# The Root Canary

## The Evolution of a Measurement







# What's the goal of this talk?

- Some of **you may have** already **heard about** the **Root Canary** project

- So **why present** about it again **at** the **MAPRG**?

- We want to tell the **story of** an **evolving measurement**, where we started measuring one thing, but…
  - We measure other things as a **side effect**
  - We make **brilliant mistakes**
  - The measurement results in **new ways to monitor DNS operations** useful for, e.g., TLD operators

# Canary in the virtual coalmine

- **Recap**: why did we start this project?
  - **Track operational impact** of the **root KSK rollover**, act as a **warning signal** that validating resolvers are failing to validate with the new key
  - **Measure validation during** the **KSK rollover** from a global perspective **to learn from this type of event**

# Measurement methodology

- Use **four perspectives**:
  - Online perspectives:
    - **RIPE Atlas**
    - **Luminati**
    - **APNIC DNSSEC measurement**
      (current thinking: use data during evaluation)
  - "Offline" perspective (analysed after measuring)
    - **Traffic to root name servers** (multiple letters)

# Measurement methodology

- **Luminati:** HTTP(S) **proxy** service


- **Millions of** exit **nodes** - usually **residential users**
  - Allows us to send HTTP(S) traffic via a central server that egresses through the exit nodes
  - Our **HTTP** requests **trigger DNS** queries
- **Covers > 15,000 ASes**
- Of which **> 14,000** are **not covered by RIPE Atlas**

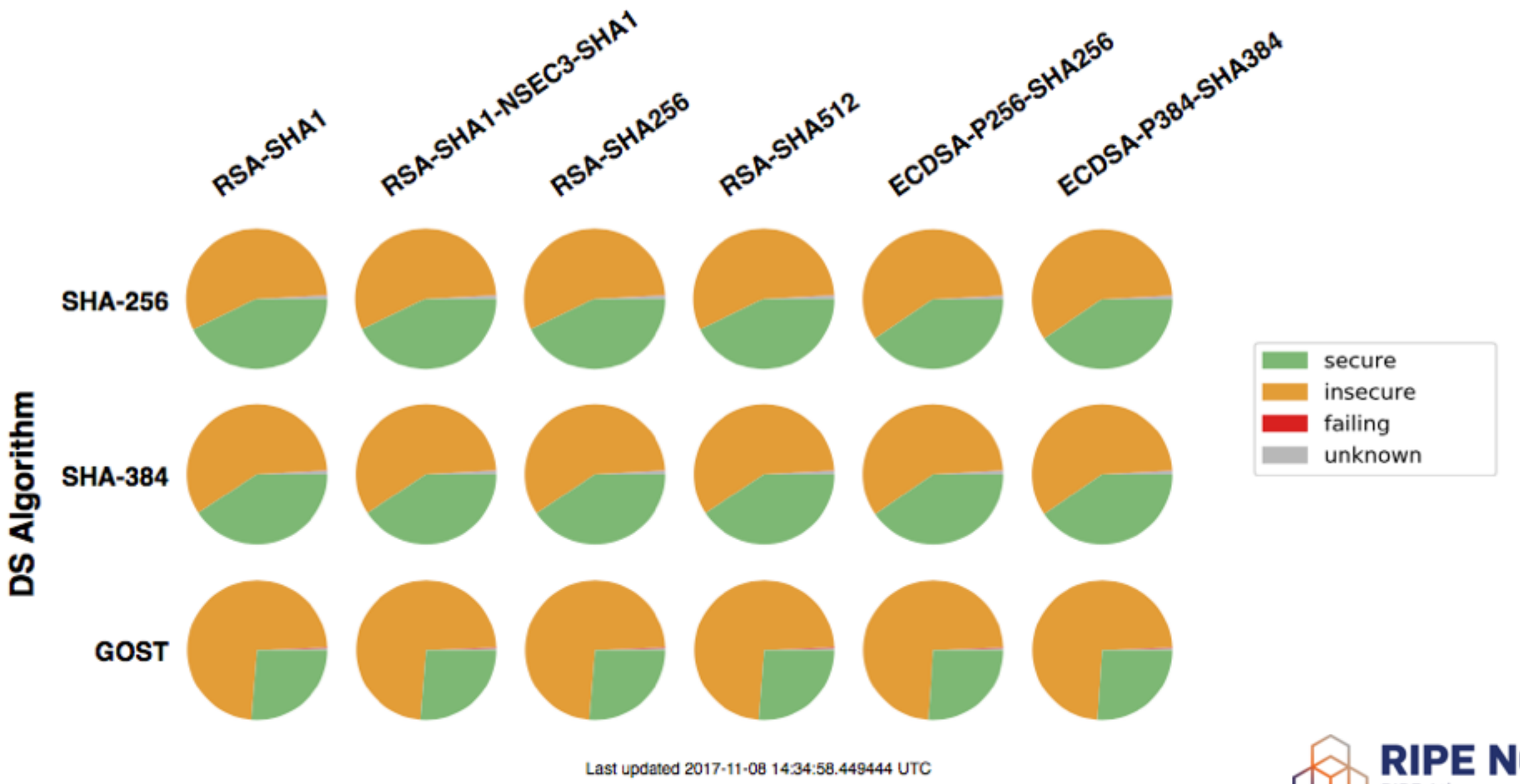
# Measurement methodology

- We have **signed and bogus** records for **all algorithms** and **most DS algorithms**

- This gives us one of three outcomes:
  - Resolver **validates correctly**
  - Resolver **fails to validate** (SERVFAIL)
  - Resolver **does not validate**
  - (yes, there are **corner cases** probably **not covered** by these three options)

# Live results

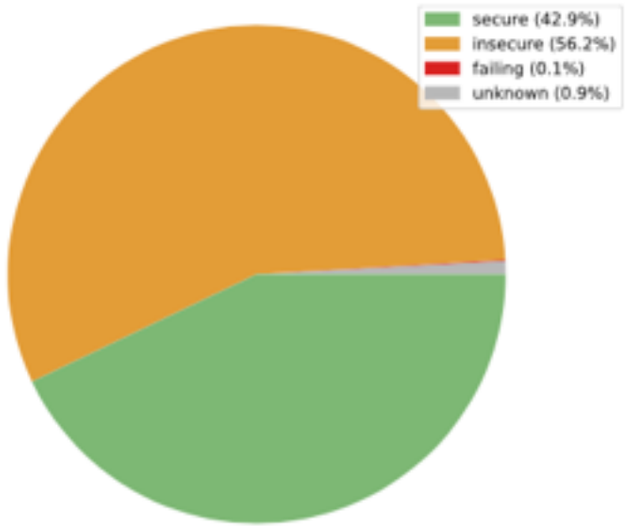
**https://portal.rootcanary.org/rcmstats.html**



