DNSSEC Operational Practices: The Good, The Bad and The Ugly

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DNSSEC in the second decade

- **Mass deployment** of DNSSEC **took off in 2008, after "Kaminsky"**
- We have **just entered the second decade** of DNSSEC
- **Things** seem to be **going well**:
  - Vast **majority of top-level domains** support DNSSEC
  - Number of **validating resolvers still growing**
- **But also: many "important" domains still not signed**
  (Google, Facebook, Amazon, ...)

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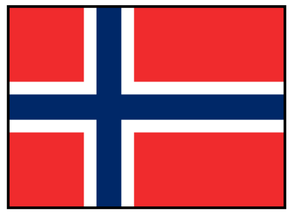
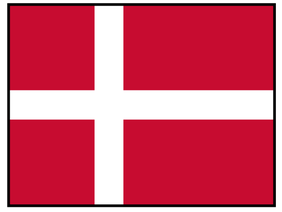
DNSSEC in the Nordic region



.no 58%

.se 54%

.is 3%



.dk 2%

.fi 1%

What do these have in common?

For comparison:

.com 0.7%

.net 1%

.org 1%

But also:

.nl 53%

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Incentives, incentives, incentives!

Studying incentives

- **Both** .nl and .se **have financial incentives for registrars** to encourage DNSSEC deployment
- These **incentives are modest** (a few percent discount on registration)
- This means that the incentives **only pay off** financially **if you deploy** DNSSEC **for 100,000s of domains**
- While this **clearly** has **led to mass deployment** of DNSSEC, we wondered if it has **also led to secure deployments?**

Study goals

- We wanted to **study** the **quality** of DNSSEC deployments **in terms of security** as **defined in** DNSSEC **best practices**

- Our **assumption: only large operators benefit economically from incentives**, therefore **we expect small operators to deploy** DNSSEC **with a different motivation**

- **Hypothesis:**
  "Despite the presence of 'per-domain' economic incentives in .nl and .se, large DNS operators deploy DNSSEC with lower compliance to security guidelines than small DNS operators."

