INTERNET STIFTELSEN

KARLSTADS UNIVERSITET COMPUTER SCIENCE
DATAVETENSKAP

Privacy and Security of DNS Resolvers

used in the Nordics and Baltics 

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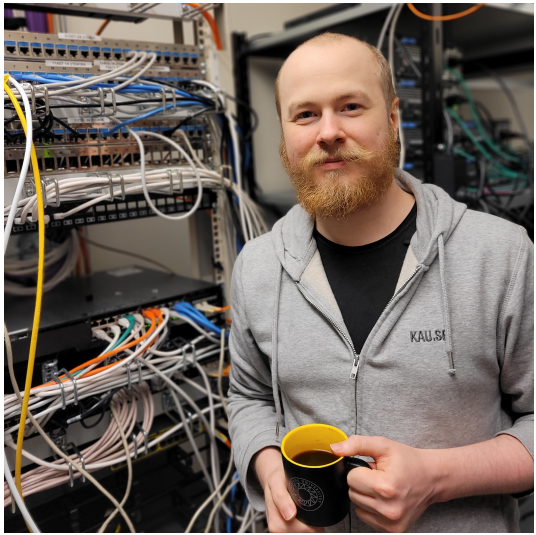
- Karlstad University, Sweden
- The Swedish Internet Foundation



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- Minimal responses (data minimization)
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Active Measurements

RIPE Atlas Probes

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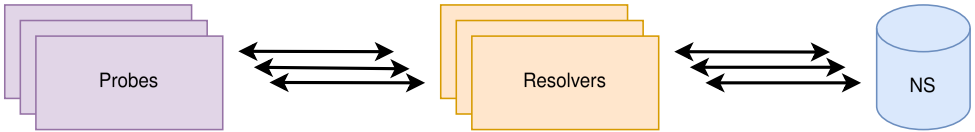
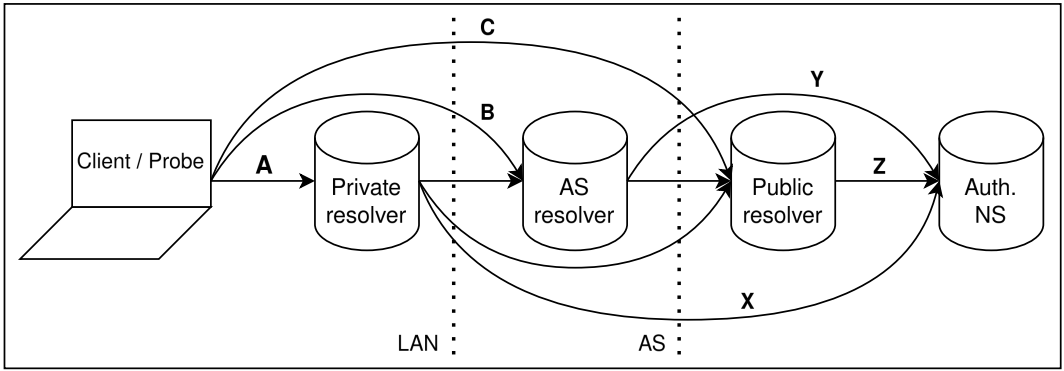


Resolver Forwarding



Preconfigured resolver types: {A, B, C}
Recursive resolver types: {X, Y, Z}

Measurement Results

RIPE Atlas

Country									Total
Probes	109	31	129	13	31	32	91	184	620

- 1066 unique probe/resolver pairs

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Preconf. \ Recursive	Private	AS	Public
Private	4.5%	14.4%	17.4%
AS	0.4%	21.6%	1.6%
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Measurement Results

Probe/resolver pair feature adoption

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	IPv6	DNSSEC	QMIN	NECS	MR
All	92%	87%	70%	83%	78%

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- Network Proximity

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Public	99%	98%	**59%**	**72%**	**61%**

Measurement Results

Probe/resolver pair feature adoption

- Network Proximity
- Popular Public

	IPv6	DNSSEC	QMIN	NECS	MR
All	92%	87%	70%	83%	78%
Private	87%	80%	79%	87%	92%
AS	90%	76%	78%	98%	84%
Public	99%	98%	59%	72%	61%
Google	100%	100%	**0%**	**27%**	**0%**
Cloudflare	100%	100%	100%	100%	100%
Quad9	100%	100%	100%	100%	100%