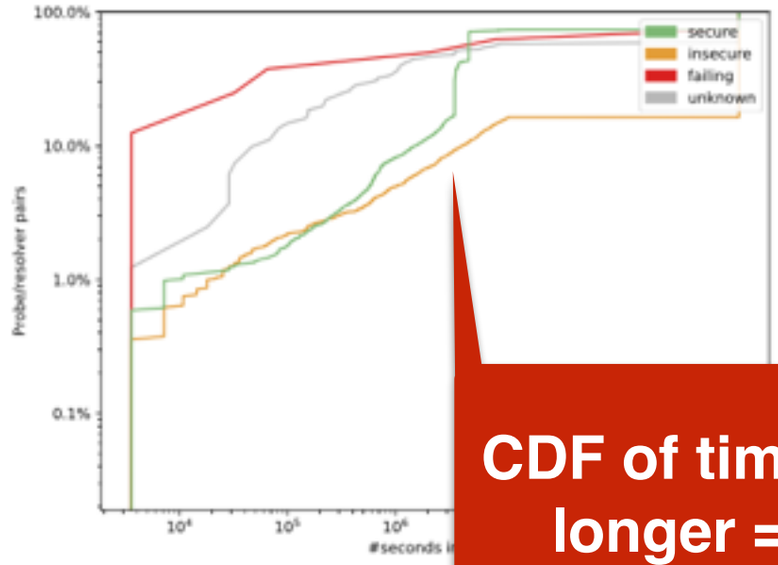

**https://rootcanary.org/**

# Live results

**DS: SHA-256, signed with RSA-SHA256**

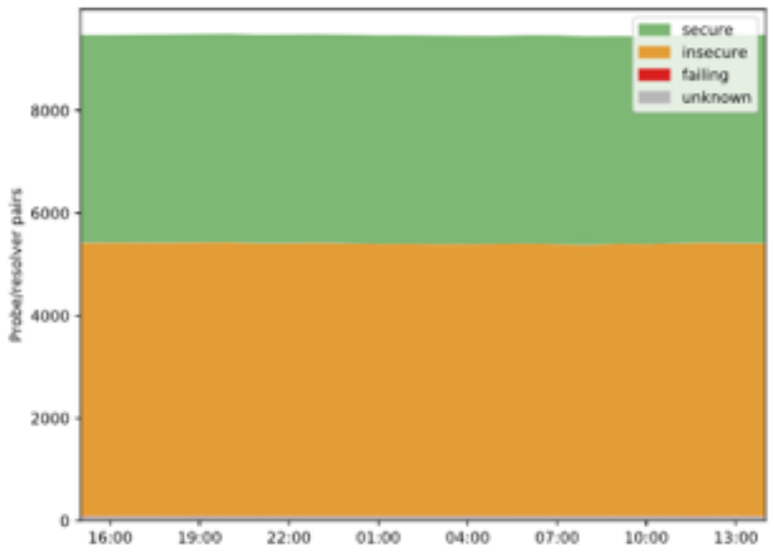



Current probe status for all probes

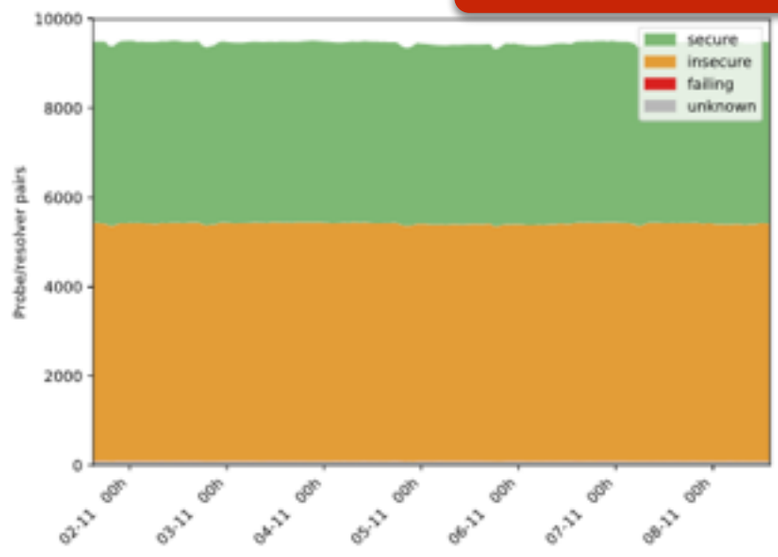



CDF for current tim

**CDF of time spent in state; longer == more stable ( > 80% of probes )**




All probes (24h)




All probes (7 days)