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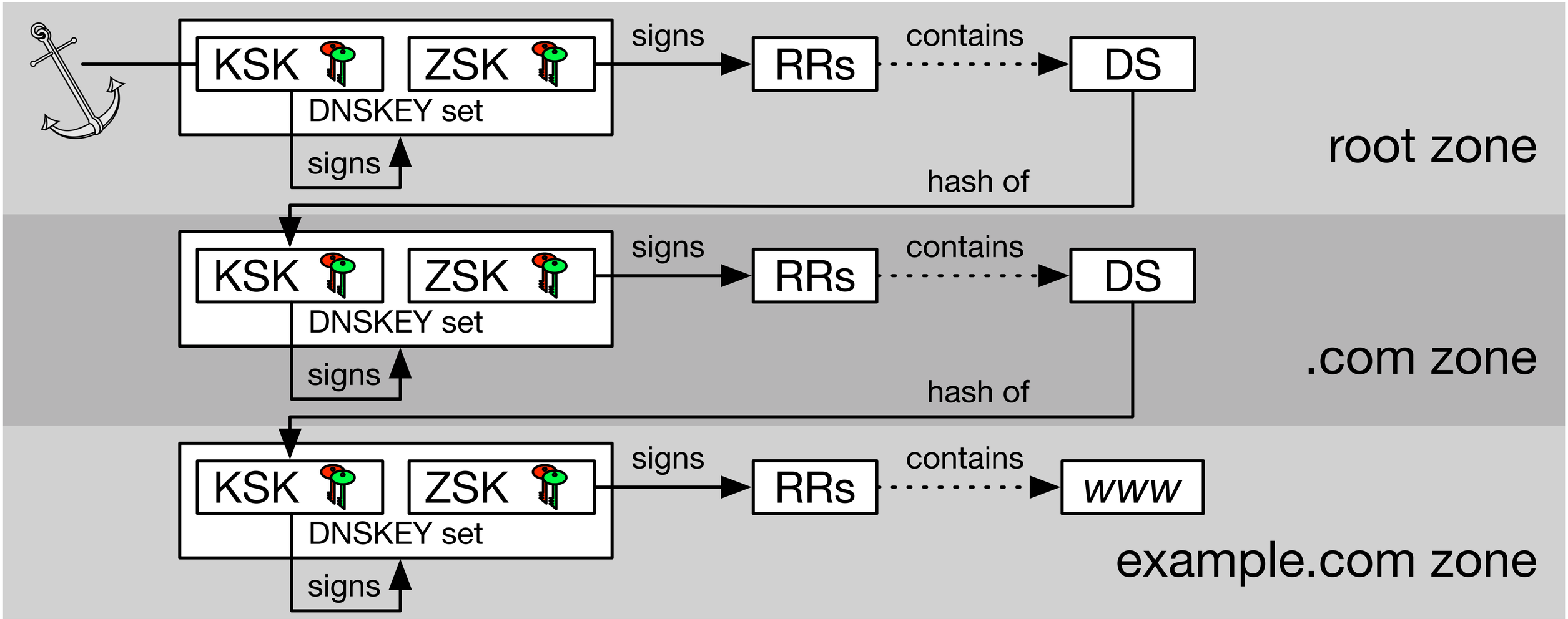
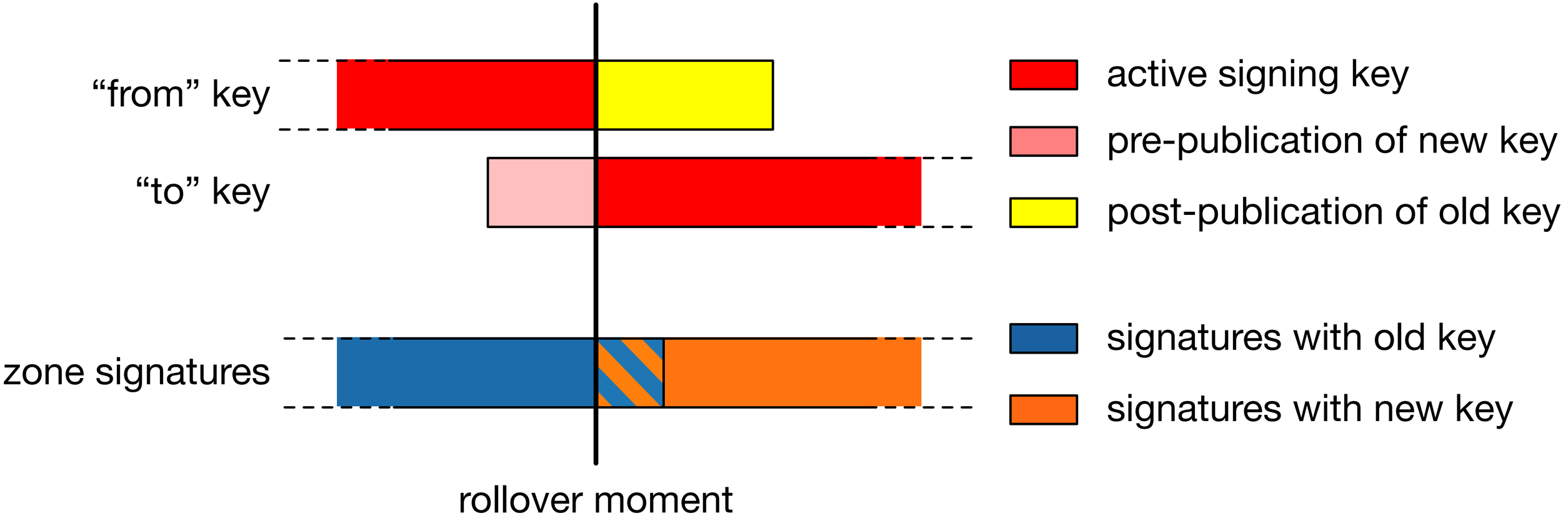
DNSSEC in two slides



DNSSEC in two slides



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Best Current Practice

Aspects	NIST recommendation
Key size	- ECDSA keys. - RSA: KSKs >= 2048 bits and ZSKs >= 1024 bits.
Key algorithm	- Recommended: Algorithms 8 and 10. - Highly recommended: Algorithms 13 and 14.
Key rollover	**KSKs/CSKs:** - ECDSA keys and and RSA keys (with key size >=2048 bits): rollover within 24 months. **ZSKs:** - 1024-bit RSA keys: rollover within 90 days. - RSA keys' size between 1024 - 2048 bits: rollover within 12 months. - ECDSA keys and RSA keys (with key size >= 2048 bits): rollovers within 24 months.

