Analysis of SSL certificate reissues and revocations in the wake of Heartbleed

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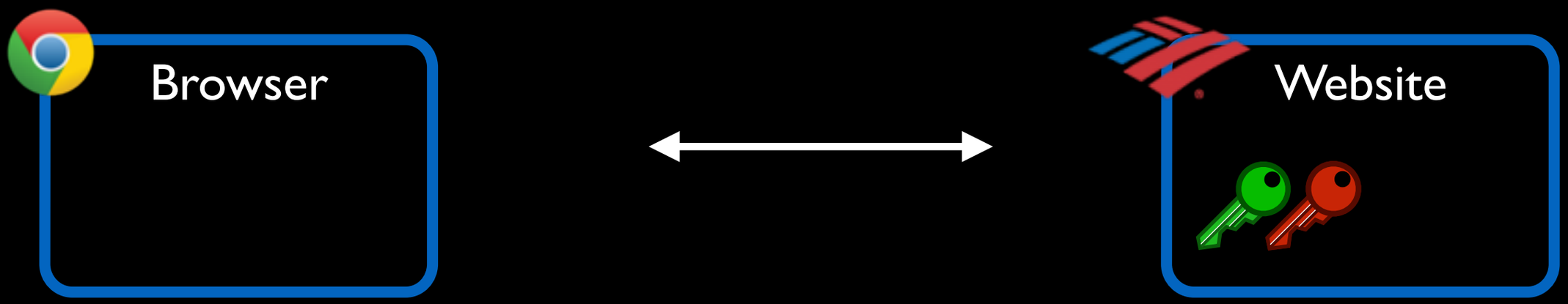
Public Key Infrastructures (PKIs)

How can users truly know with whom they are communicating?



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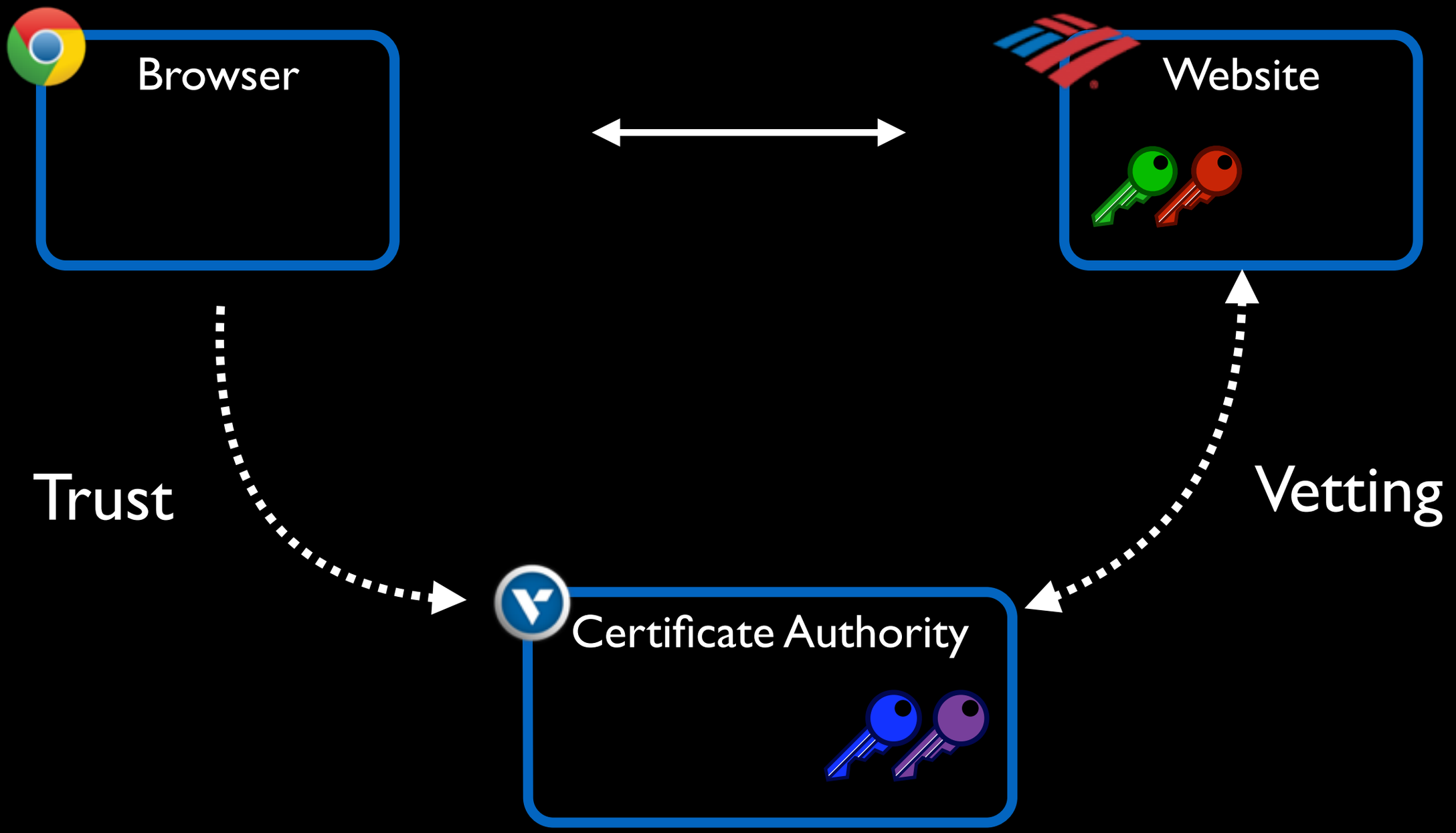

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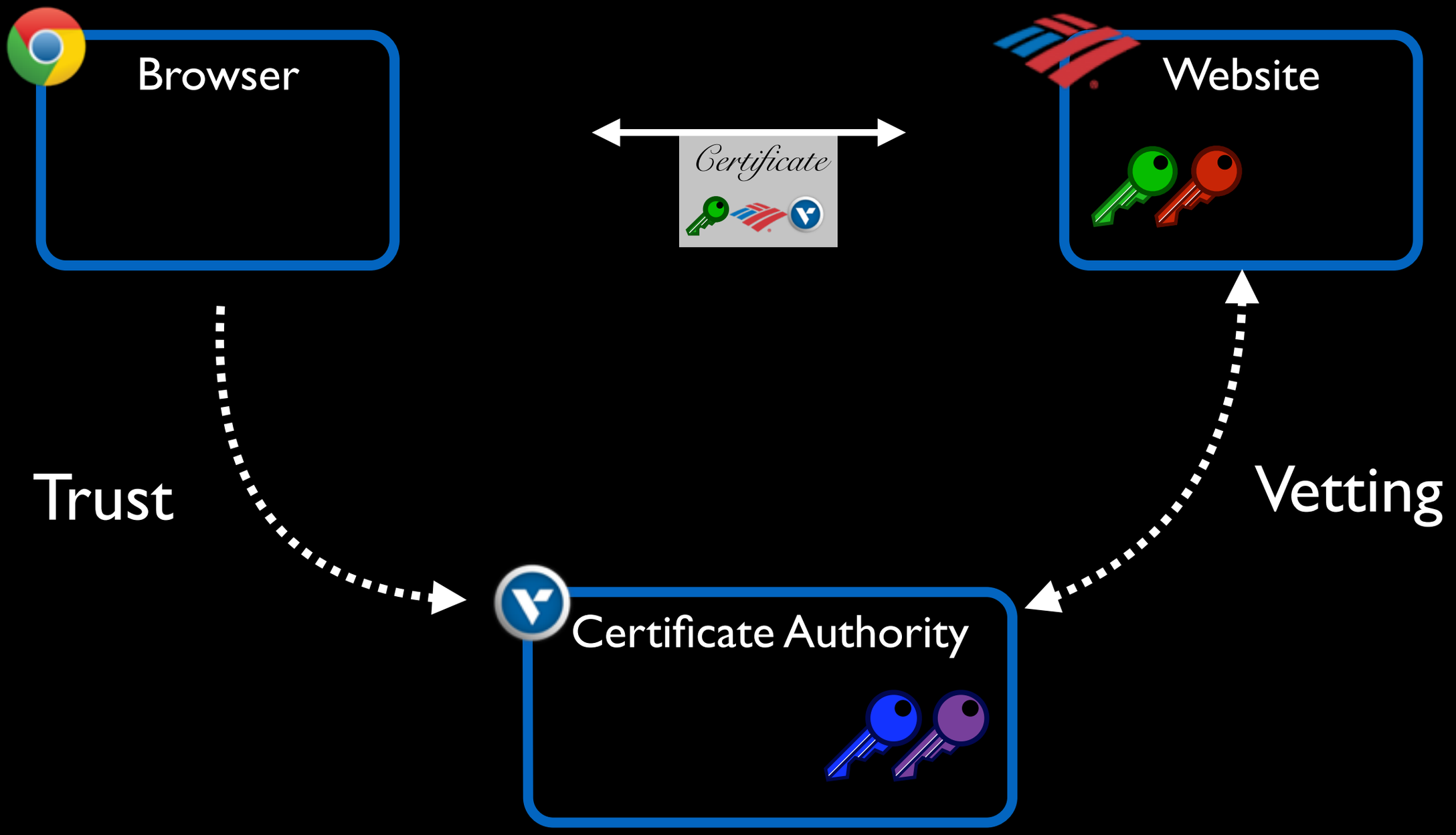