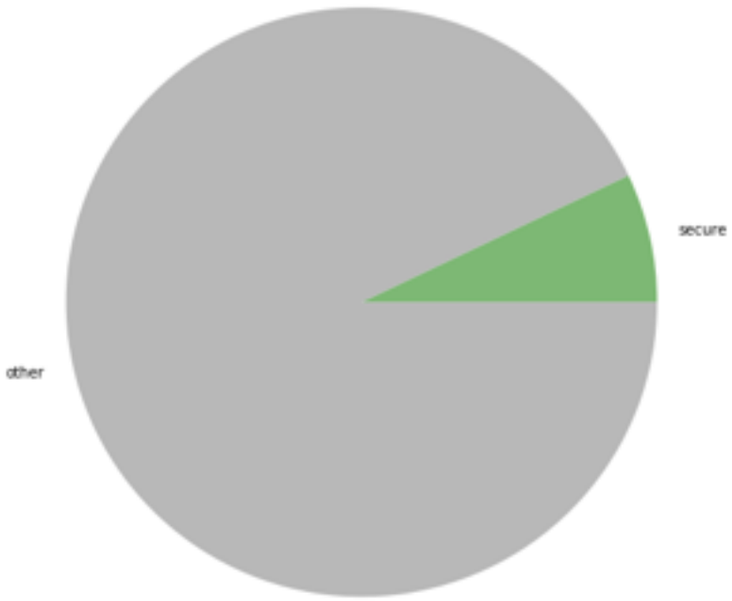
RIPE NCC
RIPE Atlas

https://rootcanary.org/

# No sh*t, RIPE Atlas is biased ;-)

## Luminati vs. RIPE Atlas: SHA256-RSA-SHA1

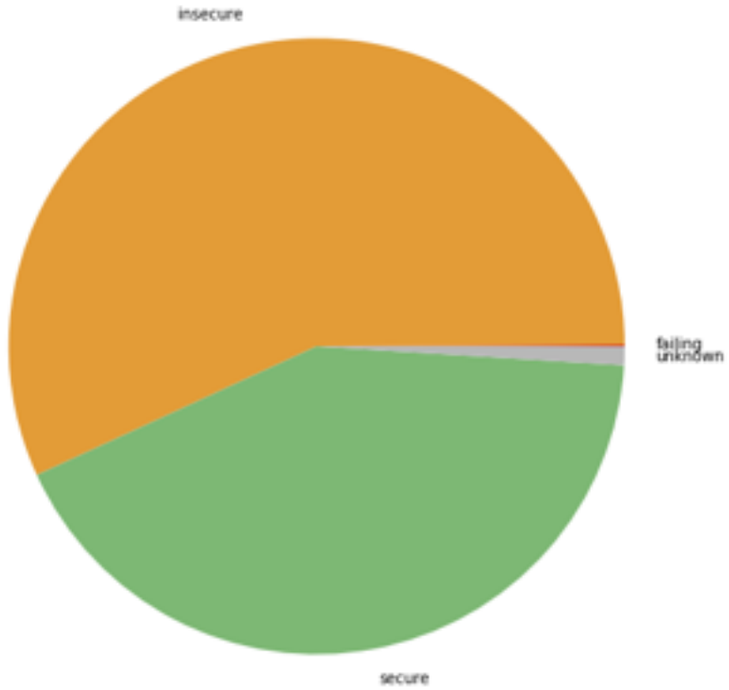
Luminati




~ 13,000 VPs

7% validating

RIPE NCC
RIPE Atlas




~ 9,000 VPs

42% validating

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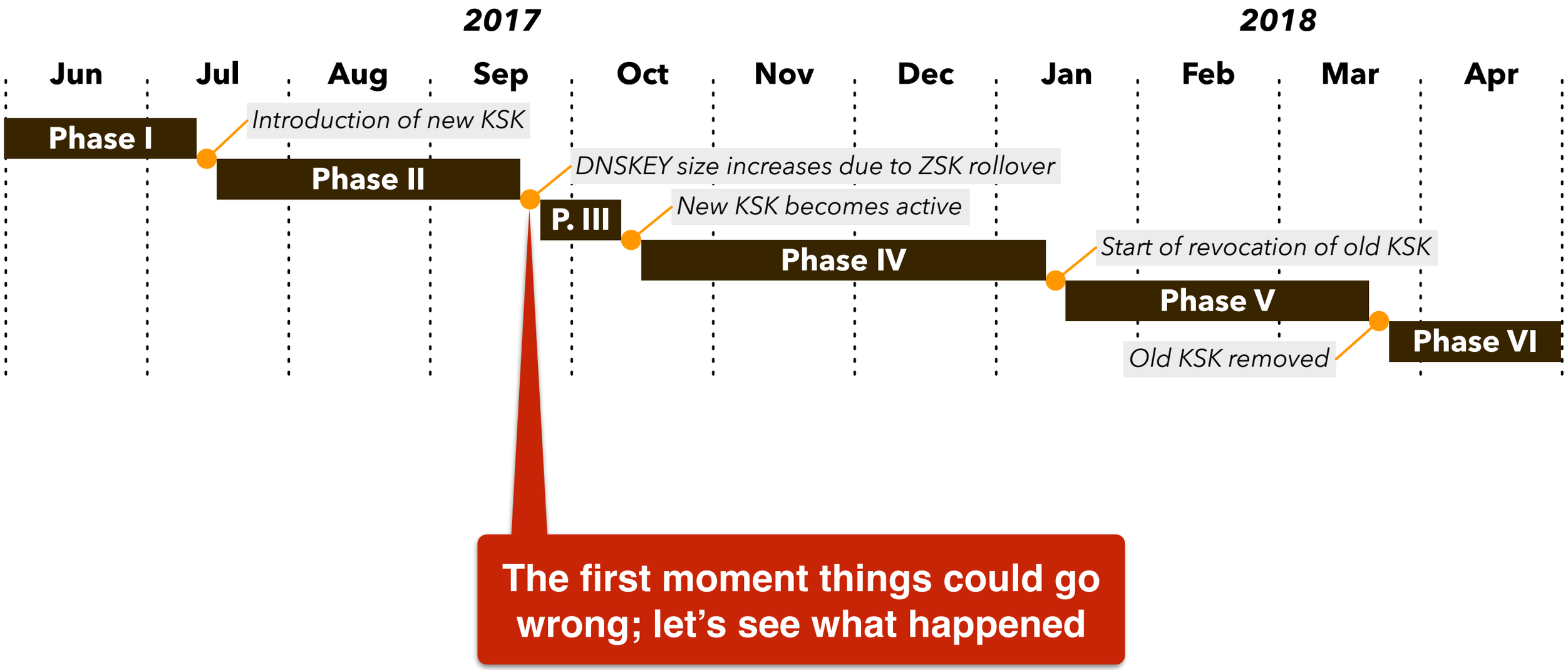
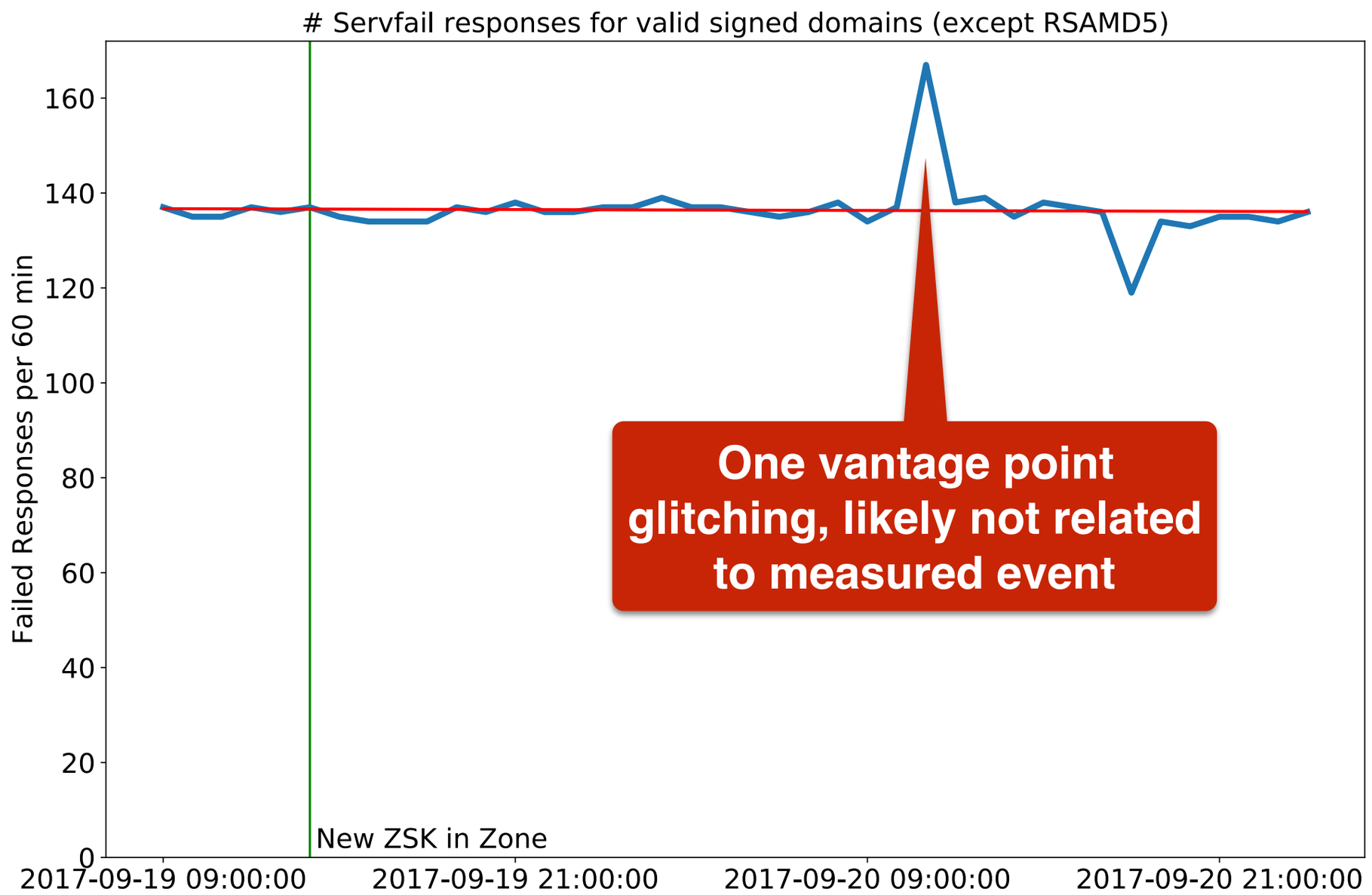
# Excitement?




