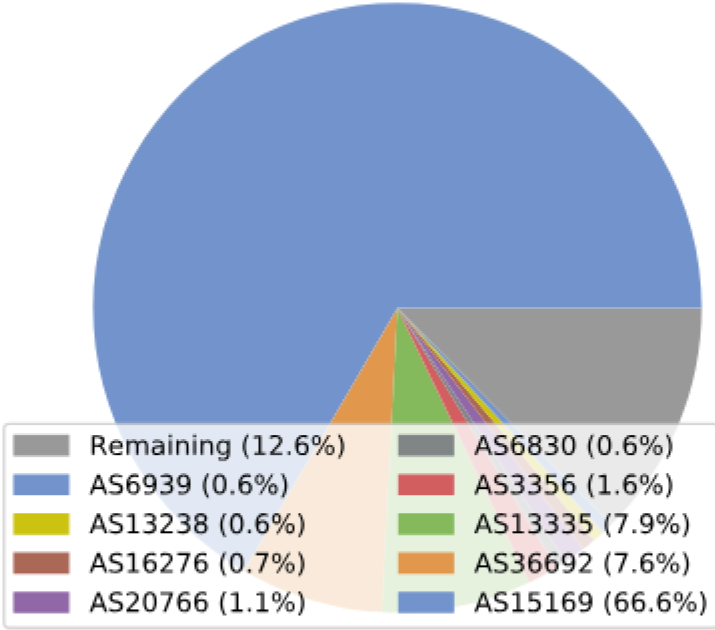
have a ASN different from the probe ASN
https://dnsthought.nlnetlabs.nl/is_external/#top_auth_asns

External
Top 10 ASNs seen @ authoritative



with 4266 resolvers

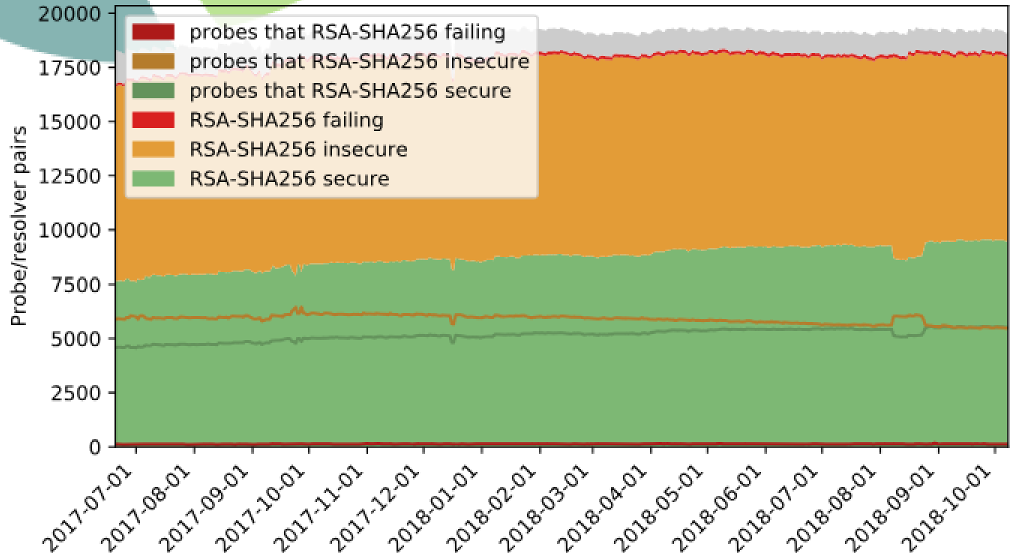


Internal, Forwarding, External

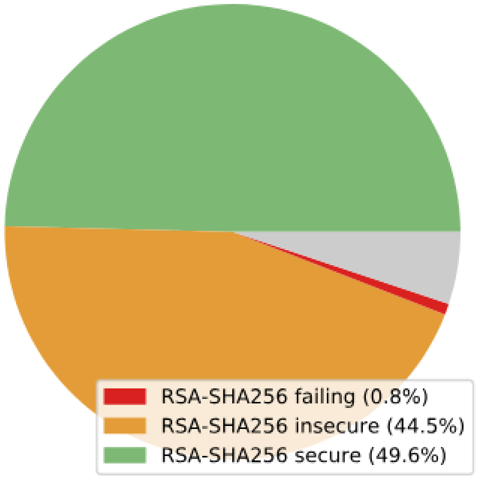
Diversity

DNSSEC
RSA-SHA256 support

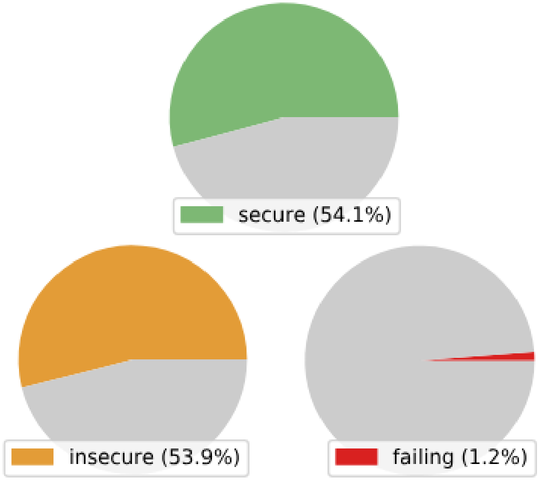
https://dnsthought.nlnetlabs.nl/#rsasha256



with 19135 resolvers



with 10178 probes



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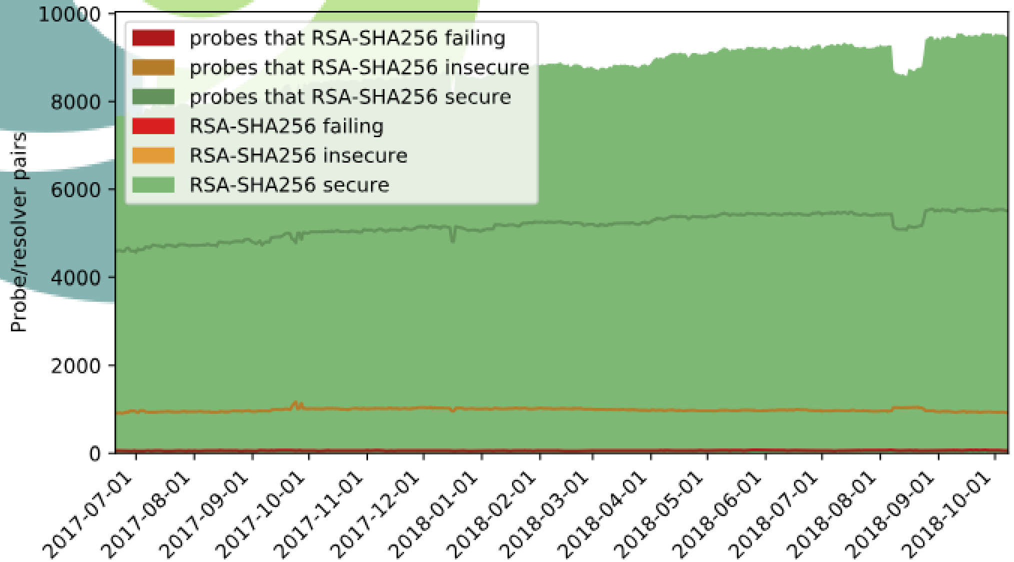
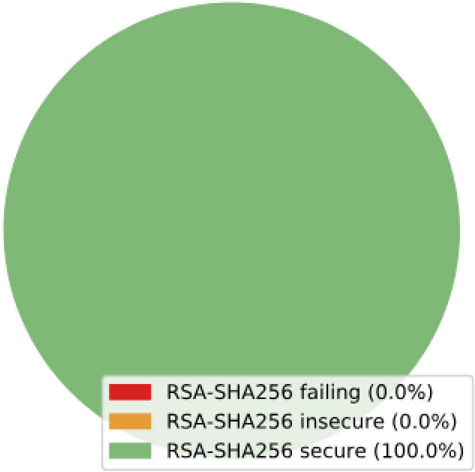
DNSSEC RSA-SHA256 support

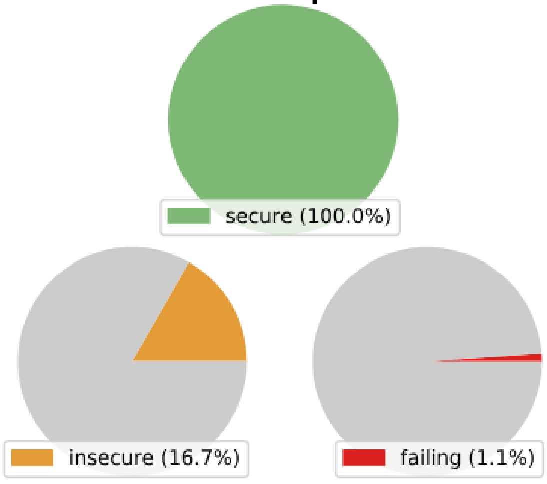
validate DNSKEY algorithm RSA-SHA256
https://dnsthought.nlnetlabs.nl/can_rsasha256/#rsasha256