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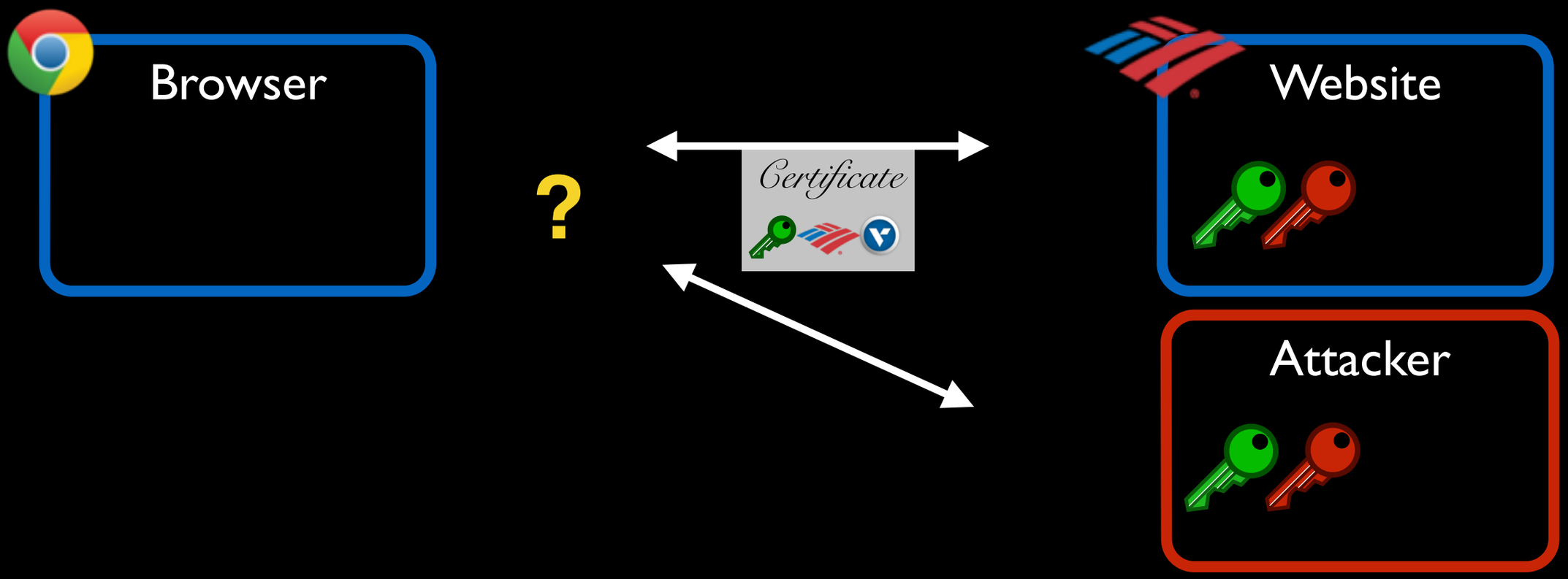

What needs to do when a certificate is no longer valid?

Certificate revocation
is a critical part of any PKI

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In practice:

How quickly and thoroughly do administrators act?

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April 7

Every vulnerable website should have:

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2. Revoked
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April 7 → *Every* vulnerable website should have:

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Heartbleed is a natural experiment:
For studying SSL certificate reissues and revocations