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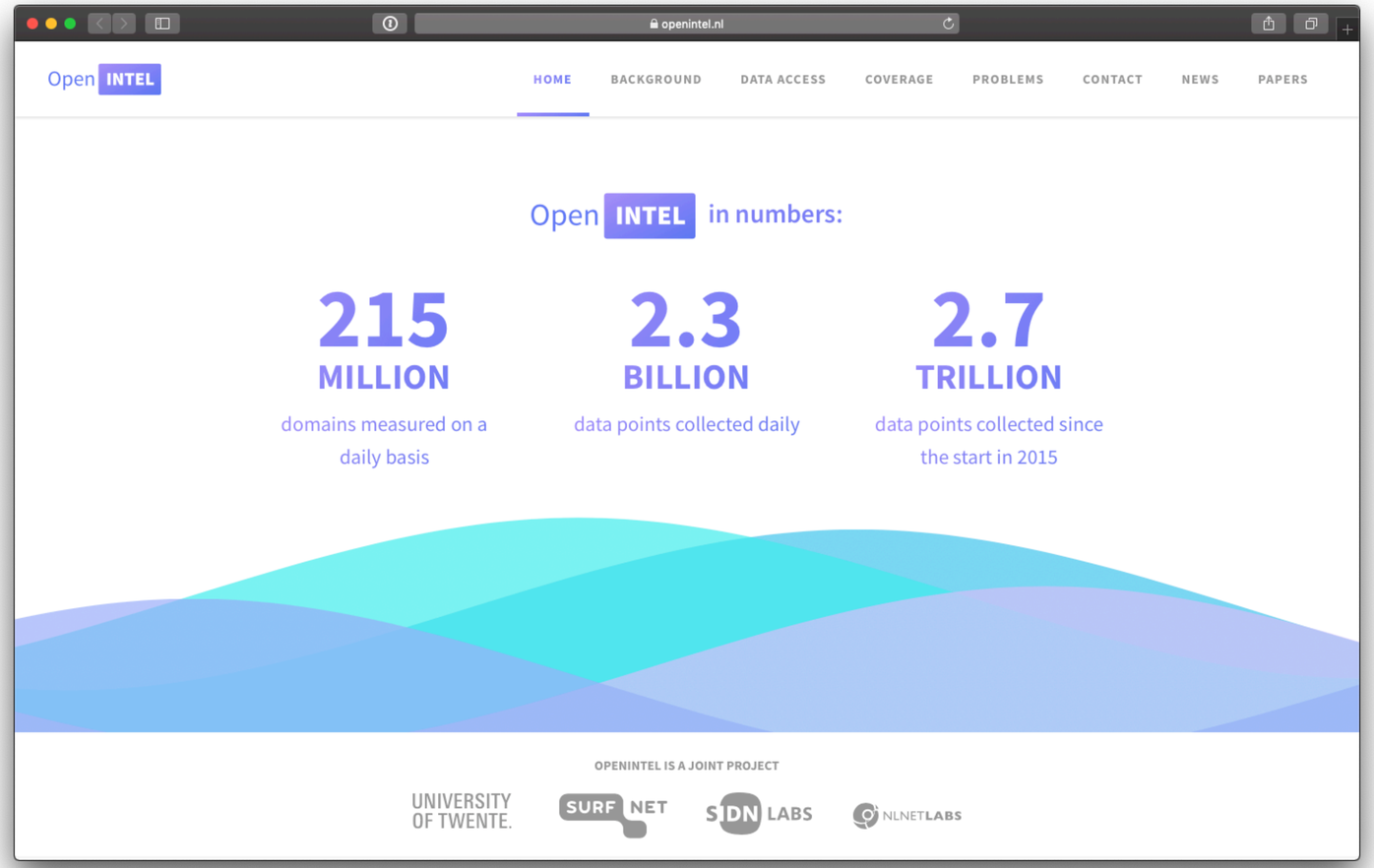
OpenINTEL