with 9493 resolvers



with 5508 probes



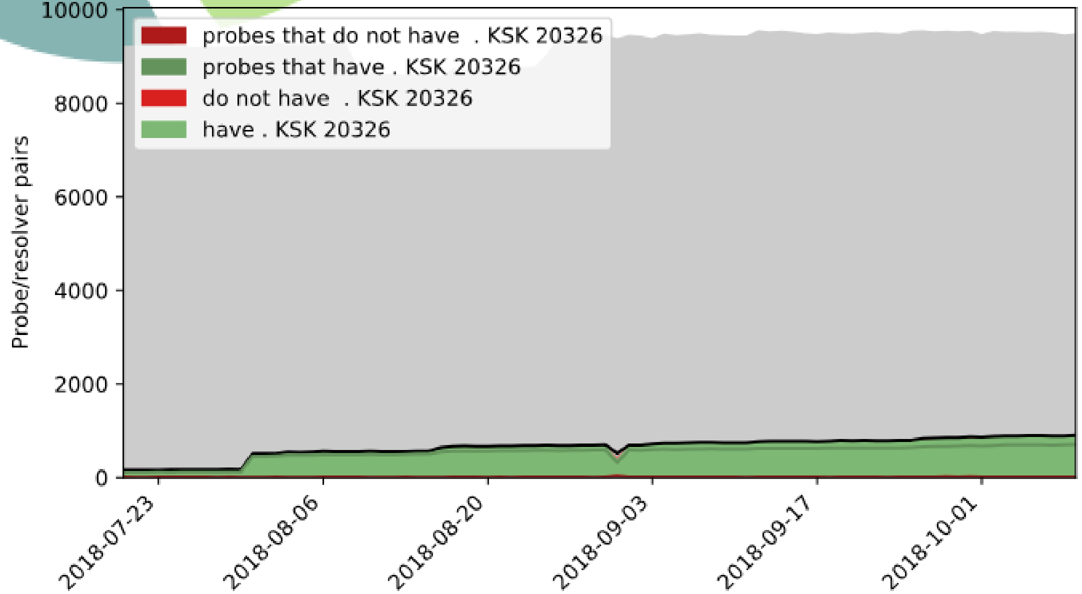
- 54.1% of probes has validating resolver
- 16.7% of those have a non validating resolver too
- So realistically only 45.1% of probes is protected

validate DNSKEY algorithm RSA-SHA256

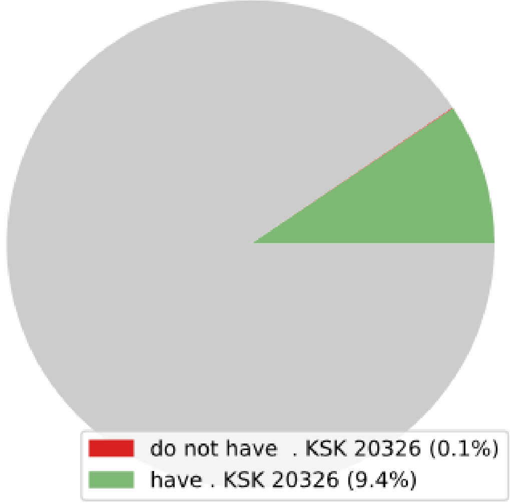
https://dnsthought.nlnetlabs.nl/can_rsasha256/#ta_20326

DNSSEC

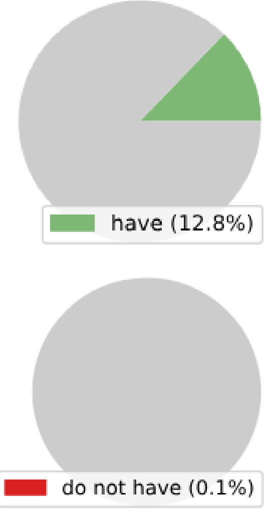
Root Key Trust Anchor Sentinel



with 9493 resolvers



with 5508 probes

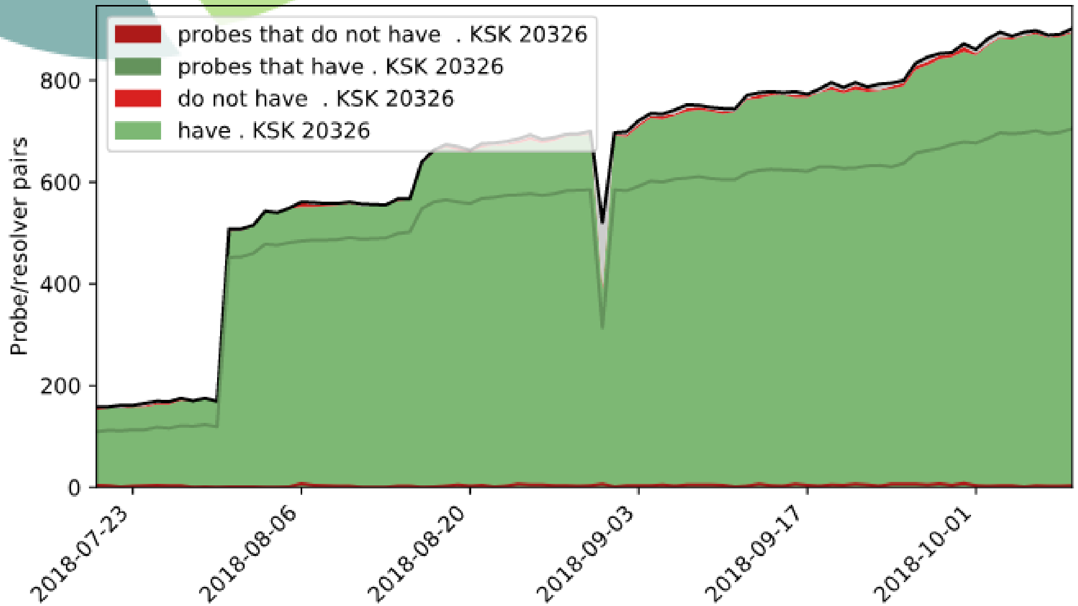


DNSSEC

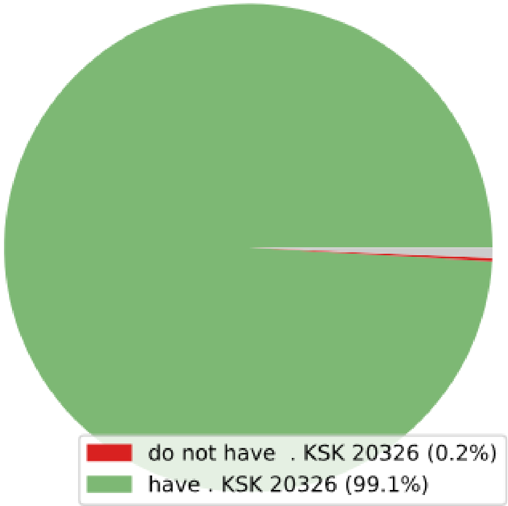
root KSK sentinel support

https://dnsthought.nlnetlabs.nl/has_ta_19036/#ta_20326

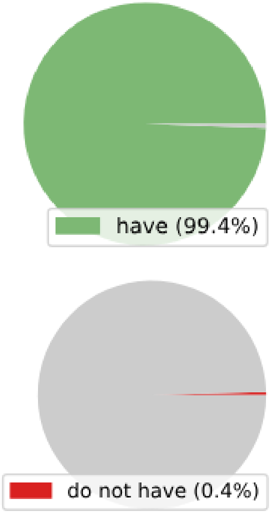
Root Key Trust Anchor Sentinel



with 902 resolvers



with 709 probes



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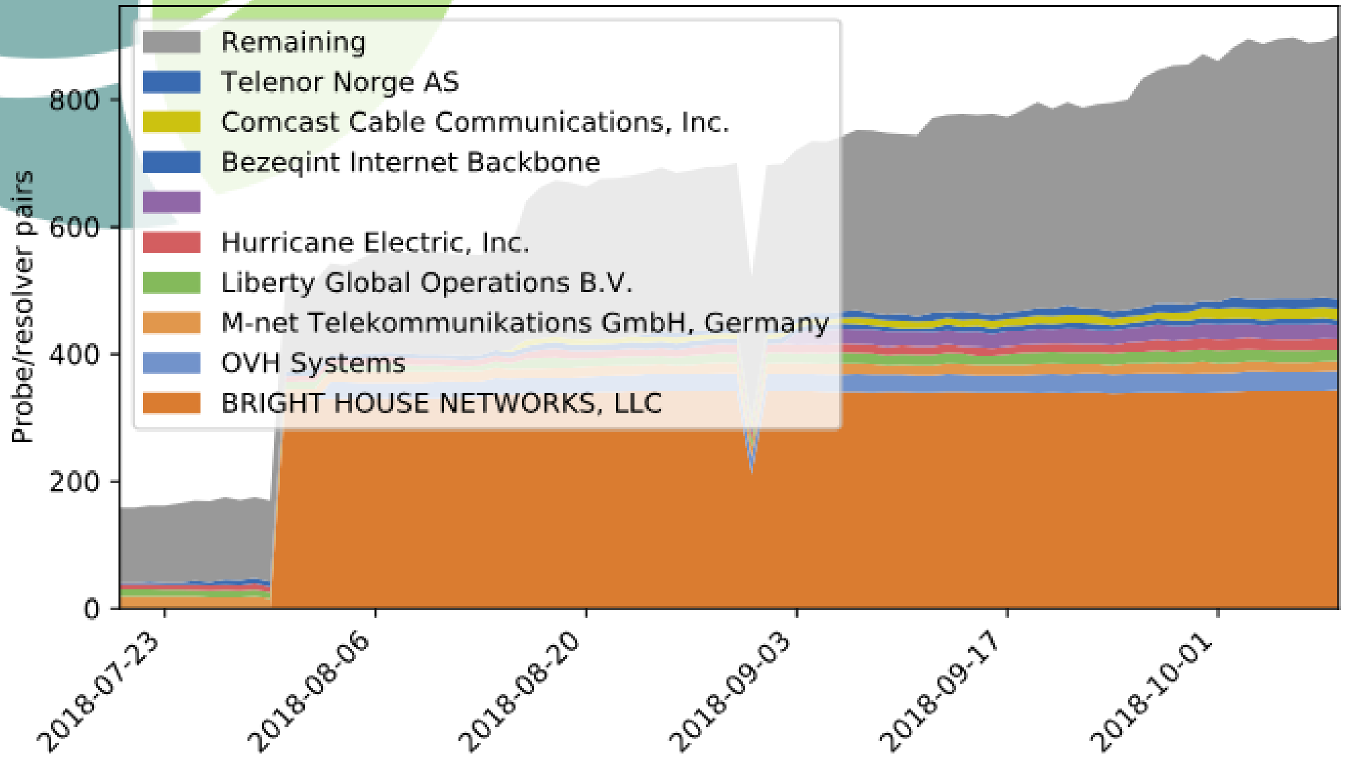
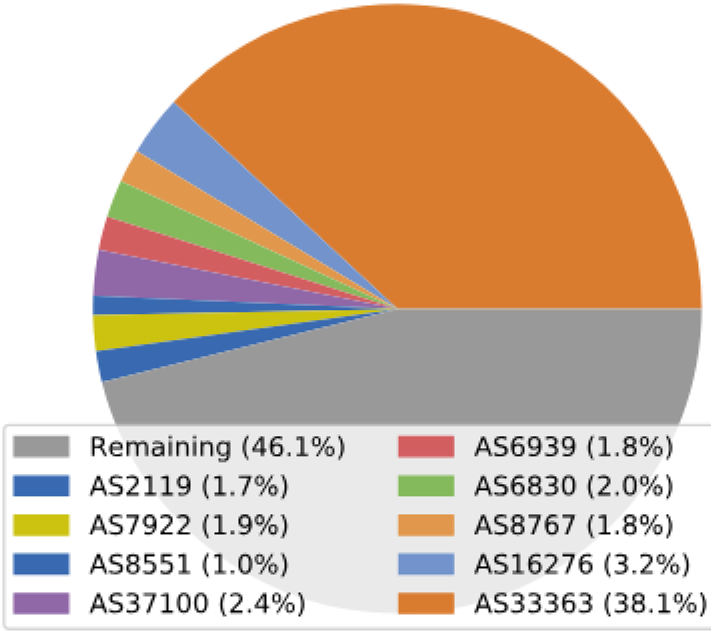
root KSK sentinel support
https://dnsthought.nlnetlabs.nl/has_ta_19036/#top_resolver_asns