Outline

1. ~~Motivation~~
2. Data and methodology
3. Analysis

Dataset

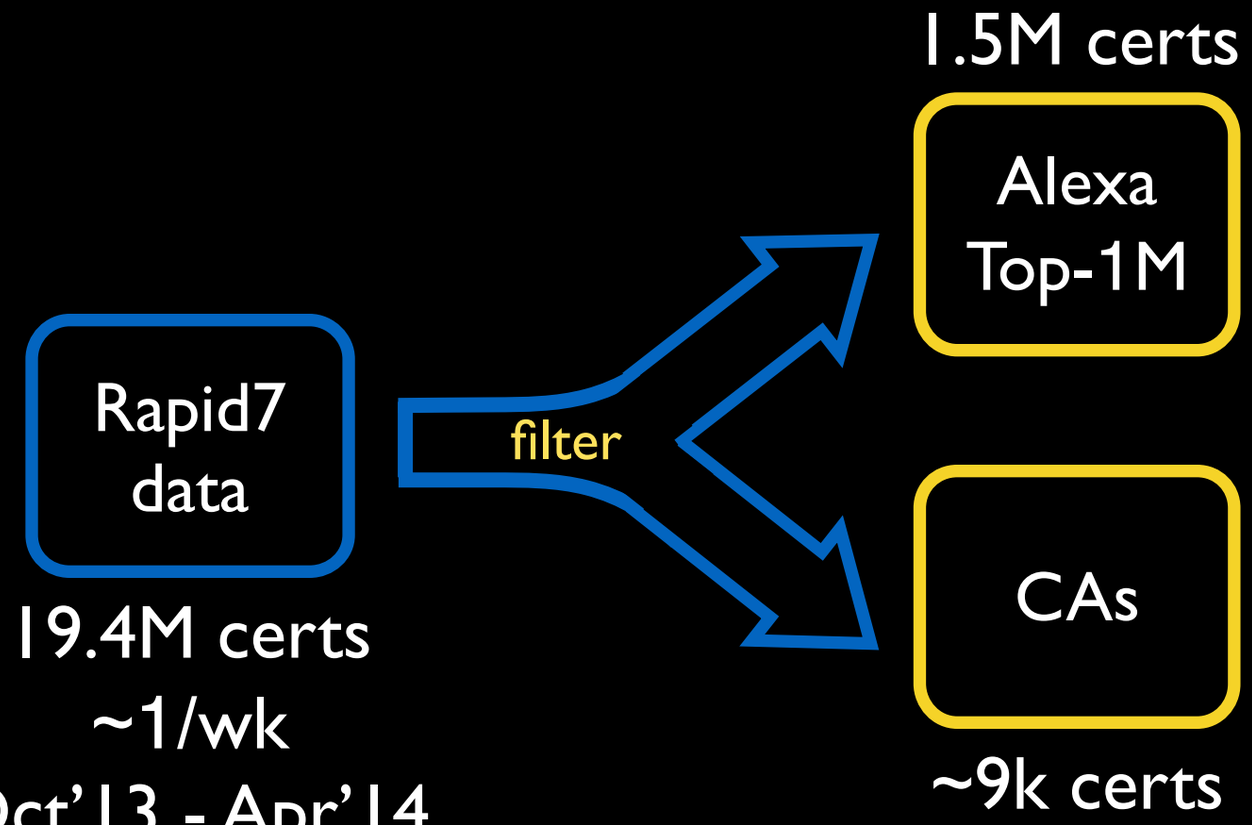
Rapid7
data

19.4M certs

~1/wk

Oct'13 - Apr'14

Dataset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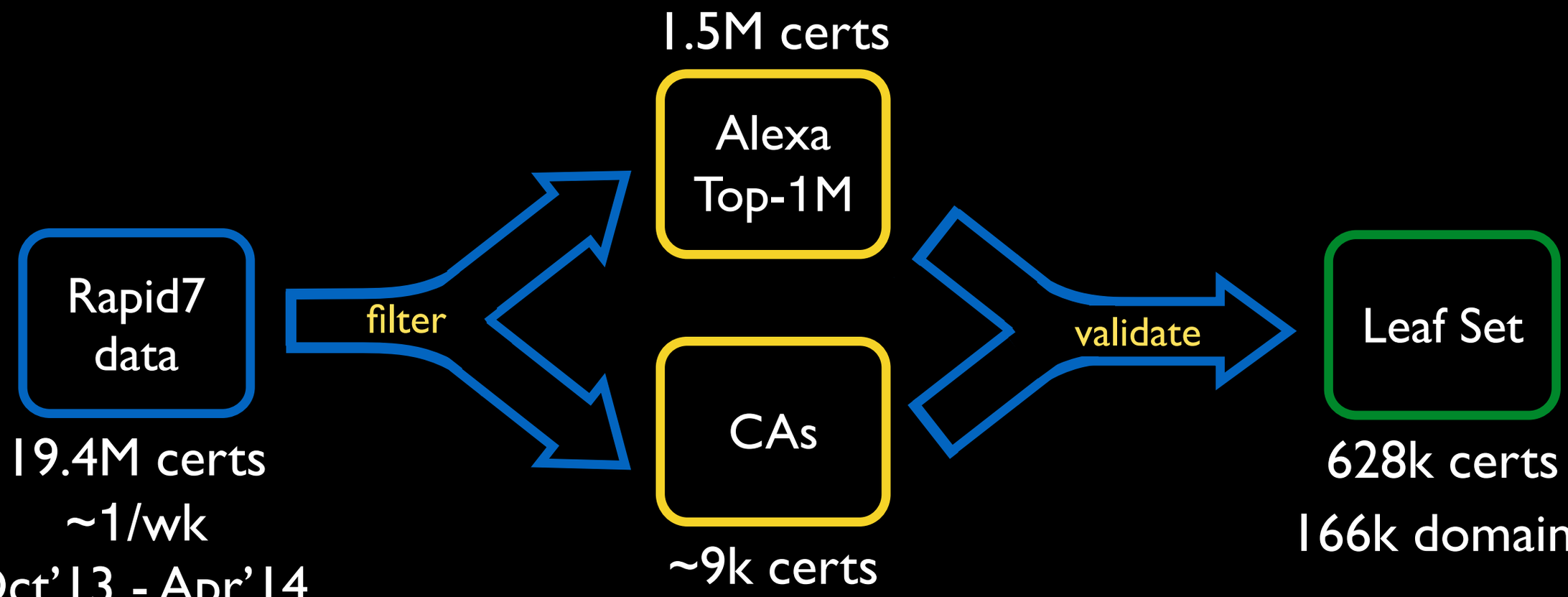
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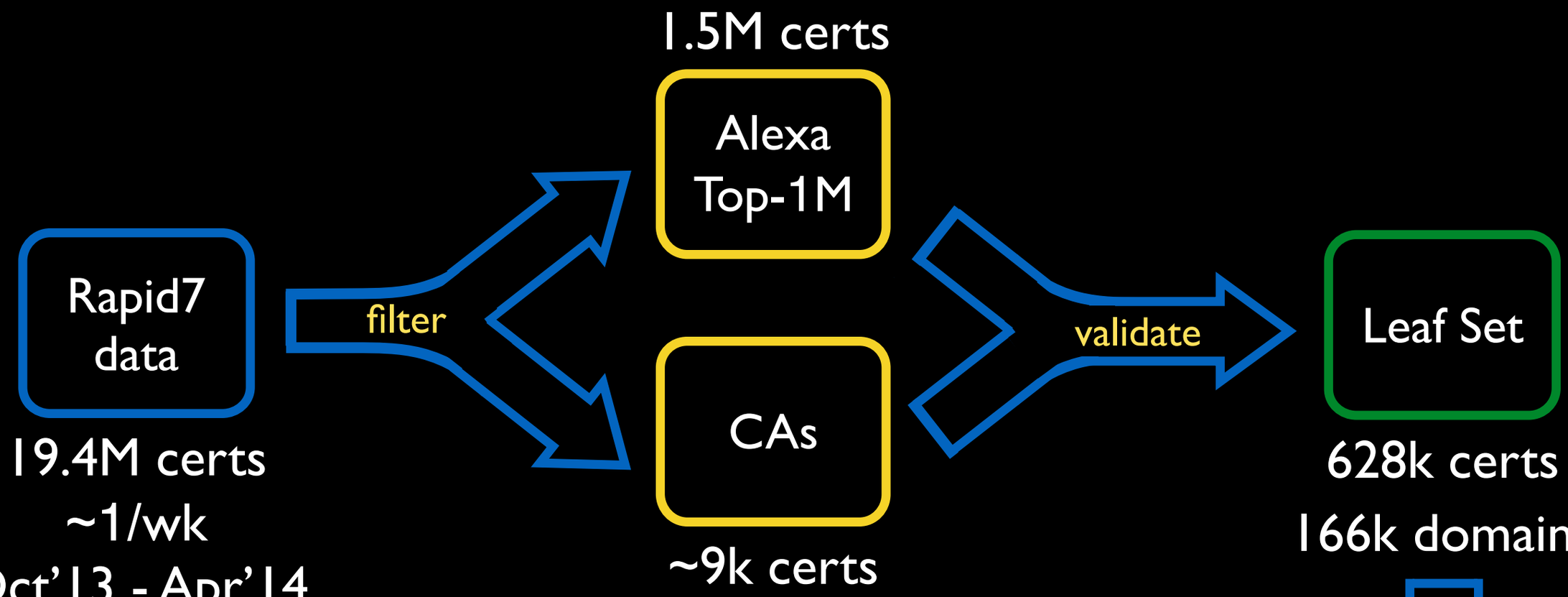
628k certs
166k domains