https://rootcanary.org/

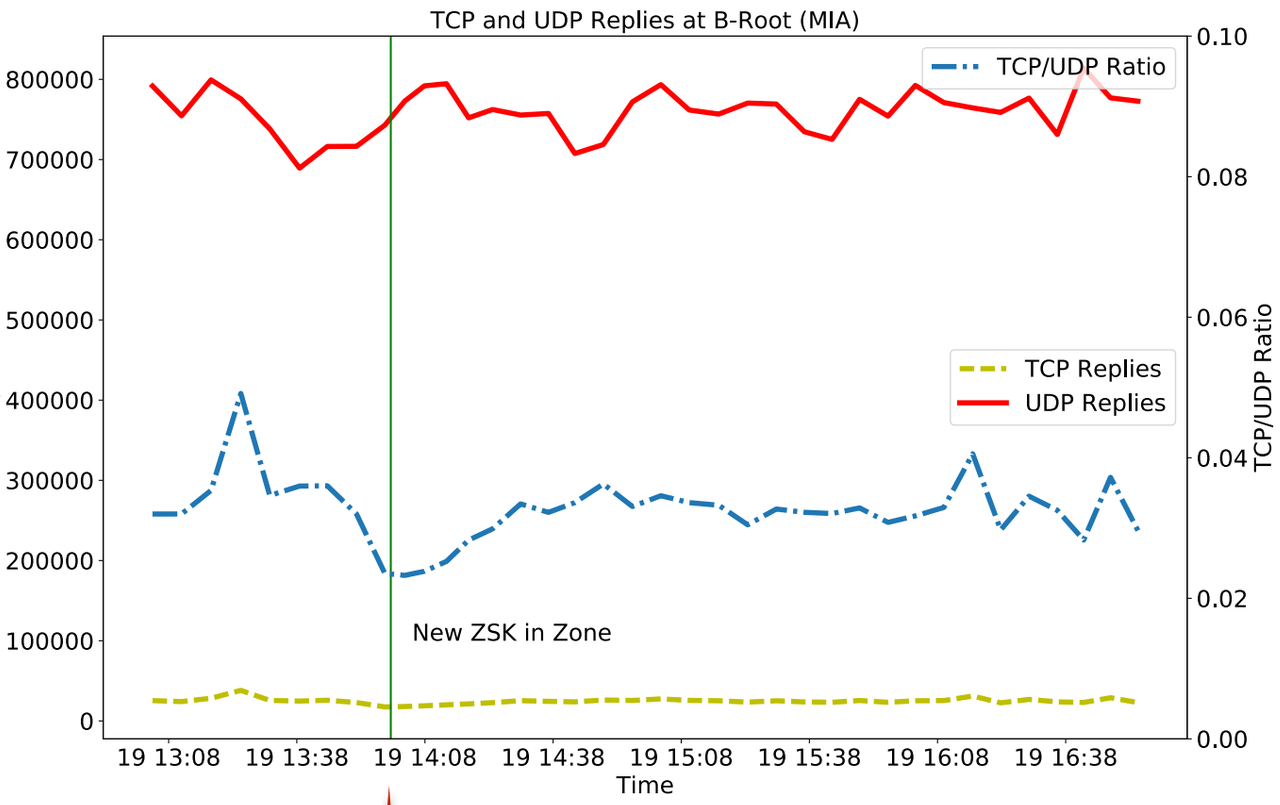
# So what happened?

- Preliminary Findings after 2017-09-19:




https://rootcanary.org/

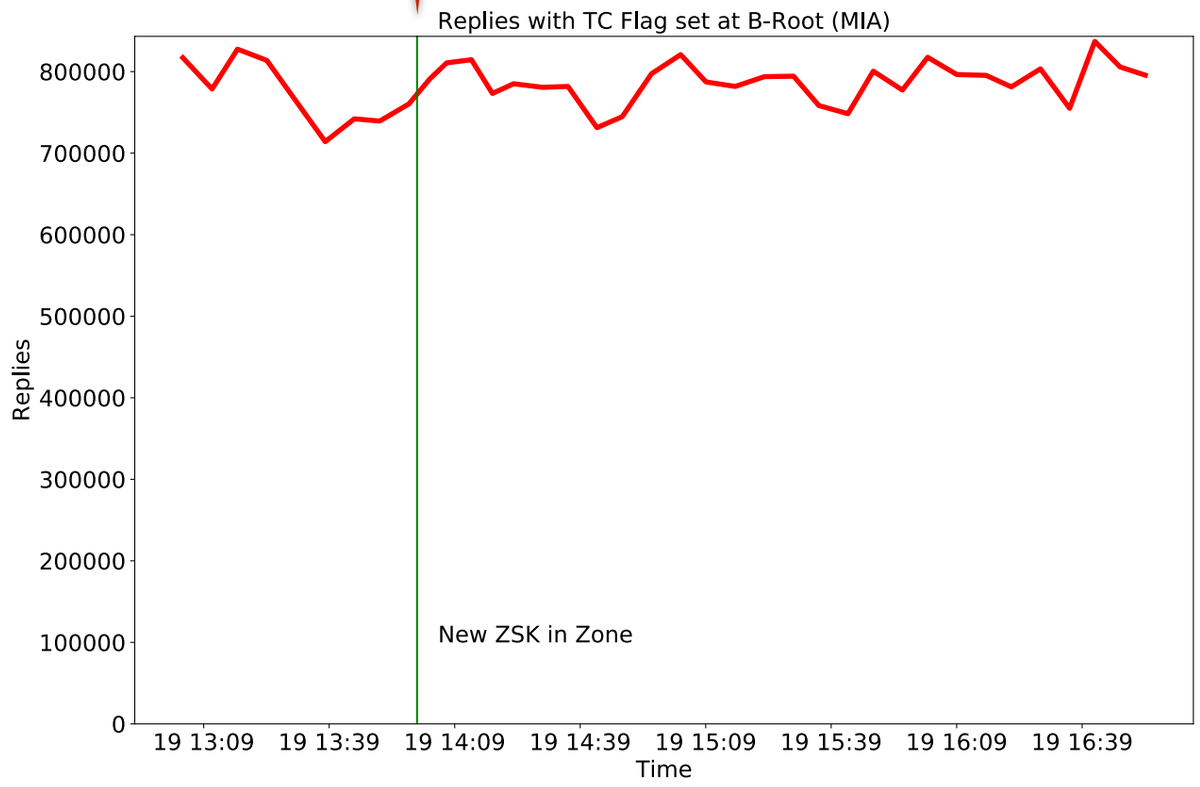
# What about traffic to the root?