DNSSEC

Root Key Trust Anchor Sentinel



with 902 resolvers
In 709 probes



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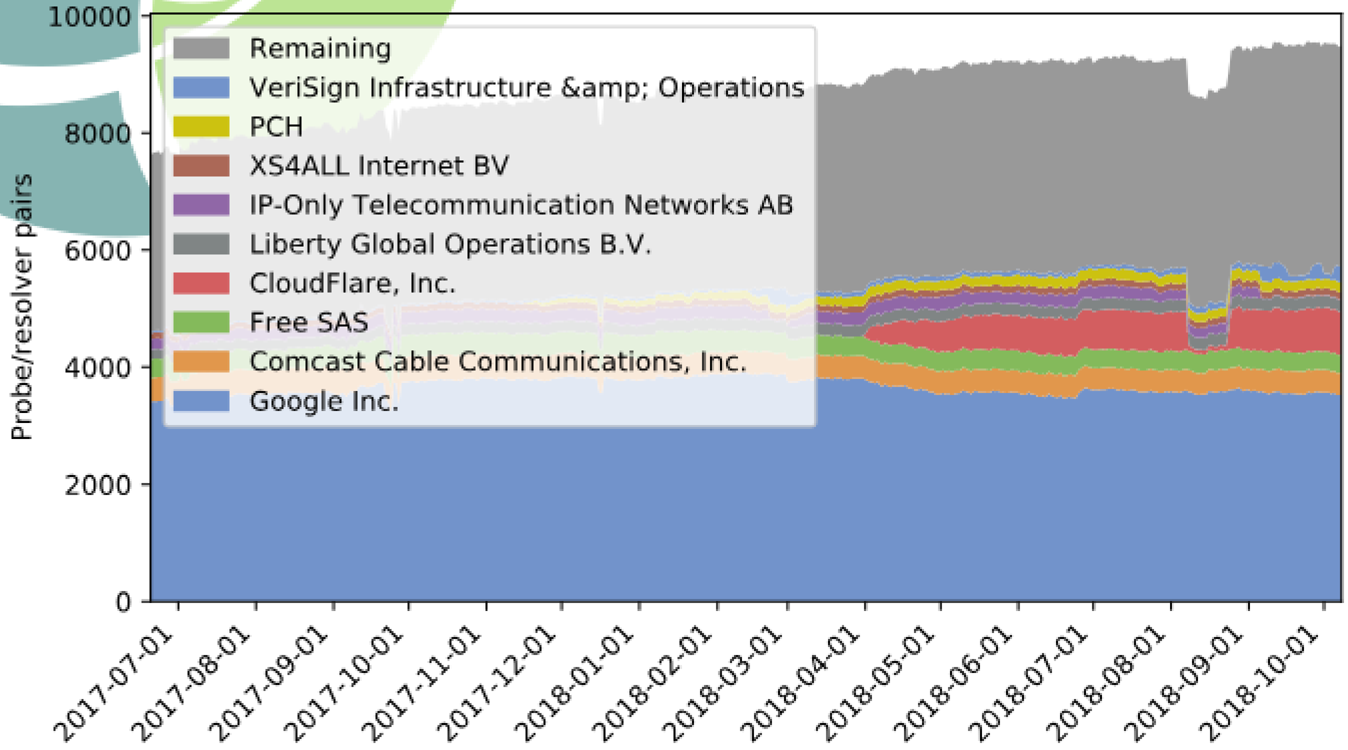
DNSSEC

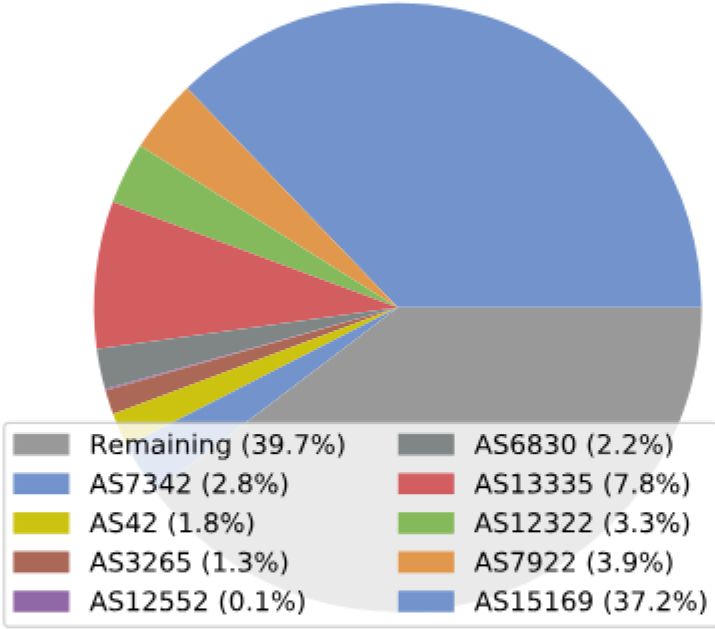
Strange dent in August

validate DNSKEY algorithm RSA-SHA256

https://dnsthought.nlnetlabs.nl/can_rsasha256/#top_auth_asns



with 9493 resolvers
In 5508 probes

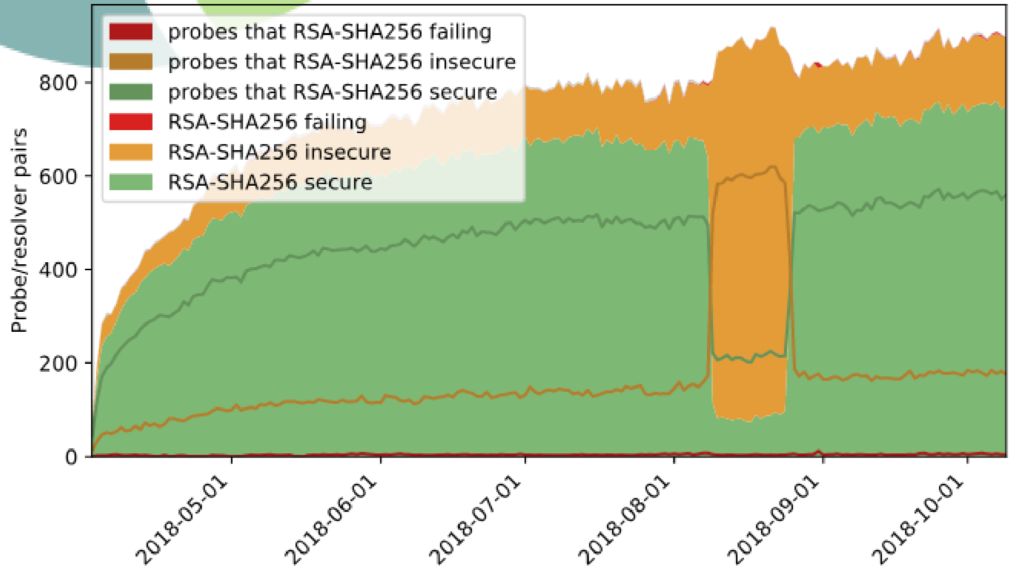


coming from AS13335

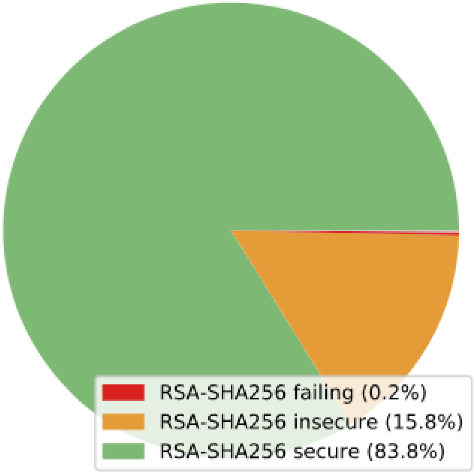
https://dnsthought.nlnetlabs.nl/auth_AS13335/#rsasha256