Dataset



- Download CRLs
- Detect Heartbleed vulnerability

Identifying reissues

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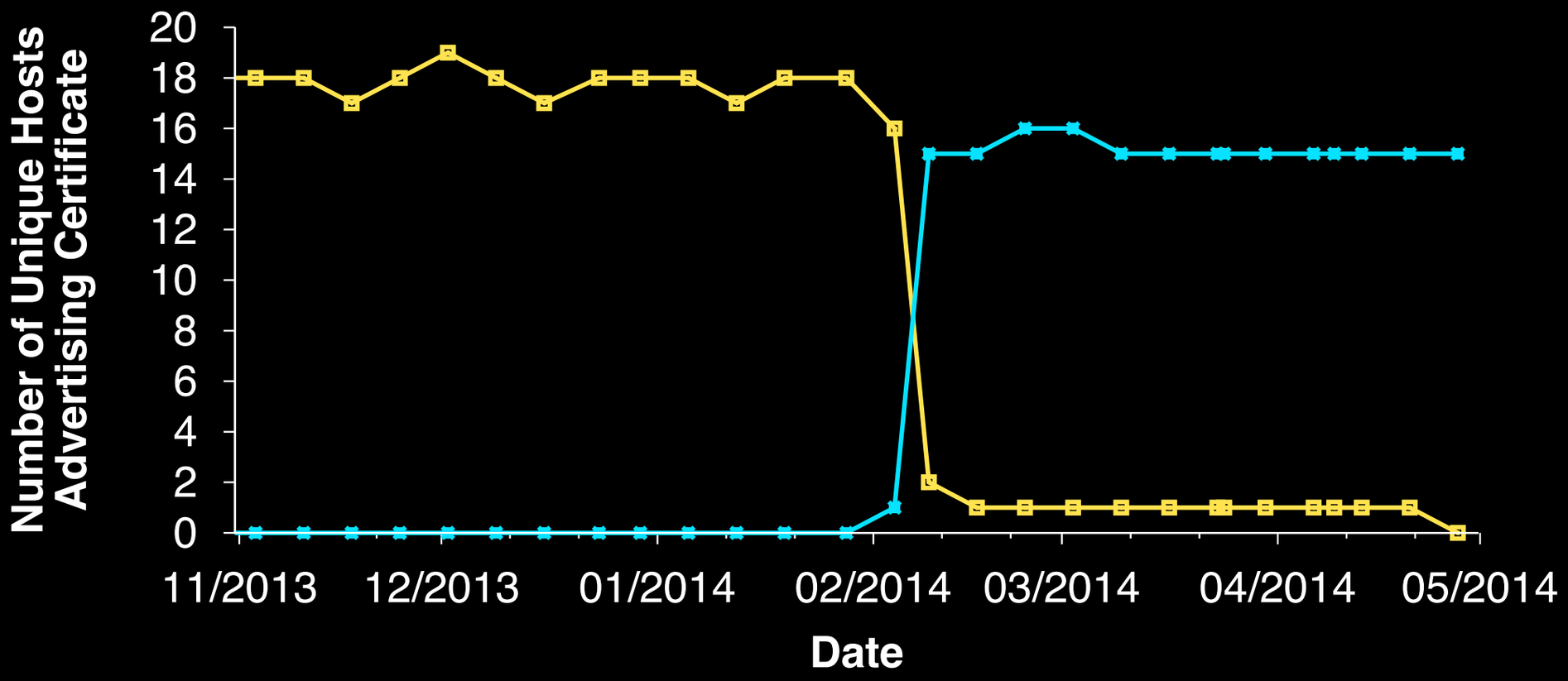

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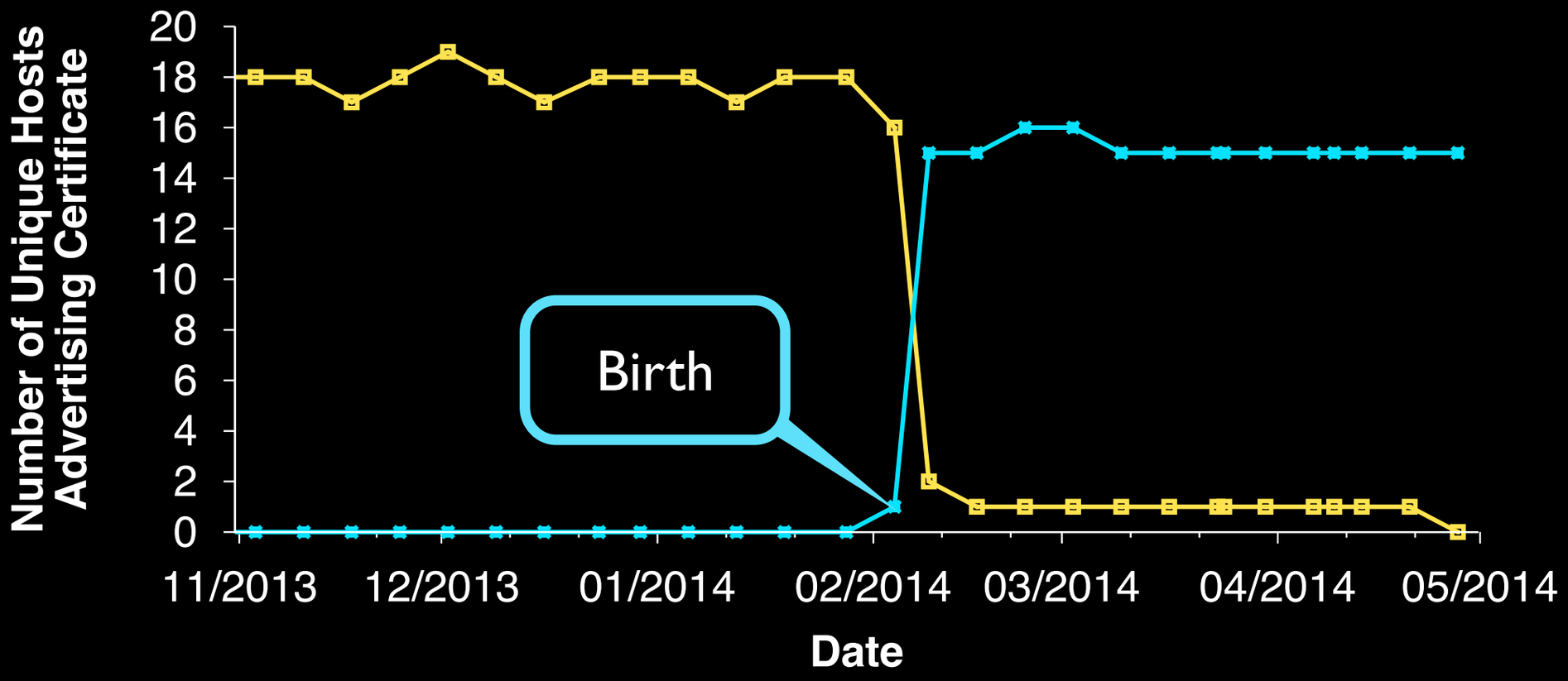