Measurement Results

Google Public DNS acting strange:

```
dig a.b.qnamemin-test.internet.nl TXT @8.8.8.8   → HOORAY
dig a.b.qnamemin-test.nlnetlabs.nl TXT @8.8.8.8 → NO
dig a.b.qnamemintest.net TXT @8.8.8.8            → NO
```

"A Second Look at DNS QNAME Minimization" by Magnusson *et al.*

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Cloudflare	100%	100%	100%	100%	100%
Quad9	100%	100%	100%	100%	100%
Private → Private	48%	61%	83%	100%	100%
Private → AS	86%	74%	91%	100%	97%
Private → Public	100%	89%	71%	77%	88%

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Analysis by country

Measurement Results

Feature adoption by country (all probe/resolver pairs)

	Pairs	IPv6	DNSSEC	QMIN	NECS	MR
Sweden	304	92%	86%	68%	**96%**	76%
Finland	234	**95%**	84%	65%	82%	62%
Denmark	179	93%	96%	73%	88%	75%
Norway	165	92%	81%	82%	93%	**83%**
Estonia	60	87%	85%	**83%**	90%	77%
Lithuania	54	80%	80%	57%	78%	69%
Latvia	49	86%	86%	76%	88%	78%
Iceland	21	90%	**100%**	67%	81%	81%

Measurement Results

Feature adoption by country (preconfigured AS resolvers)

	Pairs	IPv6	DNSSEC	QMIN	NECS	MR
Norway	63	**97%**	76%	92%	100%	**95%**
Finland	59	90%	75%	73%	100%	88%
Sweden	53	91%	77%	74%	100%	75%
Denmark	32	91%	**100%**	88%	100%	88%
Estonia	22	77%	95%	**100%**	100%	86%
Lithuania	11	36%	45%	55%	100%	91%
Latvia	9	67%	89%	89%	100%	89%
Iceland	**2**	0%	100%	100%	100%	100%

Correlation Analysis

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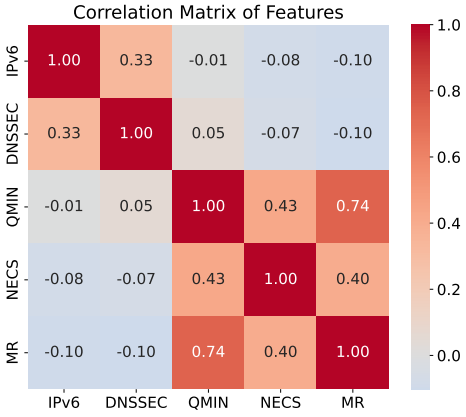

All resolvers

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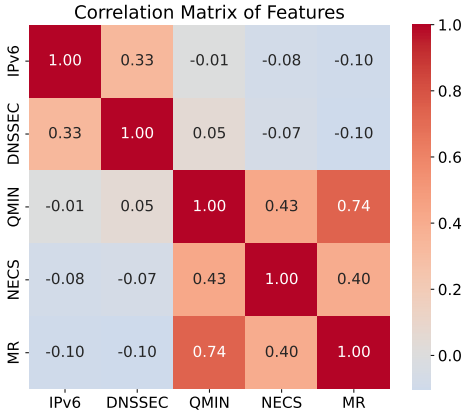

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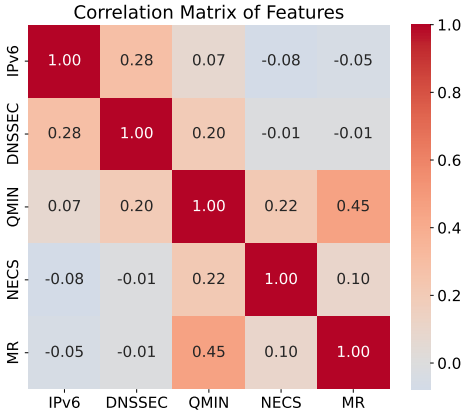

Normalized

Conclusions

- Overall adoption over 70%
- Variation across resolver type
- Google affects public average
- Best Adoption:
  - IPv6 
  - Minimal responses 
  - DNSSEC 
  - QMIN 
  - NECS 
- Feature correlations
  - IPv6 $\Leftrightarrow$ DNSSEC
  - DNSSEC $\Leftrightarrow$ QMIN
  - QMIN $\Leftrightarrow$ MR

Future Work

Study Scope

- Longitudinal
- Additional features

RIPE Atlas probes

- Representativity
- Alternatives

The End! Questions?