DNSSEC

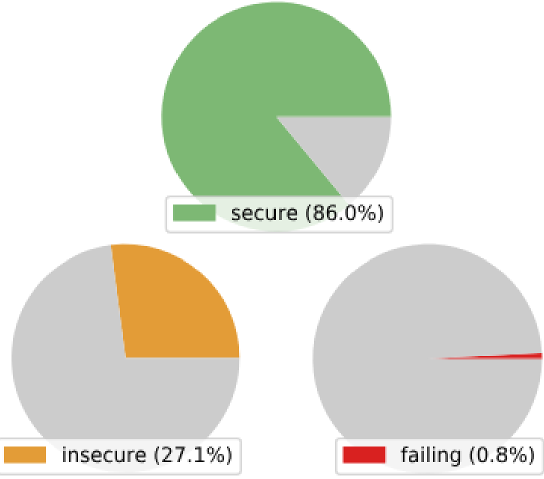
Strange dent in August



with 897 resolvers



with 650 probes

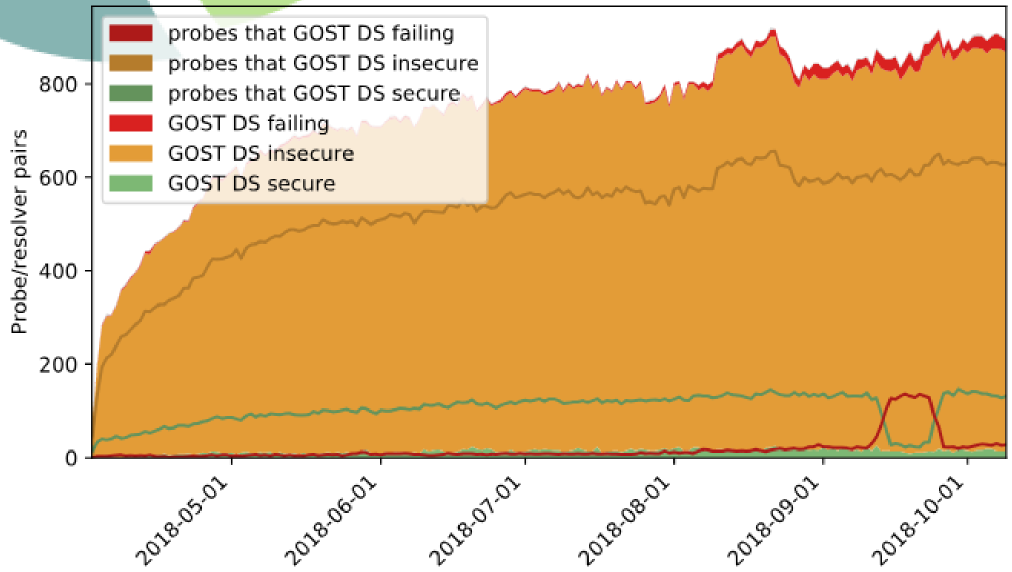


coming from AS13335

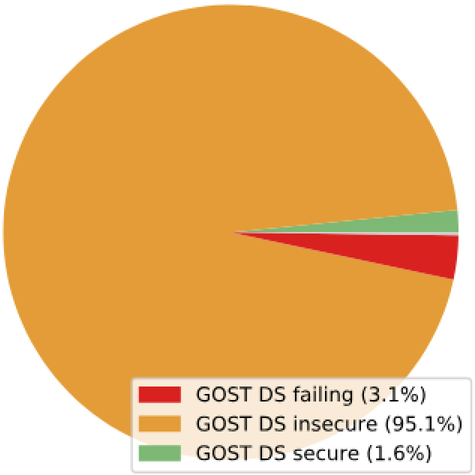
https://dnsthought.nlnetlabs.nl/auth_AS13335/#gost

DNSSEC

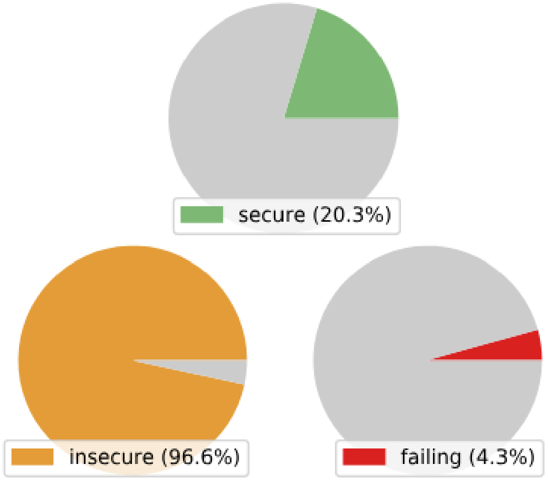
Strange broken GOST DS in September



with 897 resolvers



with 650 probes



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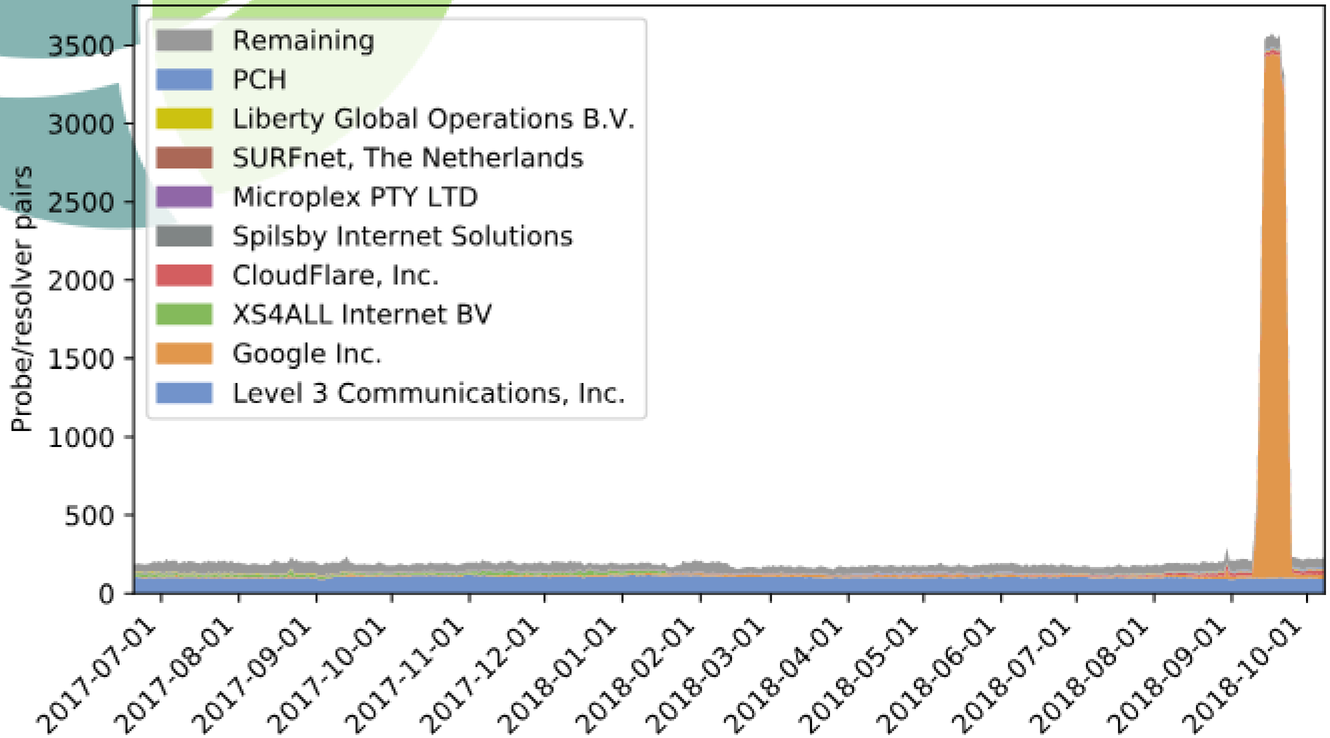
DNSThought @OARC29

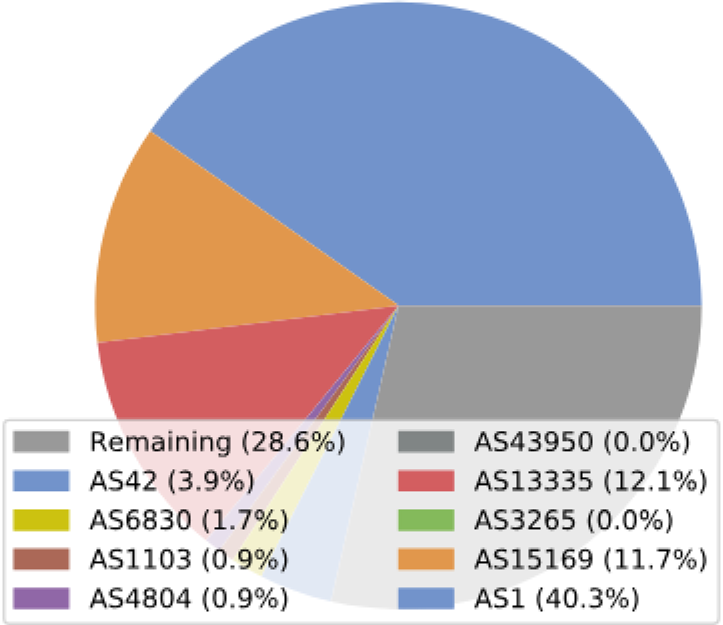
broken DS algorithm GOST validation support
https://dnsthought.nlnetlabs.nl/broken_gost/#top_auth_asns