Birth — First crawl we see it announced

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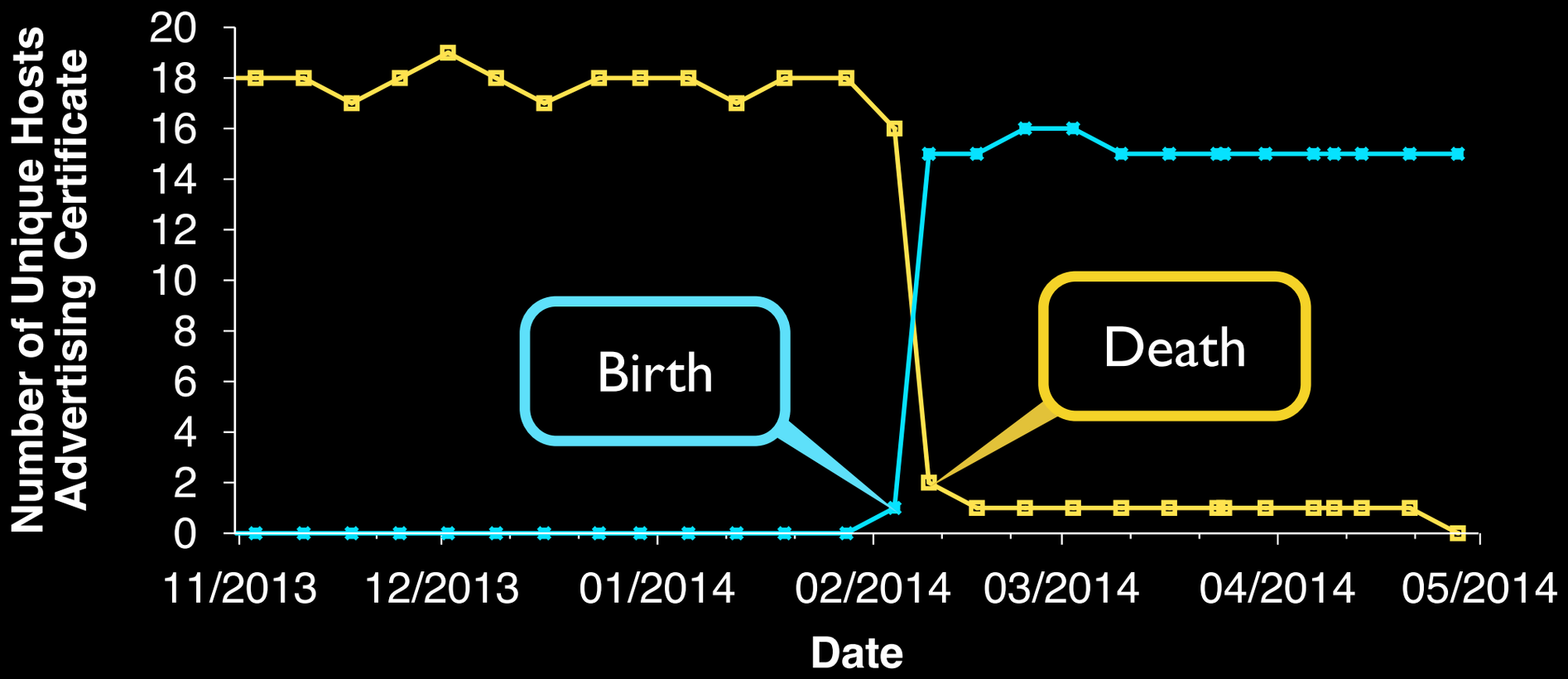

Death — First crawl with ≤10% still announcing it

Identifying reissues

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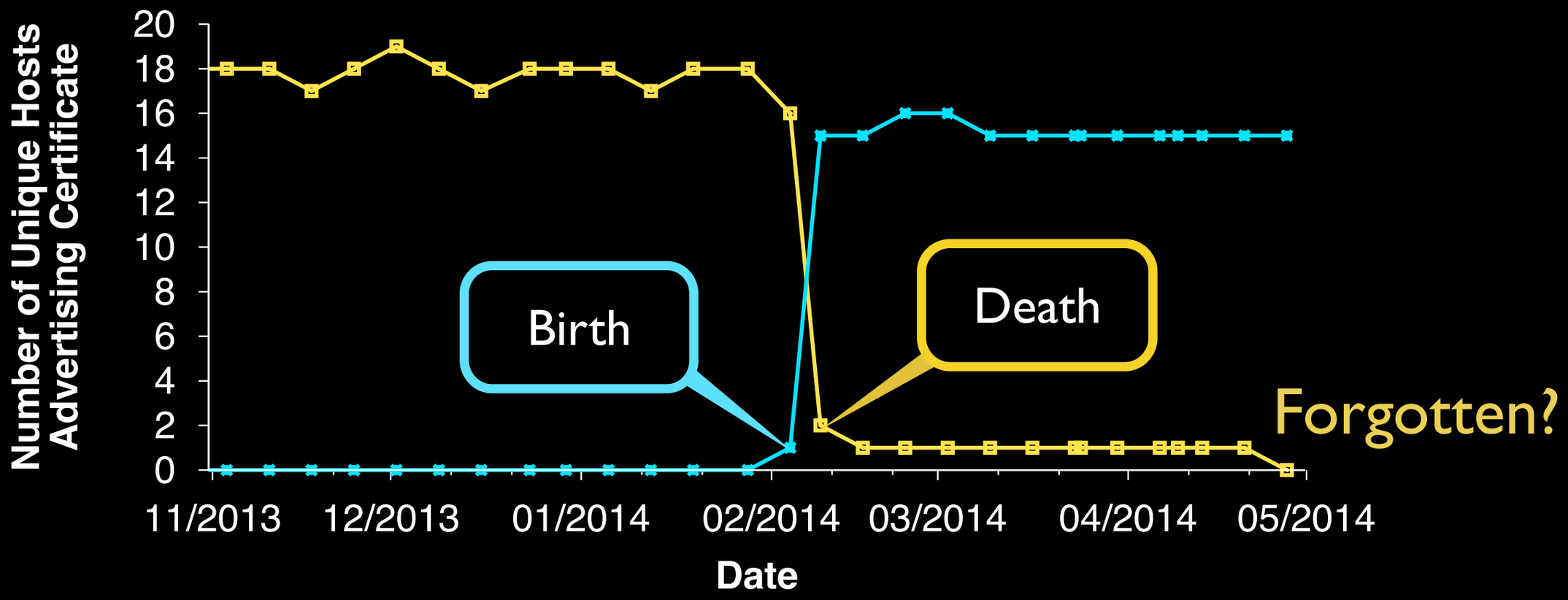

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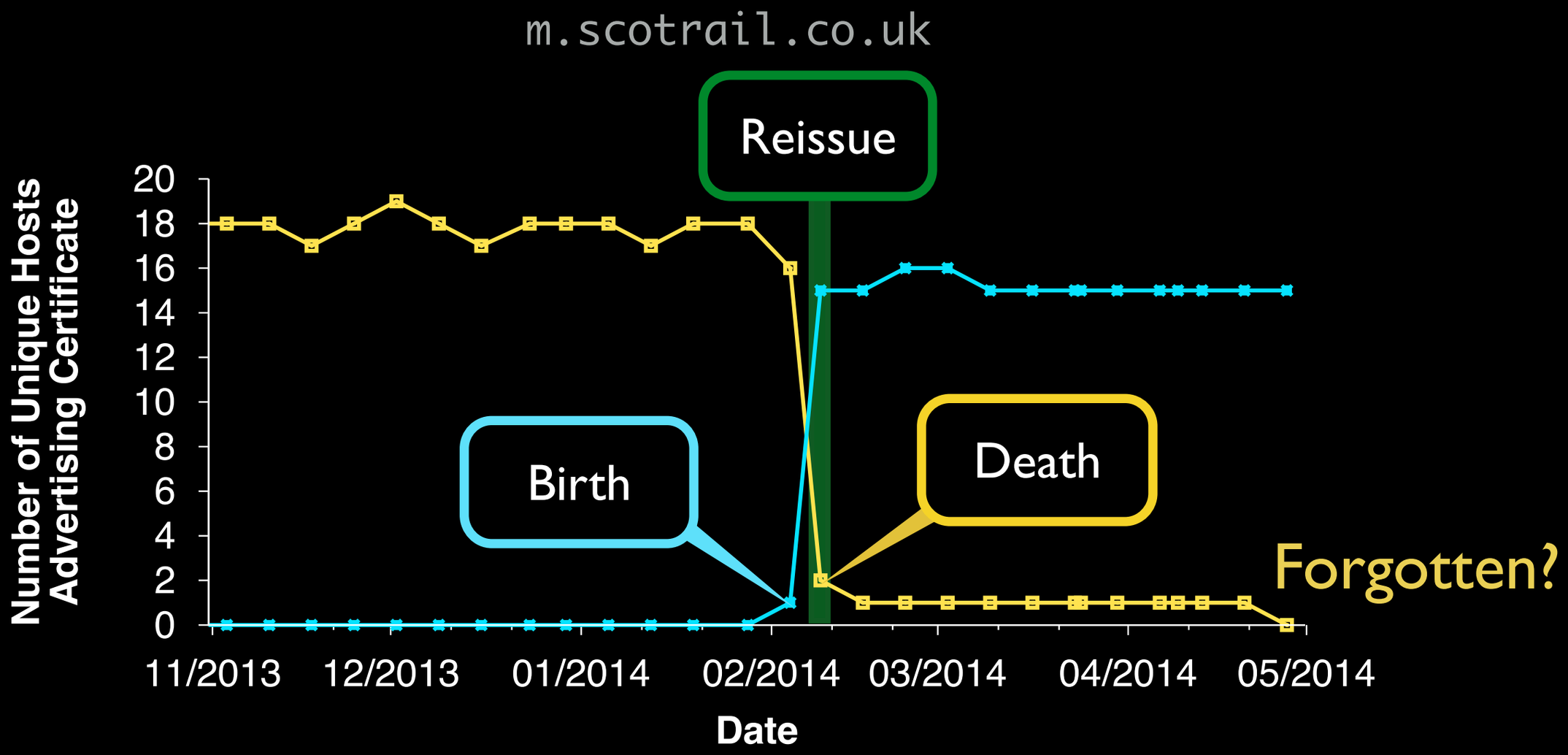