**No noticeable increase in TCP traffic**

**with thanks to Wes Hardaker (USC/ISI) for preliminary access to B-root traffic**

**No noticeable increase in truncated responses**

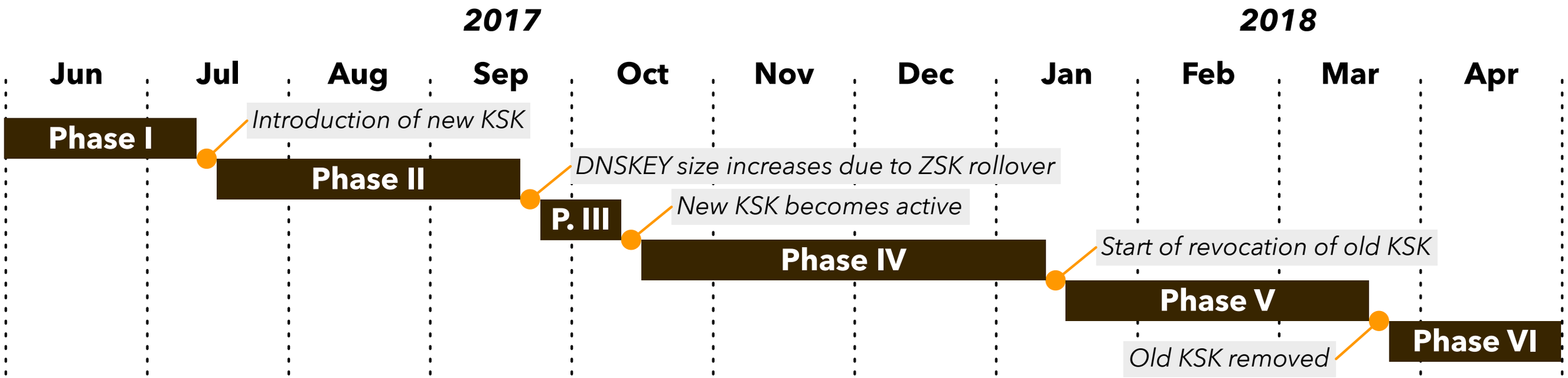



https://rootcanary.org/

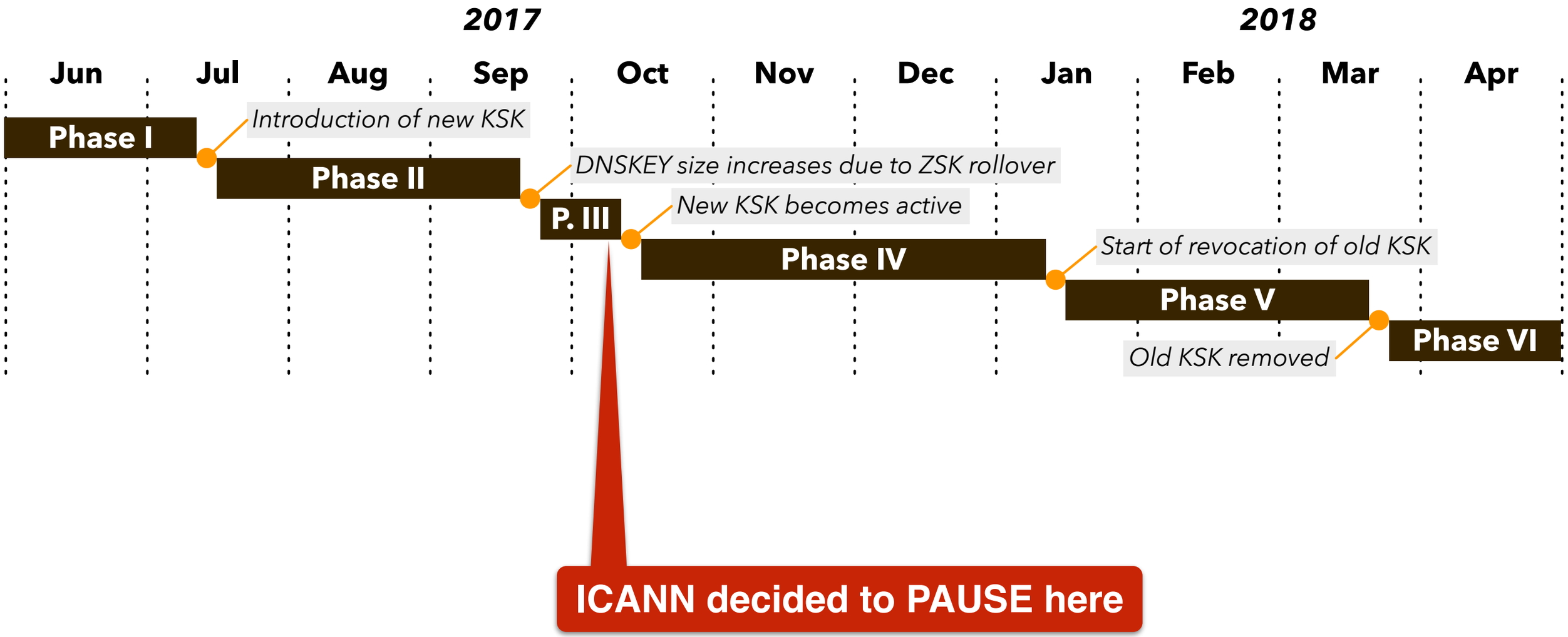
# Summary

Nothing *exciting* happened.

# And then…


2017
2018
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Phase I
Introduction of new KSK
Phase II
DNSKEY size increases due to ZSK rollover
P. III
New KSK becomes active
Phase IV
Start of revocation of old KSK
Phase V
Old KSK removed
Phase VI