For this study we used data from the OpenINTEL project



https://openintel.nl/

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Approach

TLDs	Measurement Period	#Domains	
.com	2015-02-28 - 2017-07-31	116,814,548	
.net	2015-02-28 - 2017-07-31	13,011,428	→ For comparison
.org	2015-02-28 - 2017-07-31	9,373,214	
.nl	2016-02-09 - 2017-07-31	5,440,975	
.se	2016-06-07 - 2017-07-31	1,440,244	→ Focus of study

- Analyse **RRSIG** and **DNSKEY** records for **all signed domains every day** to check key sizes, algorithms and key rollovers

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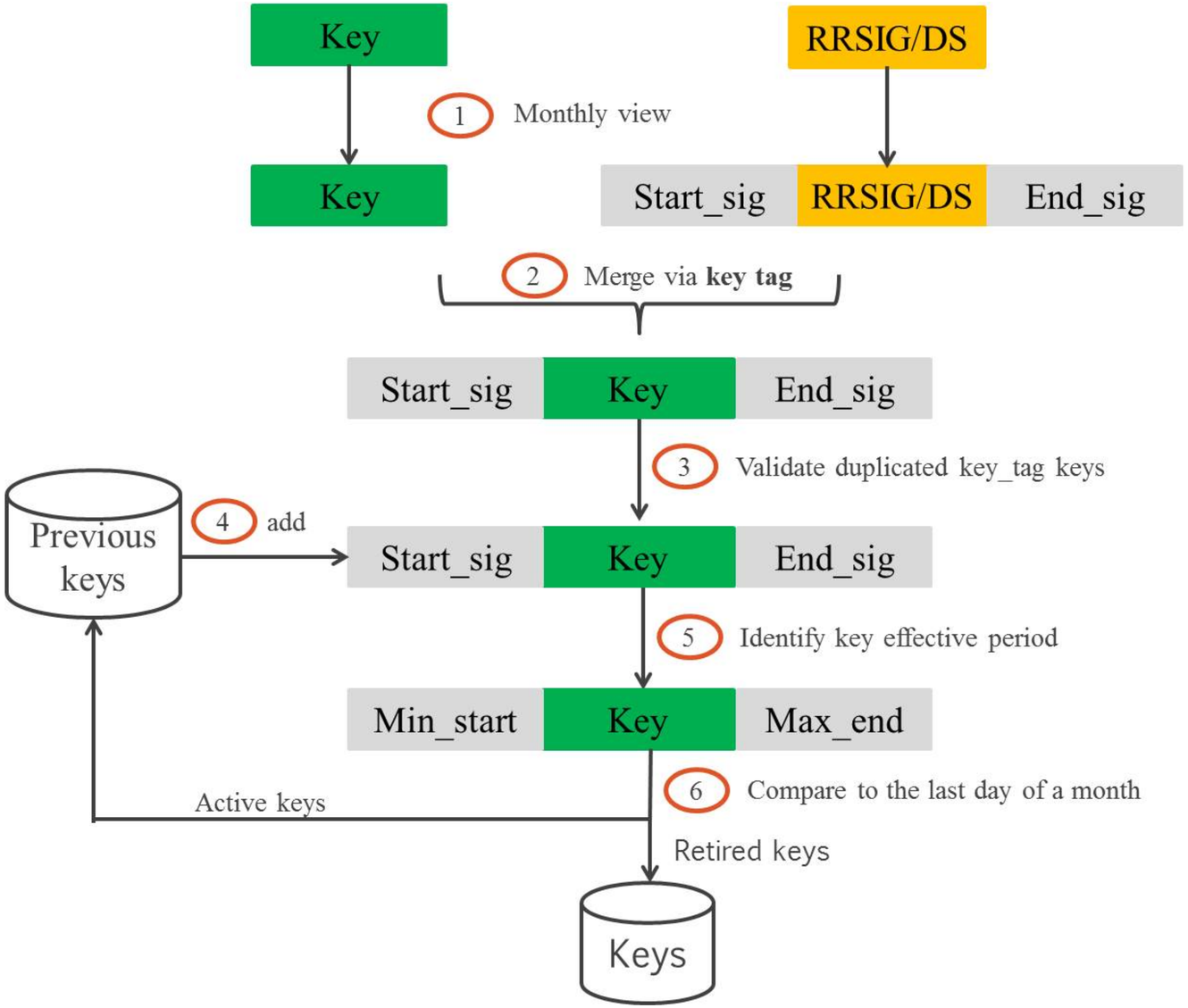
Rollover complexity