DNSSEC

Strange broken GOST DS in September

with 231 resolvers
in 185 probes

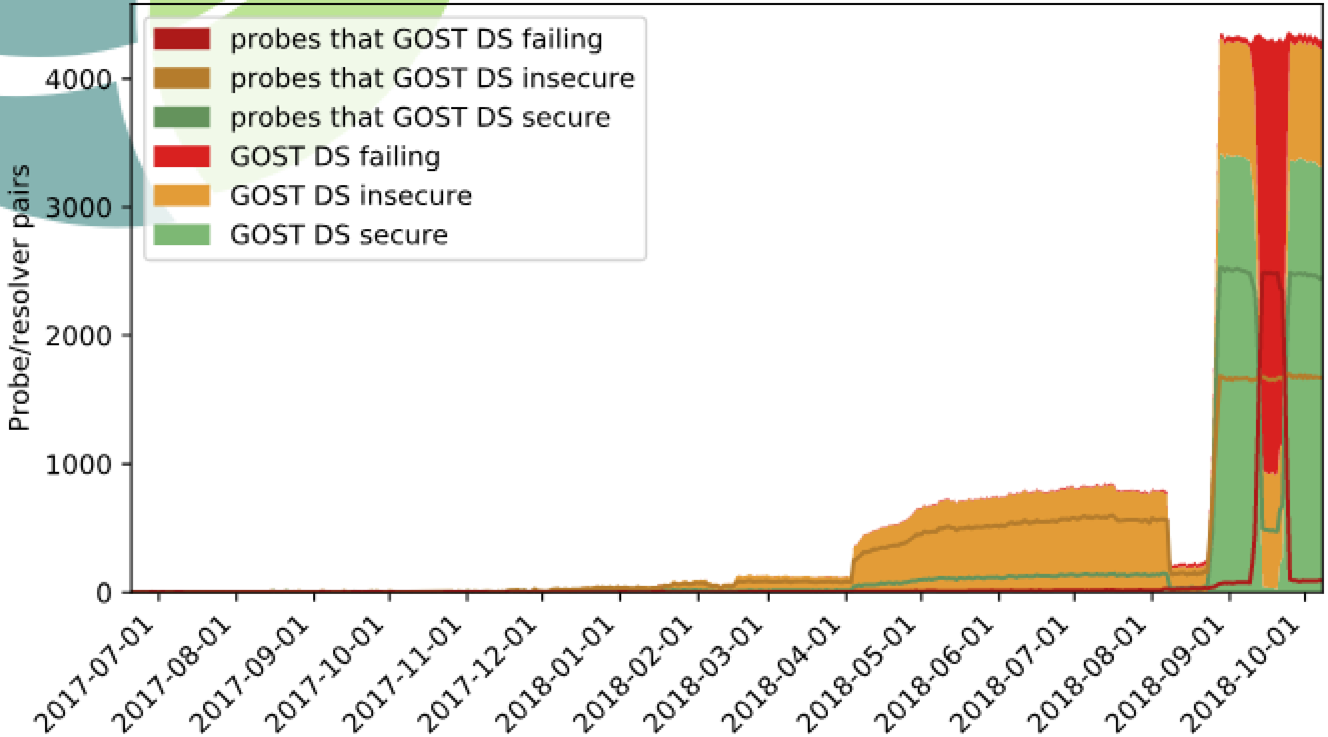




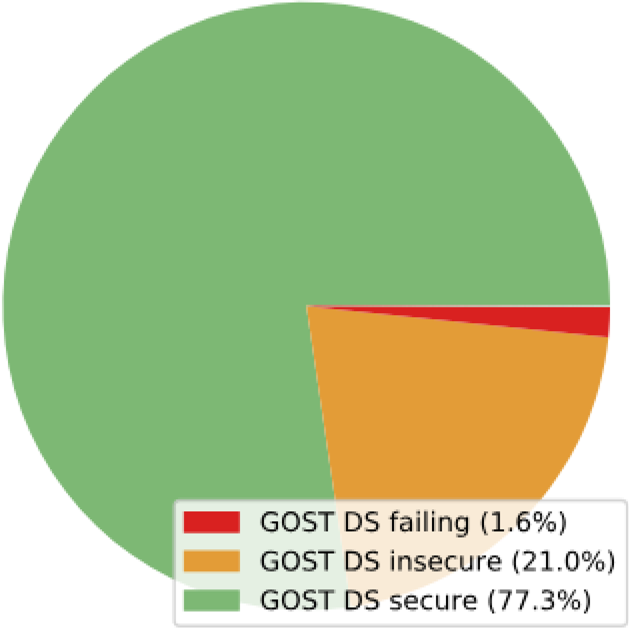
validate DNSKEY algorithm ED25519
https://dnsthought.nlnetlabs.nl/can_ed25519/#gost

DNSSEC

The two incidents side by side



with 4304 resolvers
in 3025 probes



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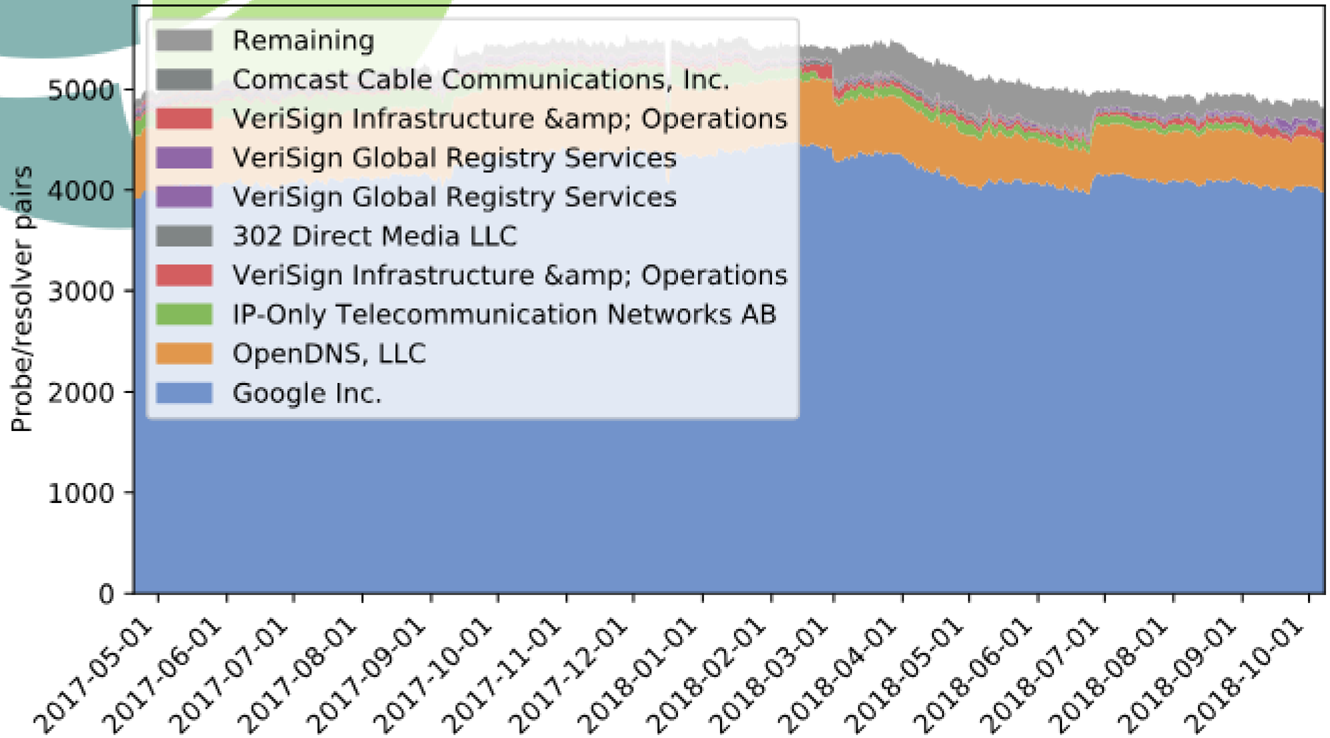
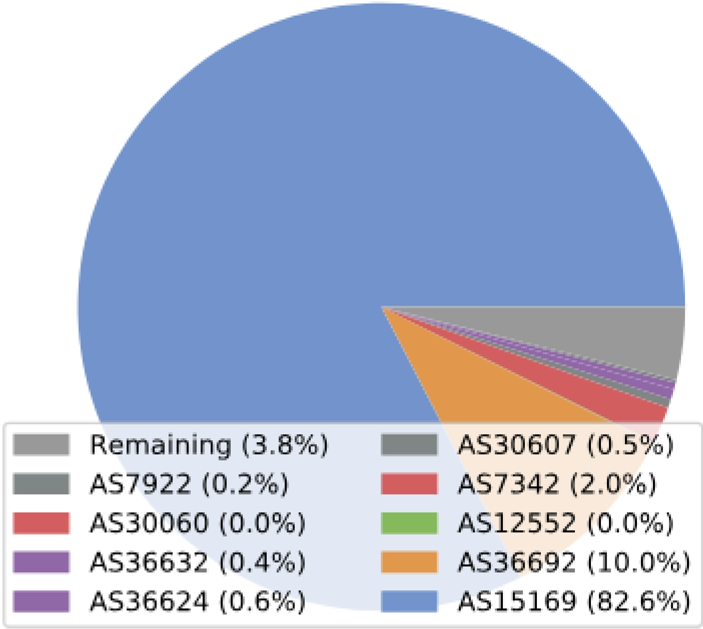
send an EDNS Client Subnet option
https://dnsthought.nlnetlabs.nl/does_ecs/#top_auth_asns