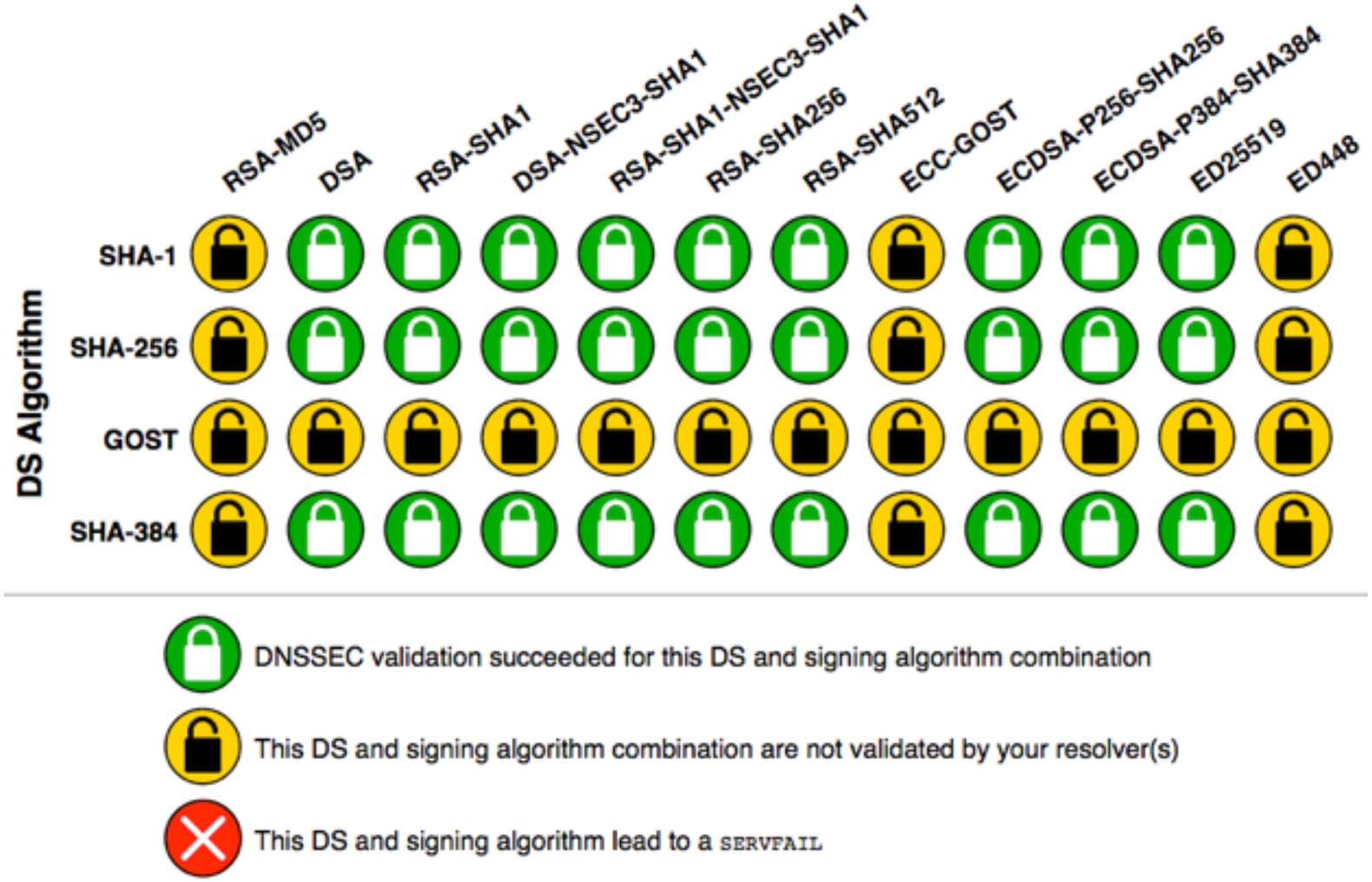
# And then…




- So did we do **all this work for nothing?**

# Spin-offs (1)

- First spin off: **online algorithm test**

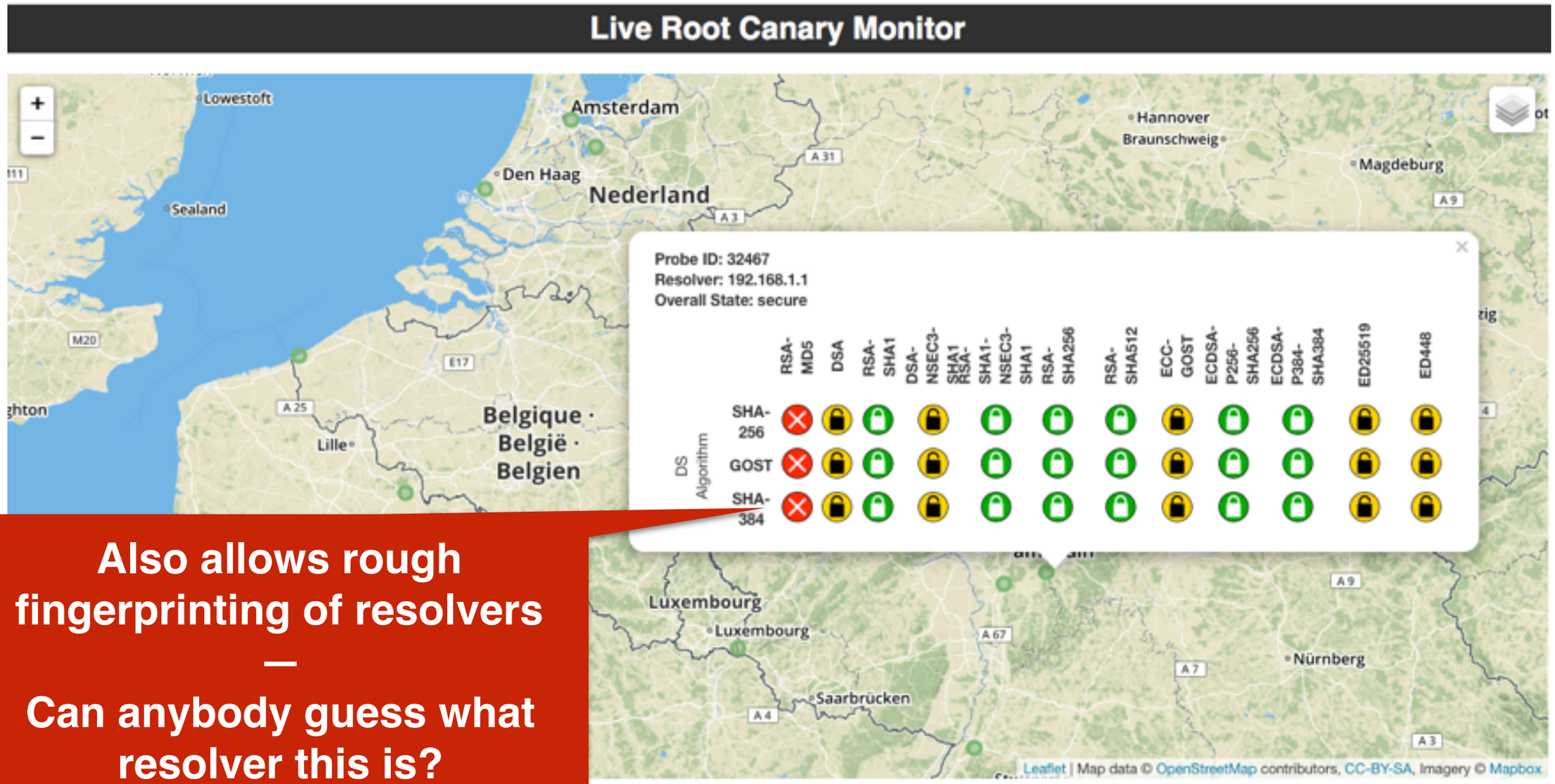



**https://portal.rootcanary.org/**

**https://rootcanary.org/**

# Spin-offs (2)

- We **test** algorithm support for **all probes over time**