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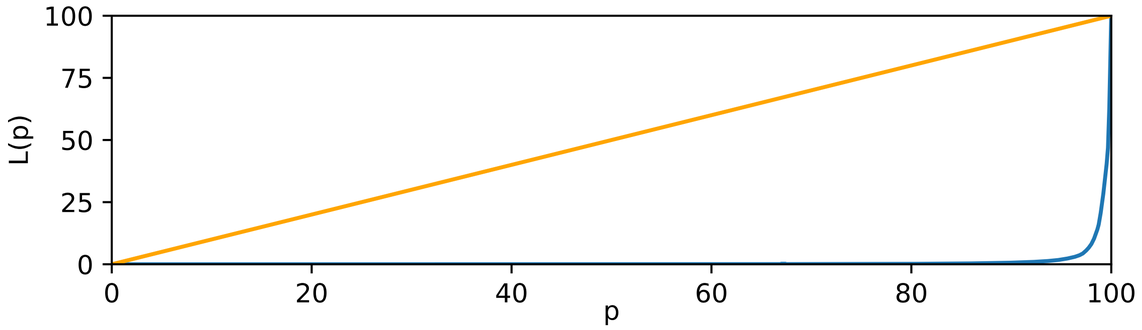
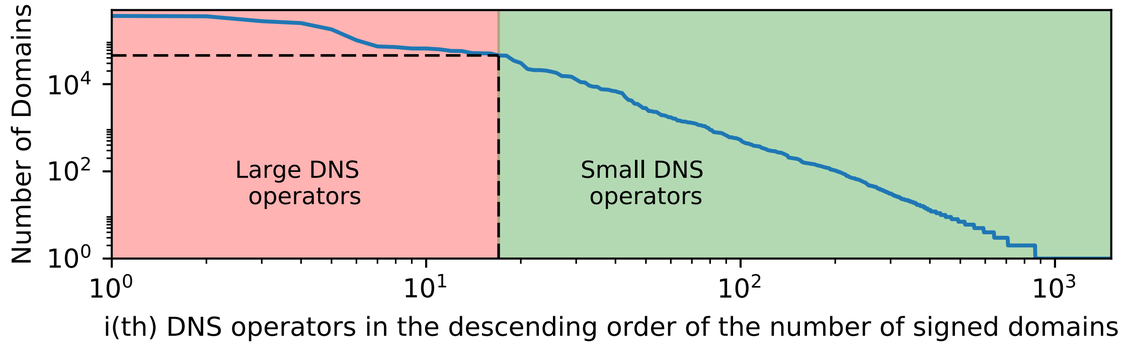
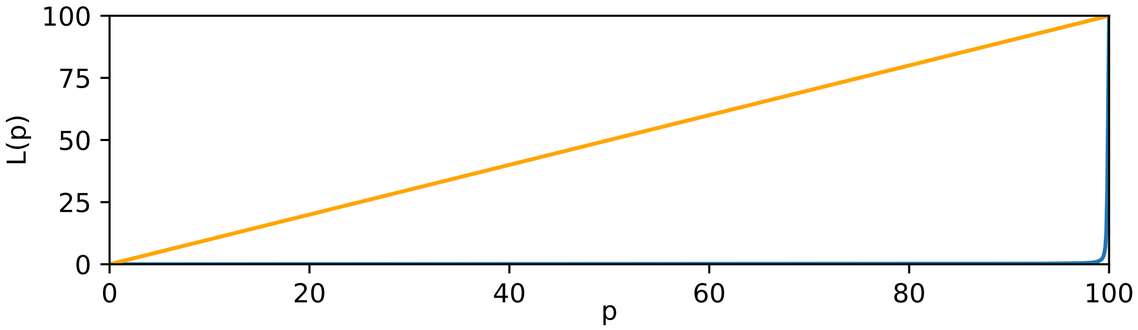
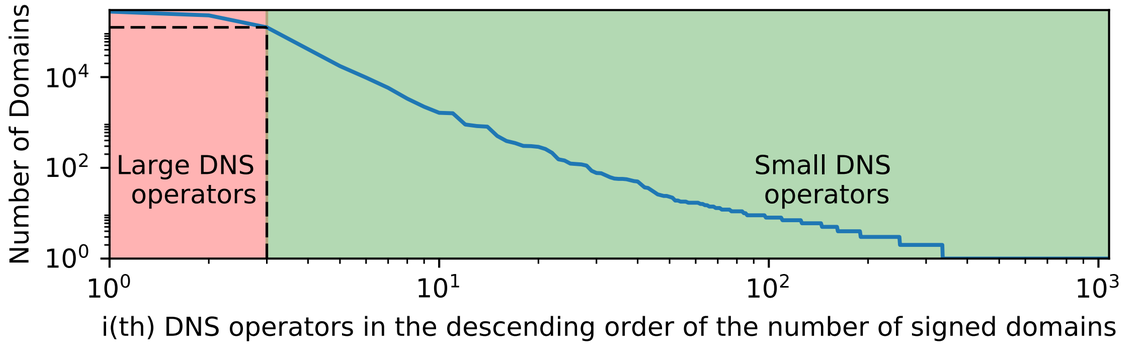
Large versus Small