Reissue — Birth + death + we see a host swap

Attributing reissues to Heartbleed

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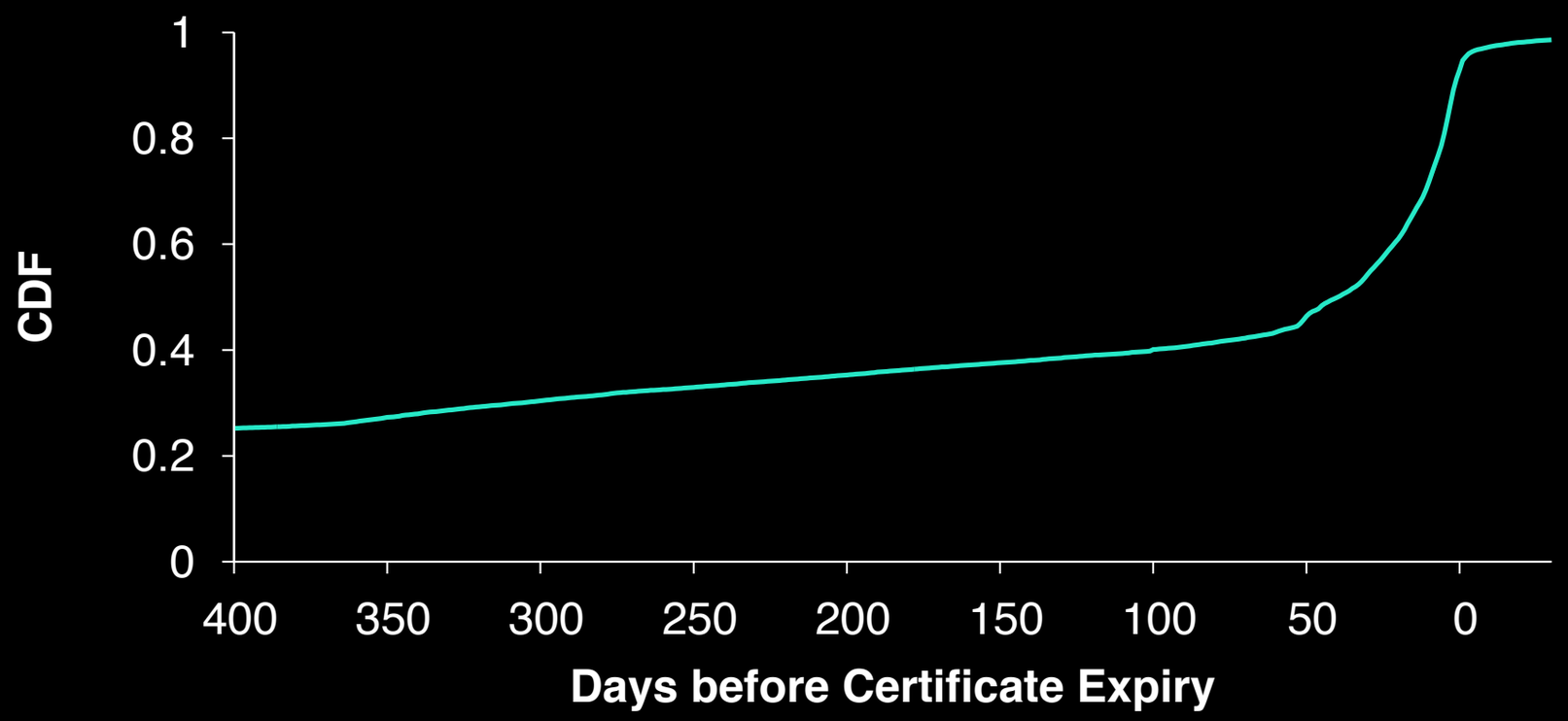

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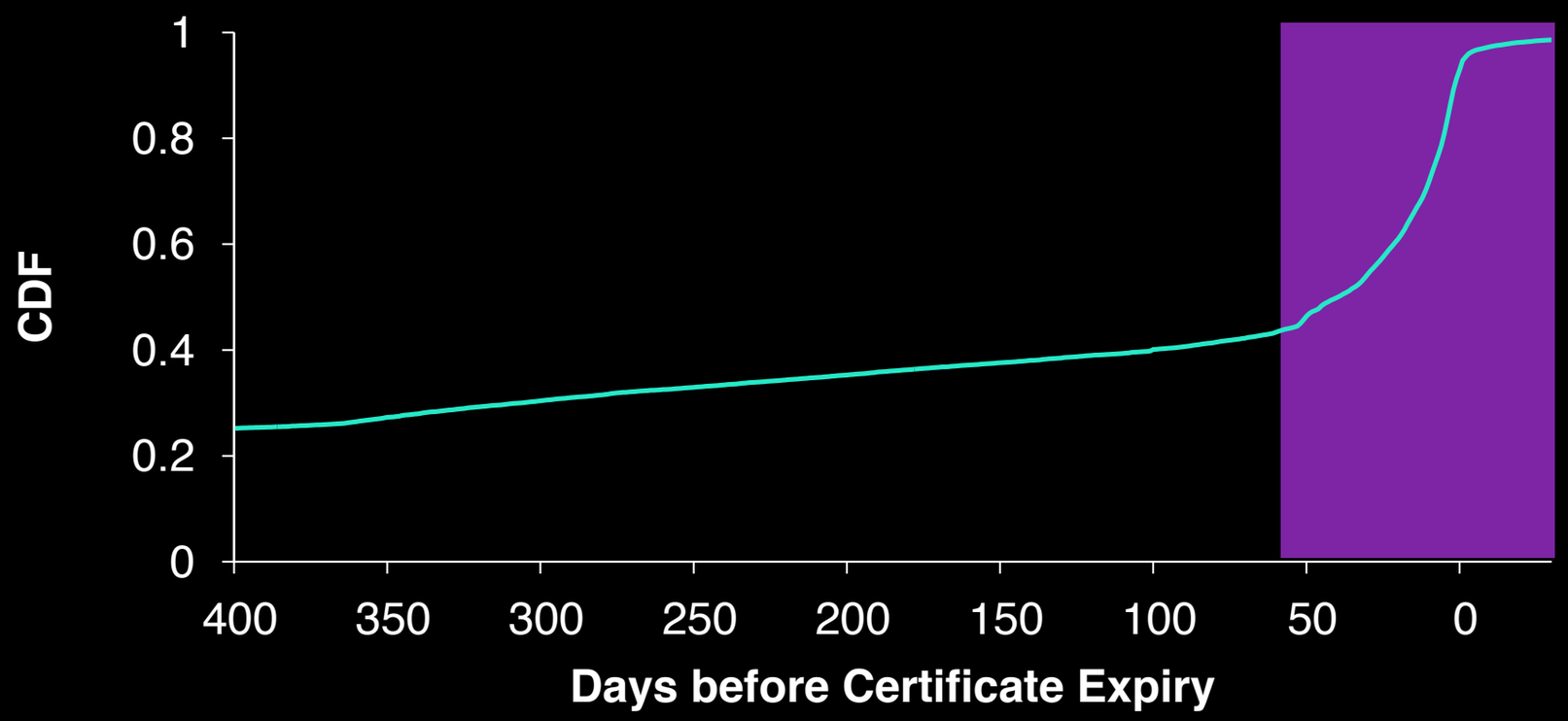