**Also allows rough fingerprinting of resolvers**

**—**

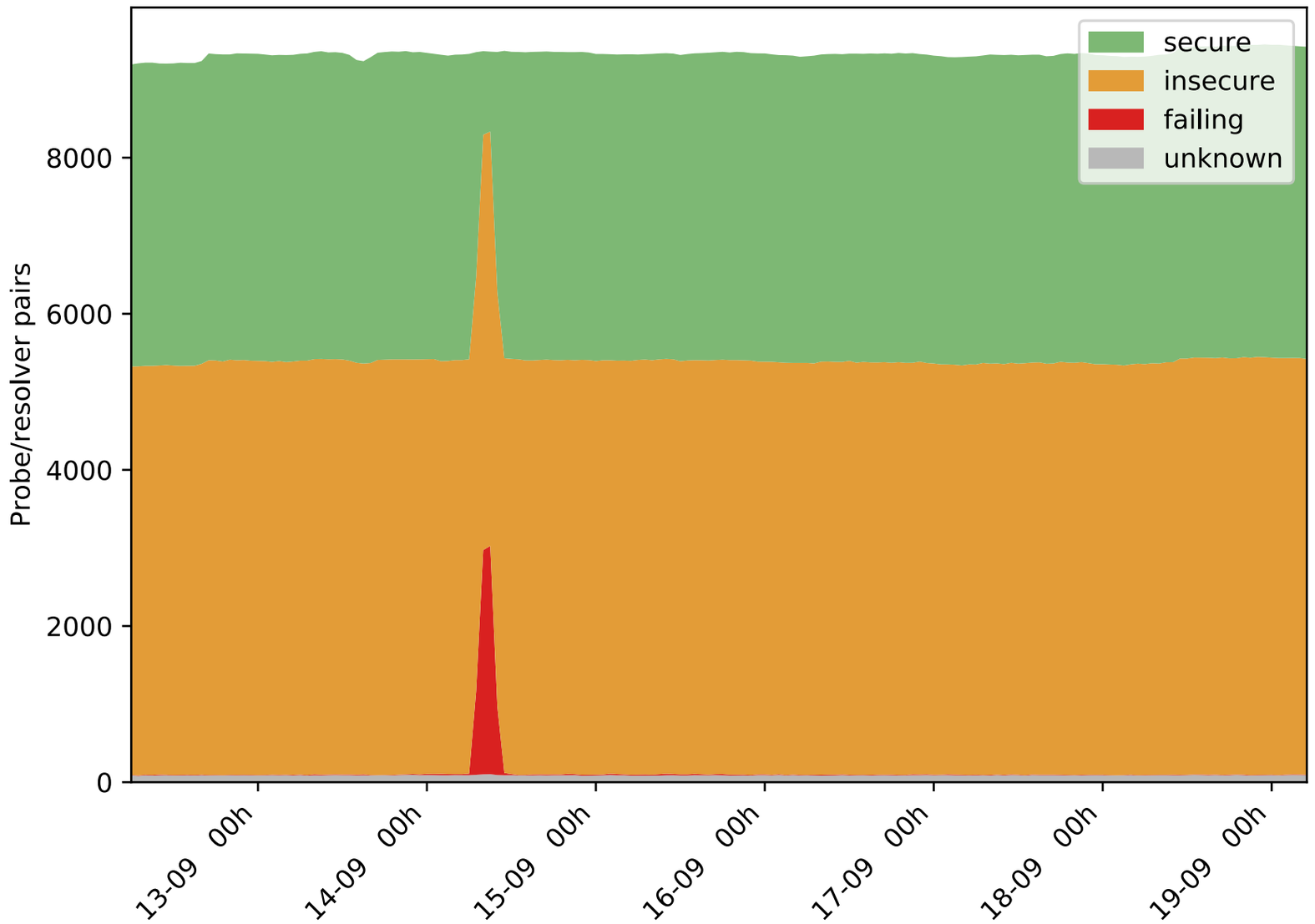
**Can anybody guess what resolver this is?**

**https://monitor.rootcanary.org/**

**https://rootcanary.org/**

# Spin-offs (3)

- **Oops**, we **forgot to re-sign** our test domains…




**https://rootcanary.org/**

# Spin-offs (3)

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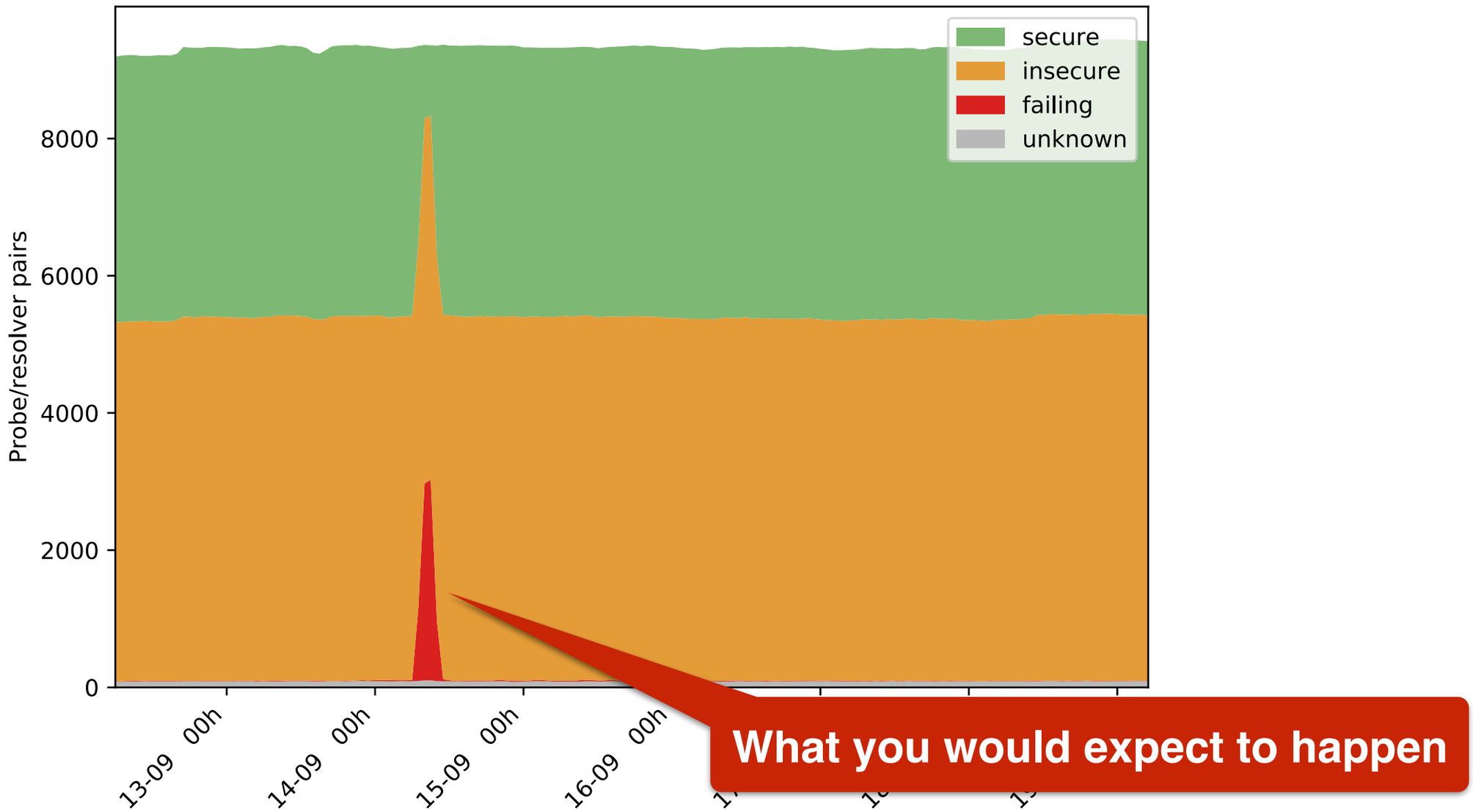