.nl

Just **14 operators** responsible for **over 80% of signed domains**

.se

Just **3 operators** responsible for **over 80% of signed domains**

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All the DNSSEC large and small

- To check if **large operators** are **more likely to deploy** DNSSEC **under an incentive**, we **compared .com/.net/.org to .nl and .se**

	Large operators			Small operators		
TLD	**#Domains**	**#Signed**	**%**	**#Domains**	**#Signed**	**%**
.com	93,464,626	712,162	0.76%	23,349,922	224,251	0.96%
.net	10,412,605	114,687	1.10%	2,598,823	26,400	1.02%
.org	7,501,310	85,166	1.14%	1,871,904	20,342	1.09%
.nl	4,353,518	2,736,393	62.85%	1,087,457	92,791	8.53%
.se	1,153,129	723,532	62.75%	287,115	13,794	4.80%

- **Takeaway: uptake** among large operators is an **order of magnitude higher under** an **incentive!**

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Results for large operators in .nl

DNS operator	Master NS†	#Signed	Algorithm	KSK size	ZSK size	ZSK Rollover
TransIP	*.transip.net.	265,341	✗	✓	⚠+	✗
	*.transip.nl.	206,254	✗	✓	⚠+	✗
	*.sonexo.eu.	75,256	✓	✓	⚠+	✗
	ns0.nl.	50,273	✗	✓	⚠+	✗
Metaregistrar BV	*.metaregistrar.nl.	386,913	✓	✓	⚠+	✗
Hostnet BV Network	*.hostnet.nl.	359,793	✓	✓	⚠+	✗
Cyso Hosting	*.firstfind.nl.	246,385	✓	✓	⚠+	✗
Argeweb BV	*.argewebhosting.eu.	101,993	✓	✓	⚠+	✗
Openprovider	*.openprovider.nl.	79,367	✓	✓	⚠+	✗
Village Media BV	*.webhostingserver.nl.	67,150	✓	✓	⚠+	✗
Hosting2GO	*.hosting2go.nl.	64,568	✓	✓	⚠+	✗
Flexwebhosting BV	*.flexwebhosting.nl.	60,753	✓	✓	⚠+	✗
Internedservices	*.is.nl.	57,033	✓	✓	⚠+	✗
Neostrada	*.neostrada.nl.	56,295	✓	✓	⚠+	✗
One.com	*.one.com.	55,397	✓	✗	✓	?
PCextreme	*.pcextreme.nl.	50,102	✓	✓	⚠+	✗
AXC B.V.	*.axc.nl.	47,861	✓	✓	⚠+	✗

- **Measured over 18 months** (so no KSK rollover)

Takeaways:

- **Algorithm** and **key sizes** mostly **OK**
- **ZSKs** are mostly 1024-bits (borderline secure) but **are never rolled!**

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Results for large operators in .se