Privacy

Send an EDNS Client Subnet option



With 4832 (25.3%) resolvers
in 3283 (32.3%) probes

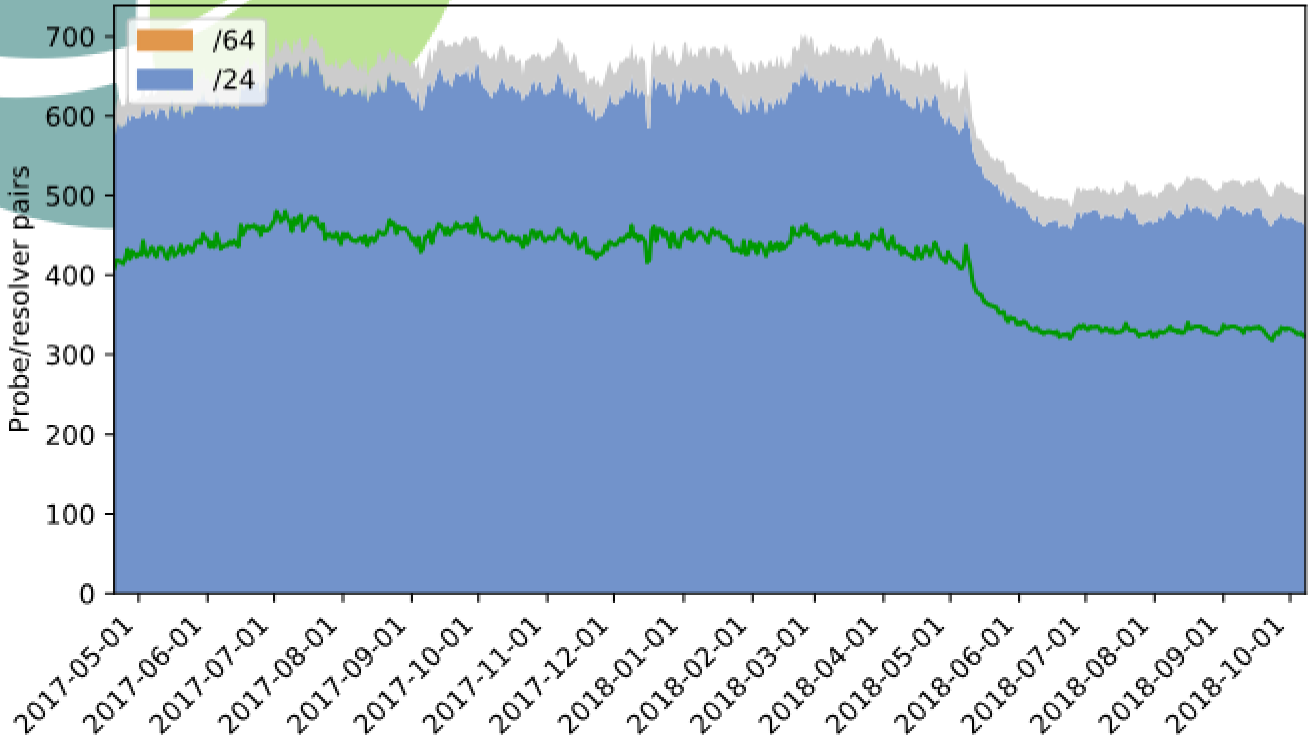


Privacy

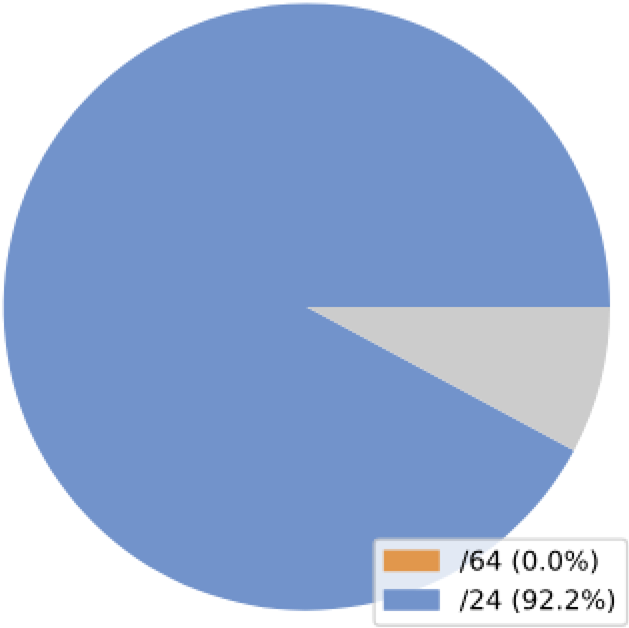
coming from AS36692

https://dnsthought.nlnetlabs.nl/auth_AS36692/#ecs_masks

Send an EDNS Client Subnet option



With 498 resolvers
in 338 probes



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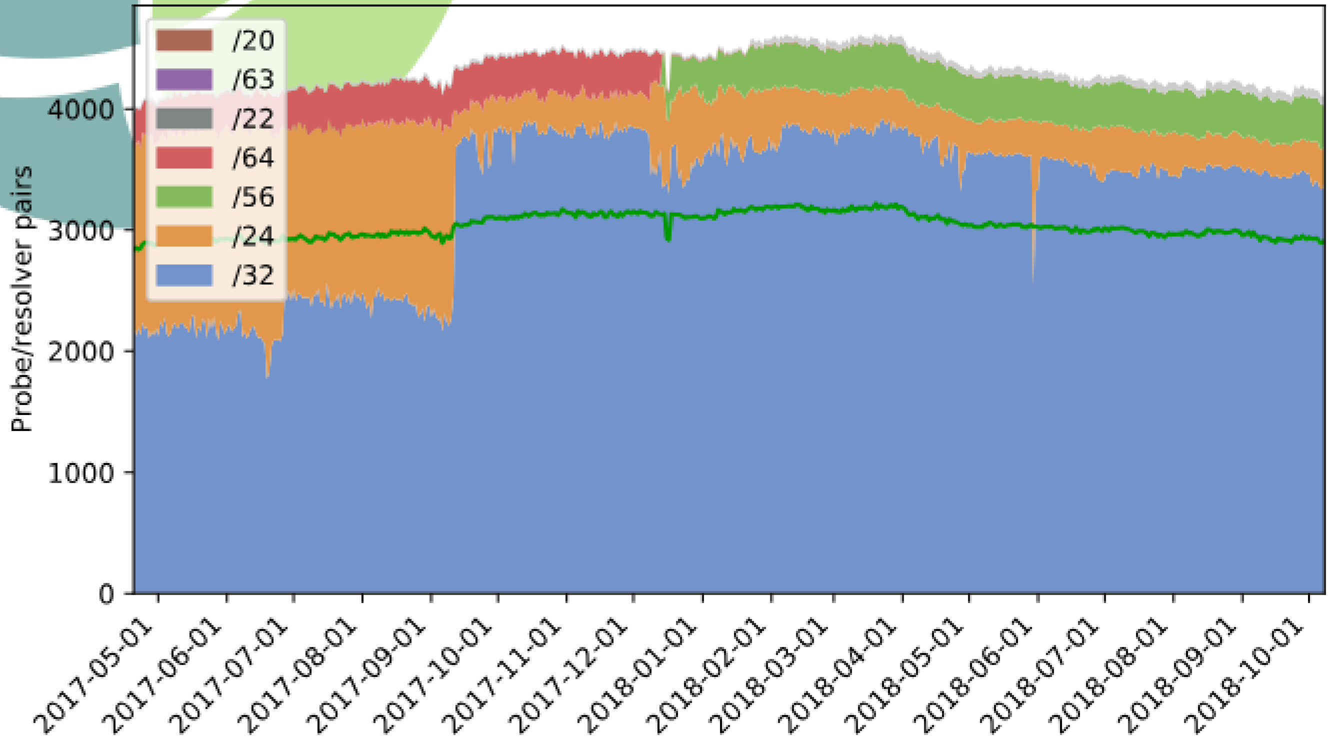
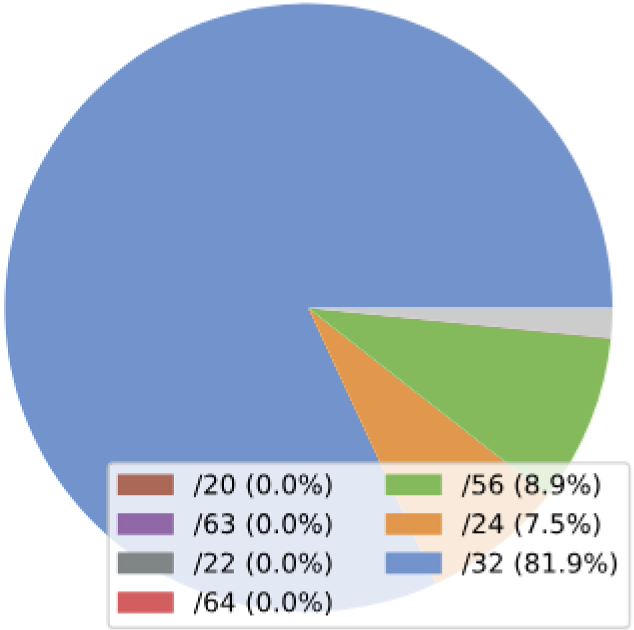
coming from AS15169
https://dnsthought.nlnetlabs.nl/auth_AS15169/#ecs_masks