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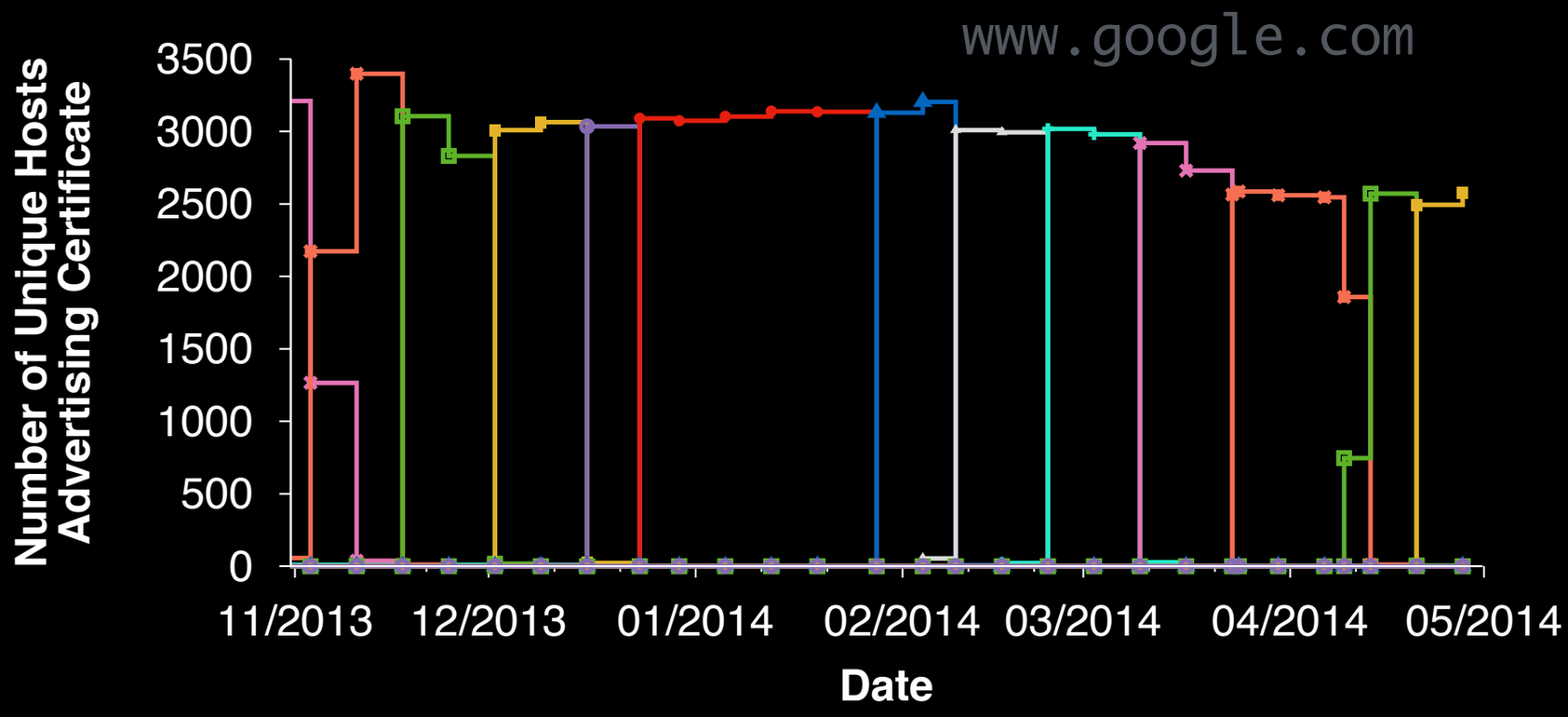

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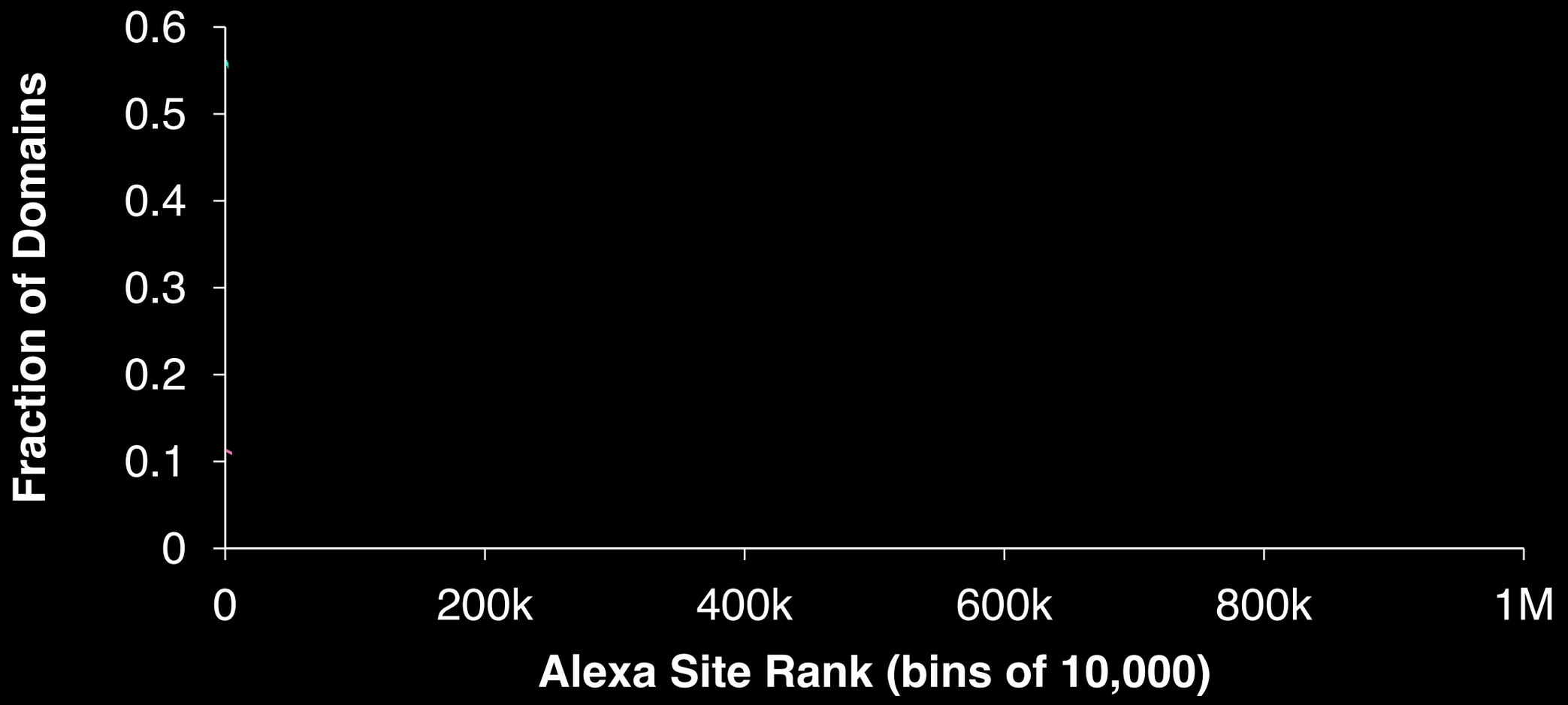
Prevalence and patch rates