DNS operator	Master NS†	#Signed	Algorithm	KSK size	ZSK size	ZSK Rollover
Loopia AB	*.loopia.se.	282,604	✔	✔	⚠+	✗
One.com	*.one.com.	221,372	✔	⚠⋆	⚠+	✗
Binero AB	*.binero.se.	123,131	✔	✔	⚠+	✗

- **Measured over 14 months** (so no KSK rollover)

Takeaways:

- Story **similar to .nl**
- **Algorithm** and **key sizes** mostly **OK**
- **ZSKs** borderline secure but **never rolled!**

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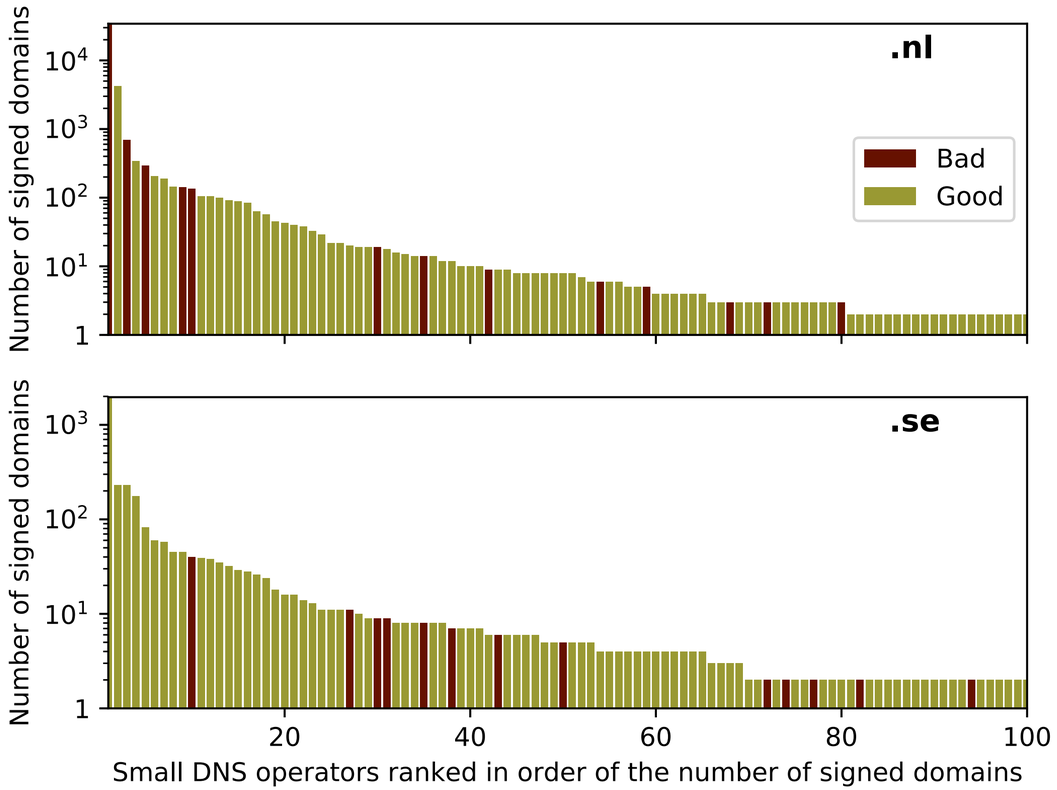
What about the smaller operators?



.nl

.se

Takeaways: Domains from **small operators much more likely to roll** their **ZSKs properly**

Compliance is **independent of size**

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Why are large operators not rolling?

- **Are you in the room? I'd love to hear from you!**
- DNSSEC is complex; **rollovers are** arguably **hard and** potentially **risky**
- We know (from private communication) **some** large **operators implement** their **own DNSSEC** signer **systems**
- **Rolling** keys **not a requirement to qualify for the** DNSSEC **incentive**
- **Smart operators** know: **reduce complexity -> reduce** operational **risk**
- No one wants to be called out of bed at 3AM because of a DNSSEC problem

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I have a theory about .se

- I had a quick look in OpenINTEL last week, for RSA keys in .se:

key size	key type	#dns records	#unique keys
2048	257	651255	202802
2048	256	1841	1839
1024	257	1179	1179
1024	256	1171742	274868