https://rootcanary.org/

# Spin-offs (3)

- **Oops**, we **forgot to re-sign** our test domains…


https://rootcanary.org/

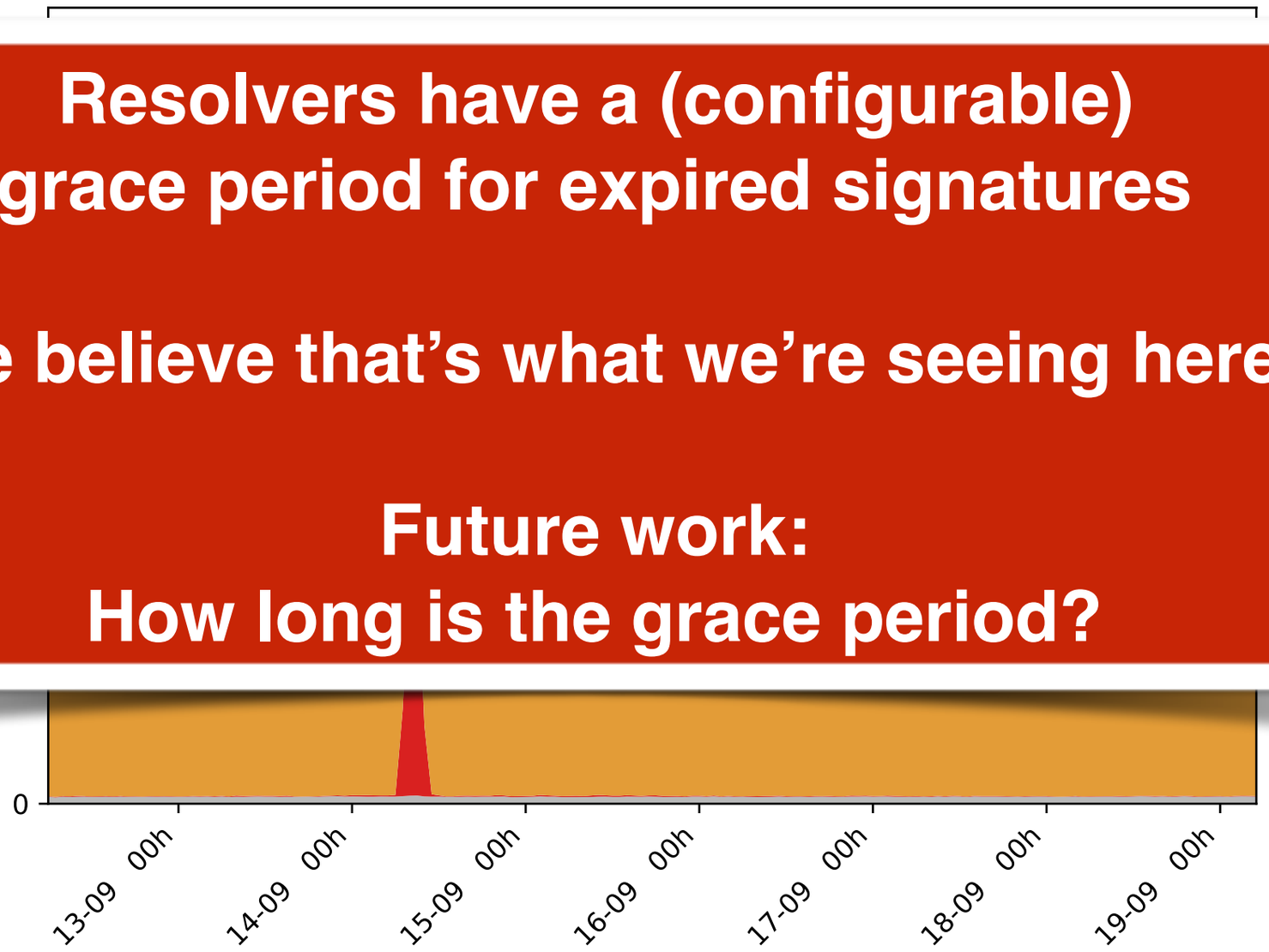
# Spin-offs (3)

- **Oops**, we **forgot to re-sign** our test domains…

**Resolvers have a (configurable) grace period for expired signatures**

**We believe that's what we're seeing here**

**Future work:**
**How long is the grace period?**



# Röot Cånåry

https://rootcanary.org/

# Röot Cånåry

- The good folks at **IIS** are performing a **KSK *and* algorithm rollover** for the **.se** ccTLD*

- Asked if Root Canary team could **measure** this event **and signal problems** to them

- Much more **“agile” timescale** than Root KSK — entire process takes **less than two weeks**

*https://www.iis.se/se-tech/se-ksk-algorithm-rollover/

# Röot Cånåry

- Developed **new methodology** for this project, to also cover **issues specific to algorithm rollover**

- **.se** was **first TLD to sign** its domain **in 2005** — this is well **pre- signed root**, consequently **resolvers with separate .se trust anchors may exist in the wild**

- **Tests** show many **resolver implementations** give **precedence to local trust anchor**, so a **rollover** may result in **SERVFAIL**s for those resolvers (!)*

*Discusion about this initiated by Moritz from our team:
https://www.ietf.org/mail-archive/web/dnsop/current/msg21179.html

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# Röot Cånåry

- Approached by .se at DNS-OARC
- .se performing algo + KSK rollover
- .se interesting position: resolvers may have fixed trust anchors as .se was first signed TLD (2005 — check)
- Will measure specific aspects of algorithm rollover (signature publication, key publication, …)
- Spin-off: methodology for operators that want to perform similar rollovers
- Learning about what resolvers do if they have a separate TA, thread on DNSOP

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# Conclusions

- We **started measuring** the Root KSK rollover **as** a sort-of **ad-hoc project**

- As our **thinking** about the measurement **evolved**, many **spin-offs developed**

- Example **case study** of why **measuring rare events** that hit **corner cases** are (extremely) useful

- **Measurements —> Better understanding —> Better protocols,** (hopefully) **fewer failures.**

# Open data

- The Root Canary measurement data performed by RIPE Atlas is publicly available through the Atlas API
- Our aggregate results can be monitored as a live stream over Websockets (https://monitor.rootcanary.org:443/new_ripe_msm)
- We will release datasets for publications coming out of this work as open data, but if you want data now, come talk to me!

# Thank you for your attention!
# Questions?

**acknowledgments: with thanks to**
**Willem Toorop, Taejoong Chung and Moritz Müller**

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