Privacy

Send an EDNS Client Subnet option



With 4129 resolvers
in 2963 probes

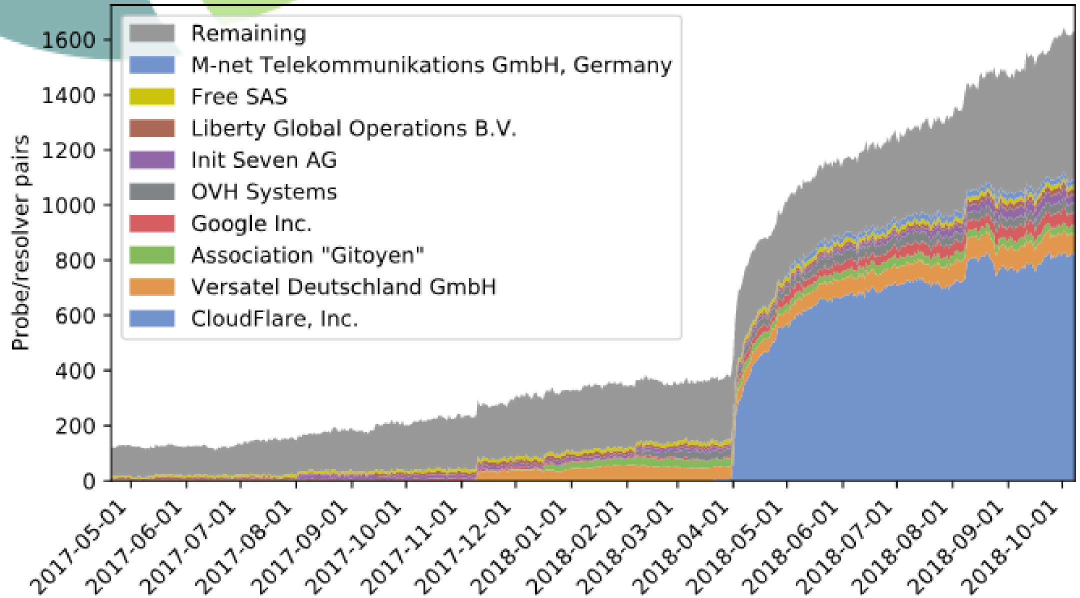


Privacy

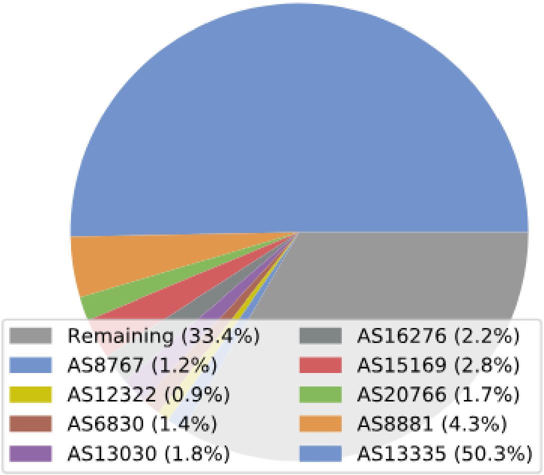
QNAME Minimization

do QNAME Minimization

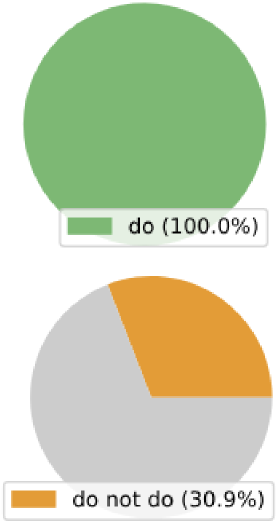
https://dnsthought.nlnetlabs.nl/does_qnamemin/#top_auth_asns



With 1624 (8.5%) resolvers
in 1140 (11.2%) probes



with 1140 probes



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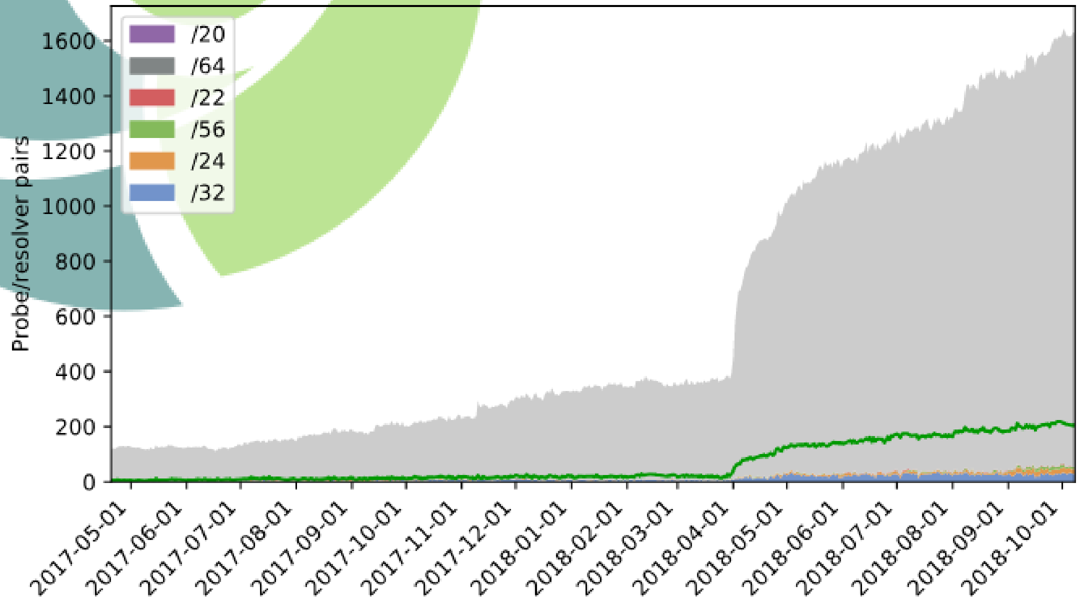
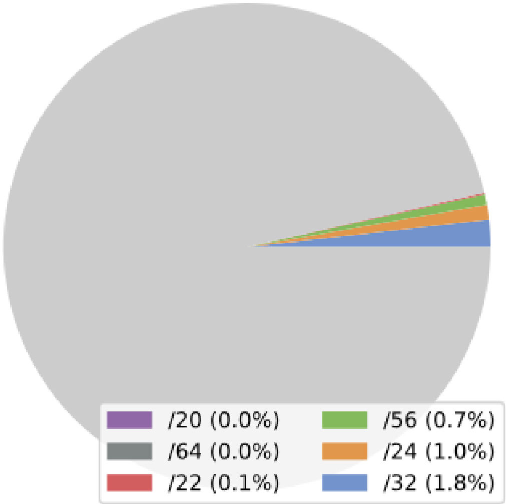
Privacy
QNAME Minimization

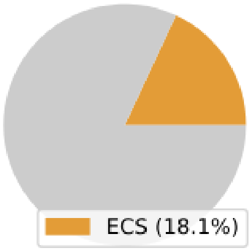
do QNAME Minimization
https://dnsthought.nlnetlabs.nl/does_qnamemin/#ecs_masks



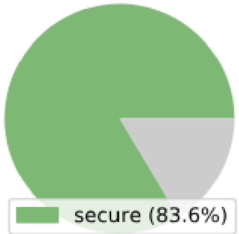
with 1624 resolvers

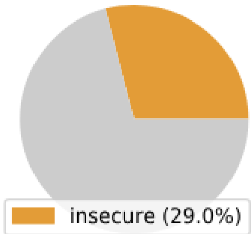


with 1140 probes



- Also zero NX domain rewriting
- Also high % DNSSEC validation:

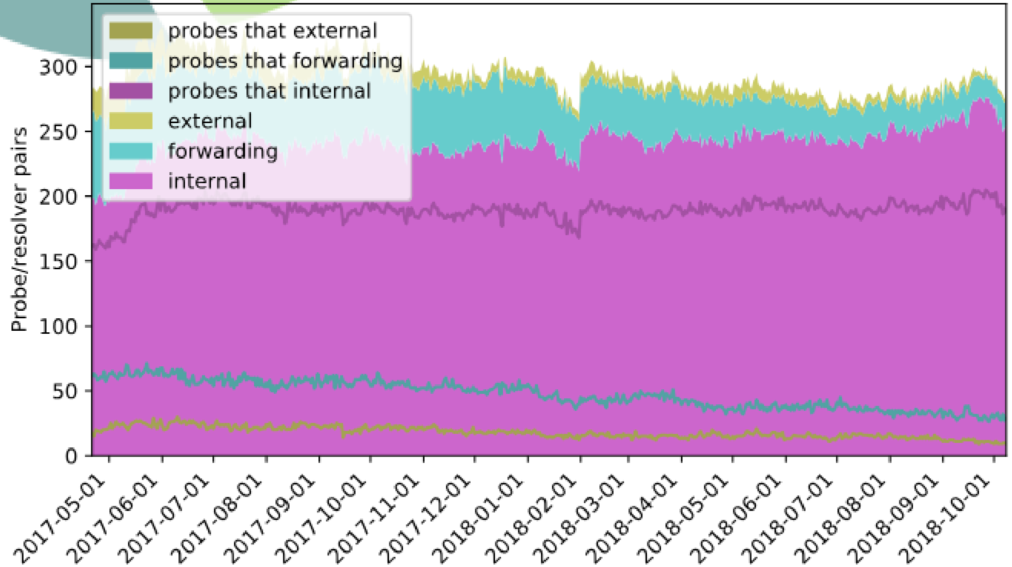




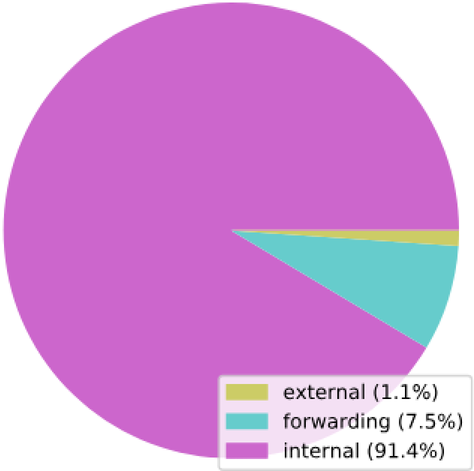
Privacy/Security
NX domain rewriting

do NX domain rewriting

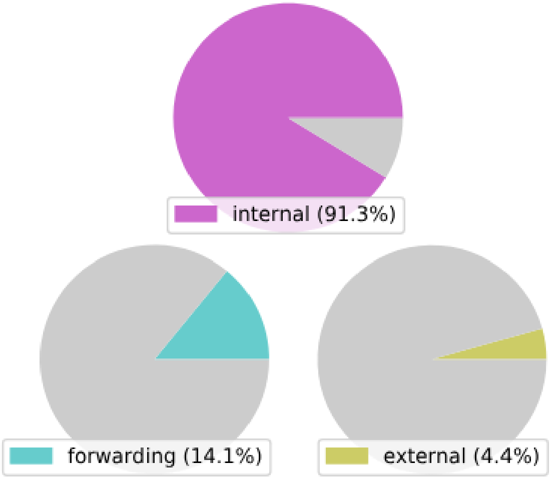
https://dnsthought.nlnetlabs.nl/does_nxdomain/#int_fwd_ext