Lots of key sharing

key size	start of key	#keys	
2048	c948a41599cc2d90	321550	**Loopia**
1024	d11791959e2af6ff	321550	
1024	eaf2a4dfbb808f12	321550	
2048	ea37aa563c6e0514	115821	**Binero**
1024	e63c67ebfc23d58a	115821	
1024	d07ba941f50034f5	115821	
2048	c38eb9a20c640dac	9450	**Telia**
1024	ceb092a78cbf7606	9450	
1024	c4cc5c2090f7d69a	9450	
2048	c9efecb5b5815640	917	**Binero**
1024	a1e9a5155ac9be2d	917	
1024	c2a2653d087aeef8	917	
2048	cacfa6615874581c	228	**Swebby**
1024	aac2b639be2a9967	228	
1024	bc231b0f27076953	228	

- Note: **rollovers are** even **trickier when** you're **sharing keys**

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Conclusions

- Incentives got us massive DNSSEC deployment
- But not necessarily secure deployments!
- So perhaps it is time to tighten incentive requirements
- How to do this while keeping operators on board?

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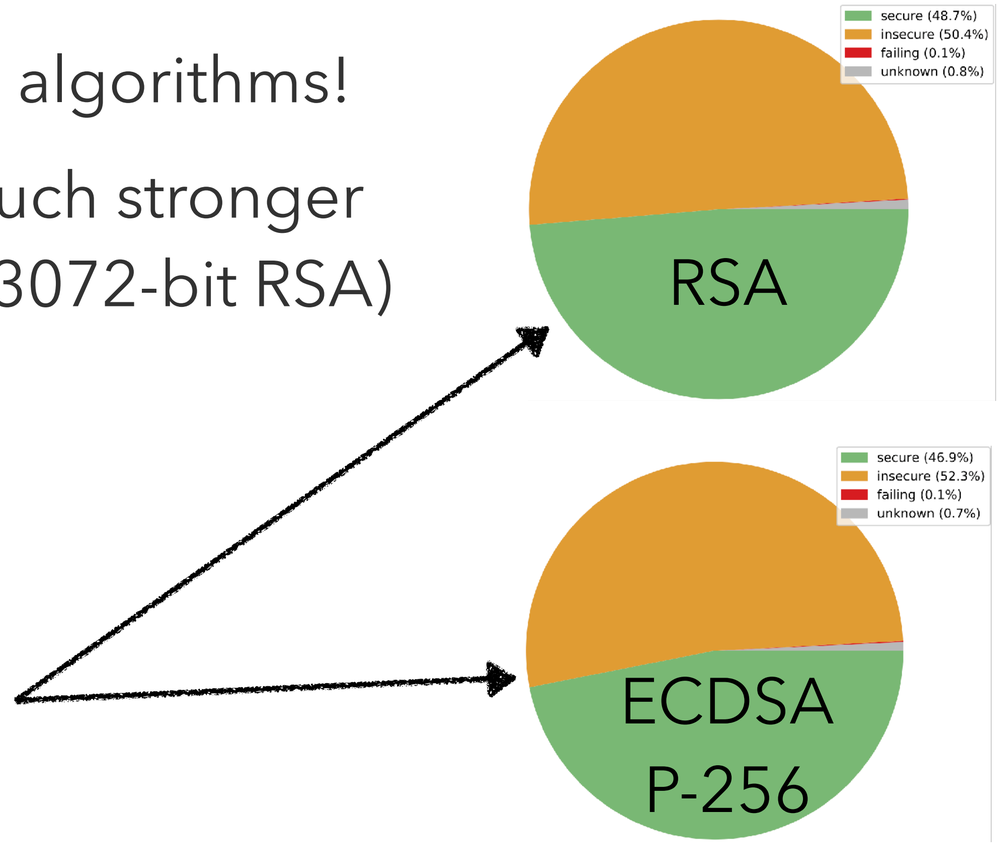
Recommendations

- Need to account for operational reality; operators want to minimise risk
- One way forward: use Elliptic Curve signing algorithms!
  - Smaller keys that are cryptographically much stronger (e.g. ECDSA P-256 roughly equivalent to 3072-bit RSA)
  - Not rolling a key is not a problem; according to current insights, these keys are good for 30+ years*
  - Widely supported by validating resolvers (source: rootcanary.org)



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Thank you! Questions?

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