With 279 (1.5%) resolvers



With 206 (2.0%) probes



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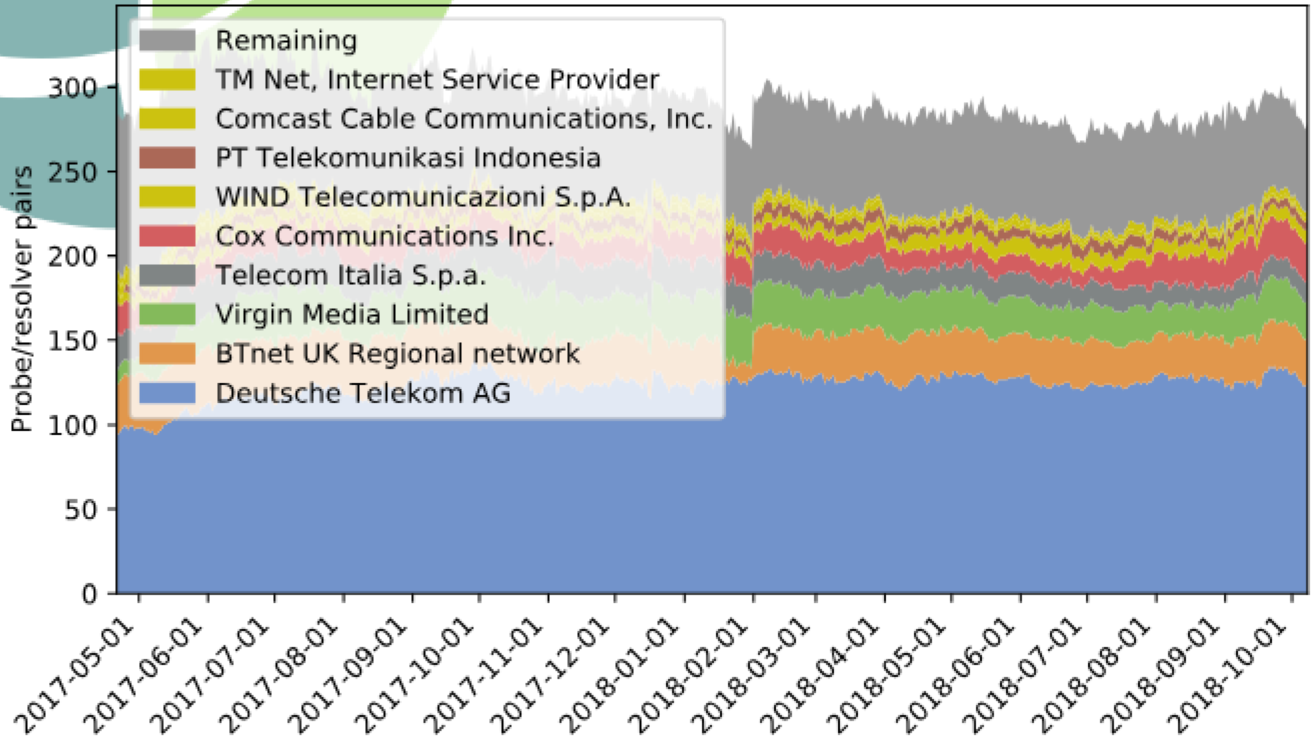
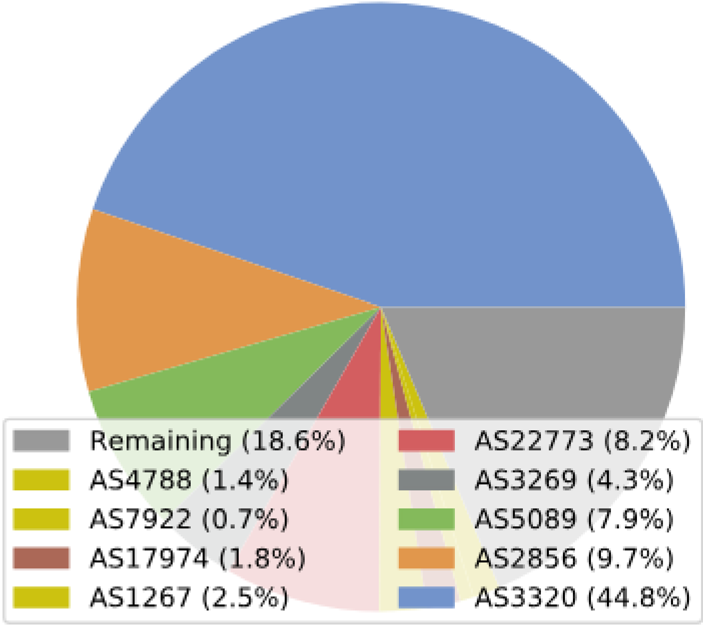
Privacy/Security NX domain rewriting

do NX domain rewriting

https://dnsthought.nlnetlabs.nl/does_nxdomain/#top_auth_asns

Top 10 Probe ASNs == Top 10 Resolver ASNs == Top 10 Authoritative ASNs

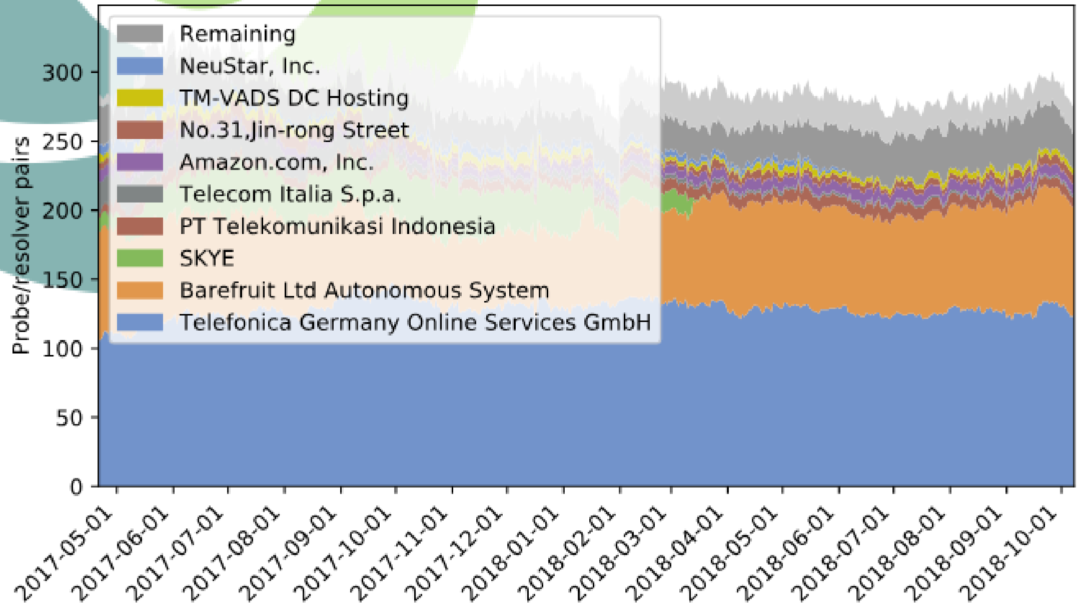




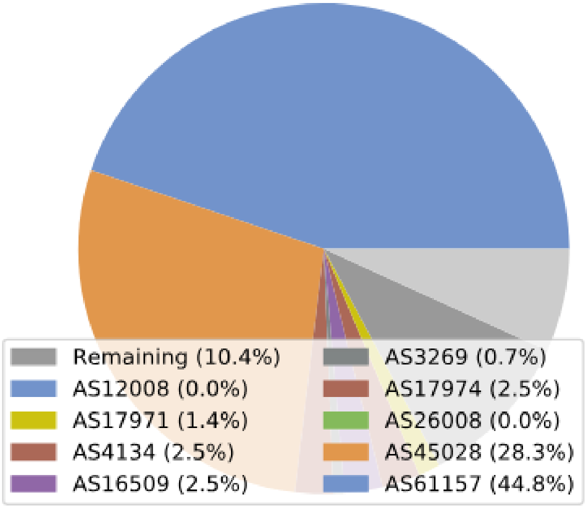
Privacy/Security

NX domain rewriting

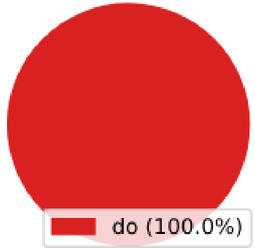
do NX domain rewriting
https://dnsthought.nlnetlabs.nl/does_nxdomain/#top_nxhj_asns

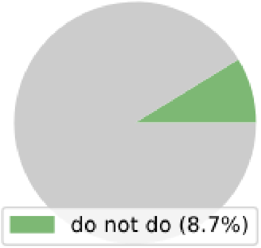


with 279 resolvers

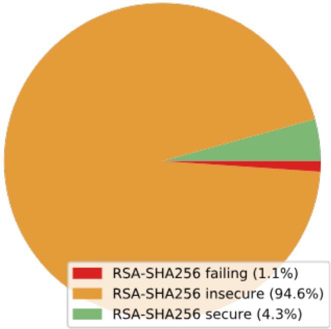


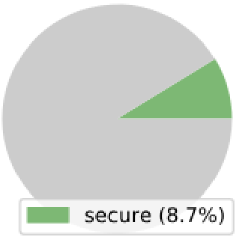
with 206 probes





- Also only 4.3% DNSSEC validation:





DNSThought

- Public, though rough, interface to data available
  https://dnsthought.nlnetlabs.nl/
- Raw processed data available too
  https://dnsthought.nlnetlabs.nl/raw
- Focus on development of properties over time
  Per probe properties & capabilities with RIPE Atlas Probe Tags
  https://atlas.ripe.net/docs/probe-tags/
- Lots to improve
  - Dynamic (zoomable) plots
  - IPv4 & IPv6 ECS detection
  - Better DS algorithm detection
  - Fragment dropping / Path MTU

Questions
Suggestions ?

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