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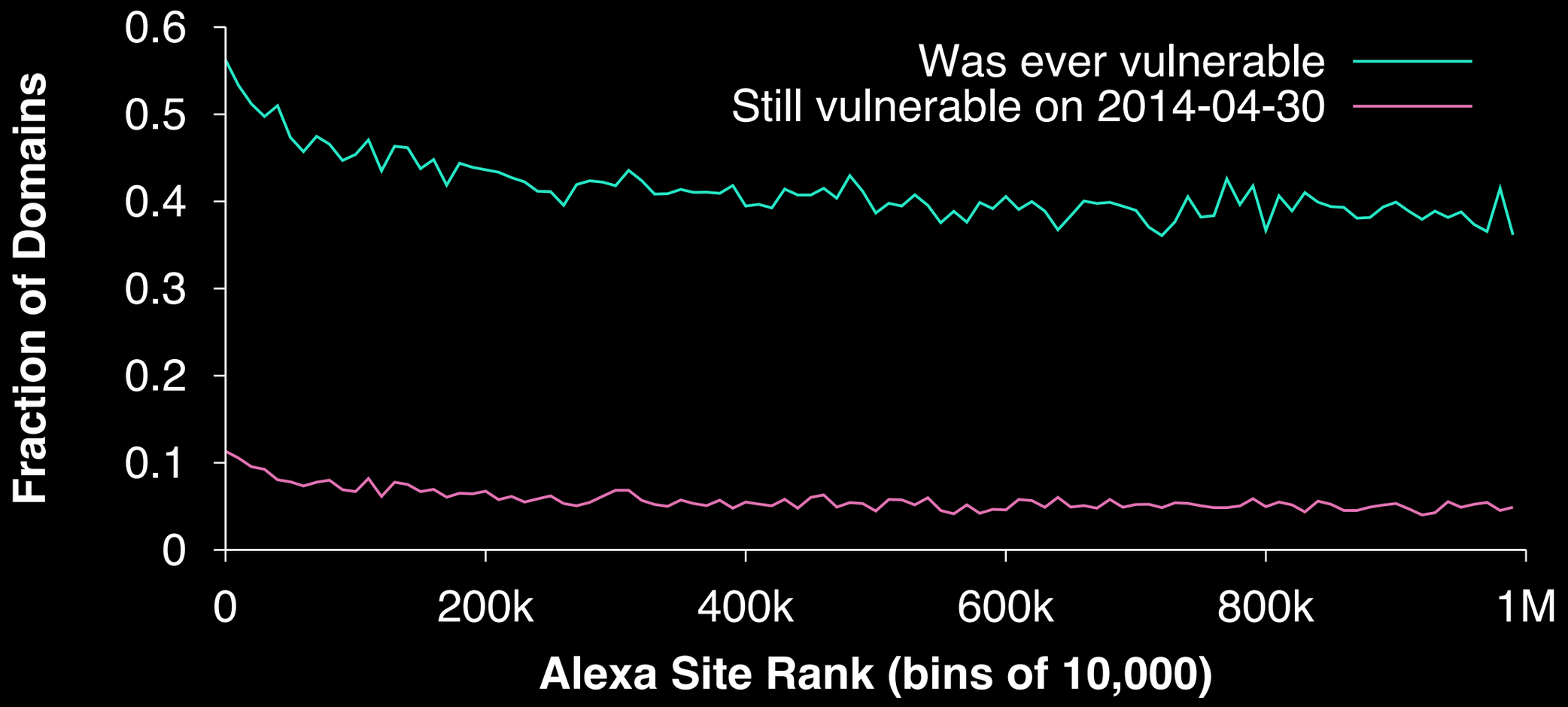
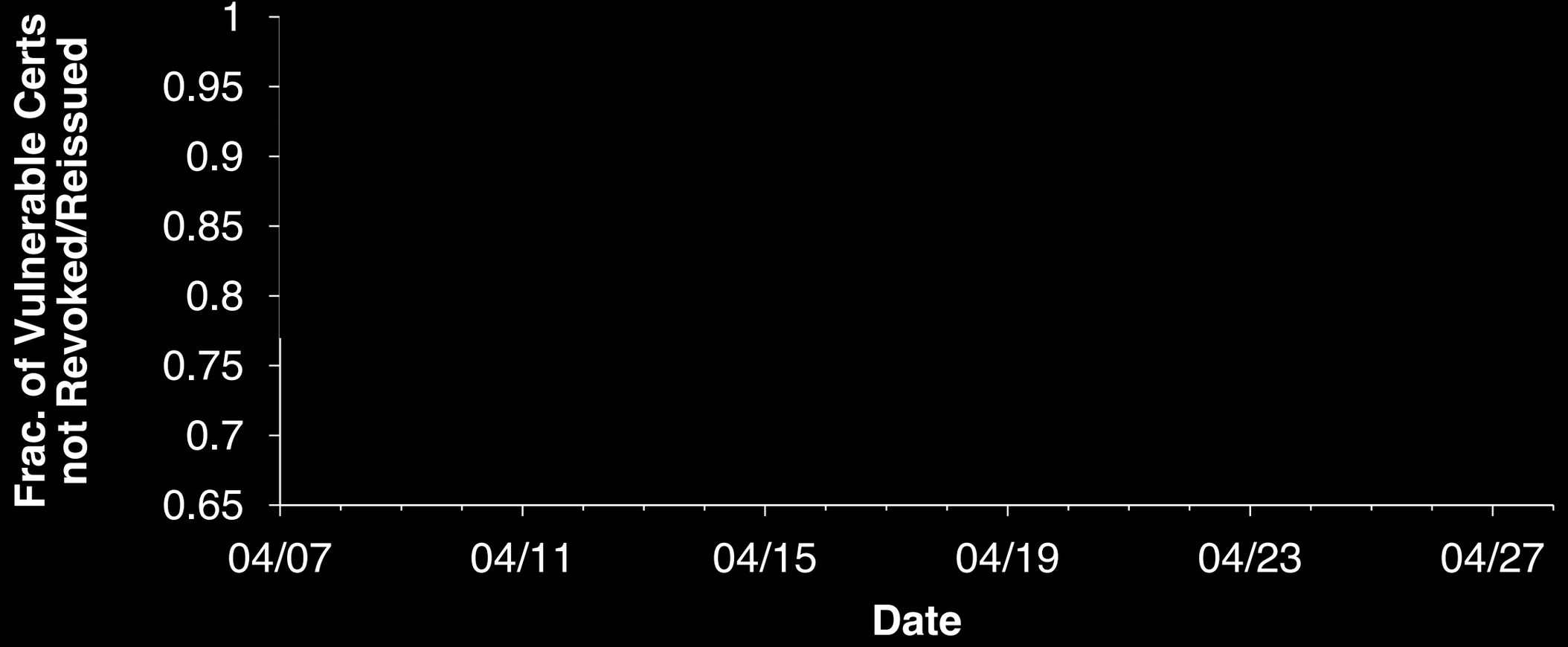


Patching rates are mostly positive

~6% still vulnerable after 3 weeks

Certificate revocation rates



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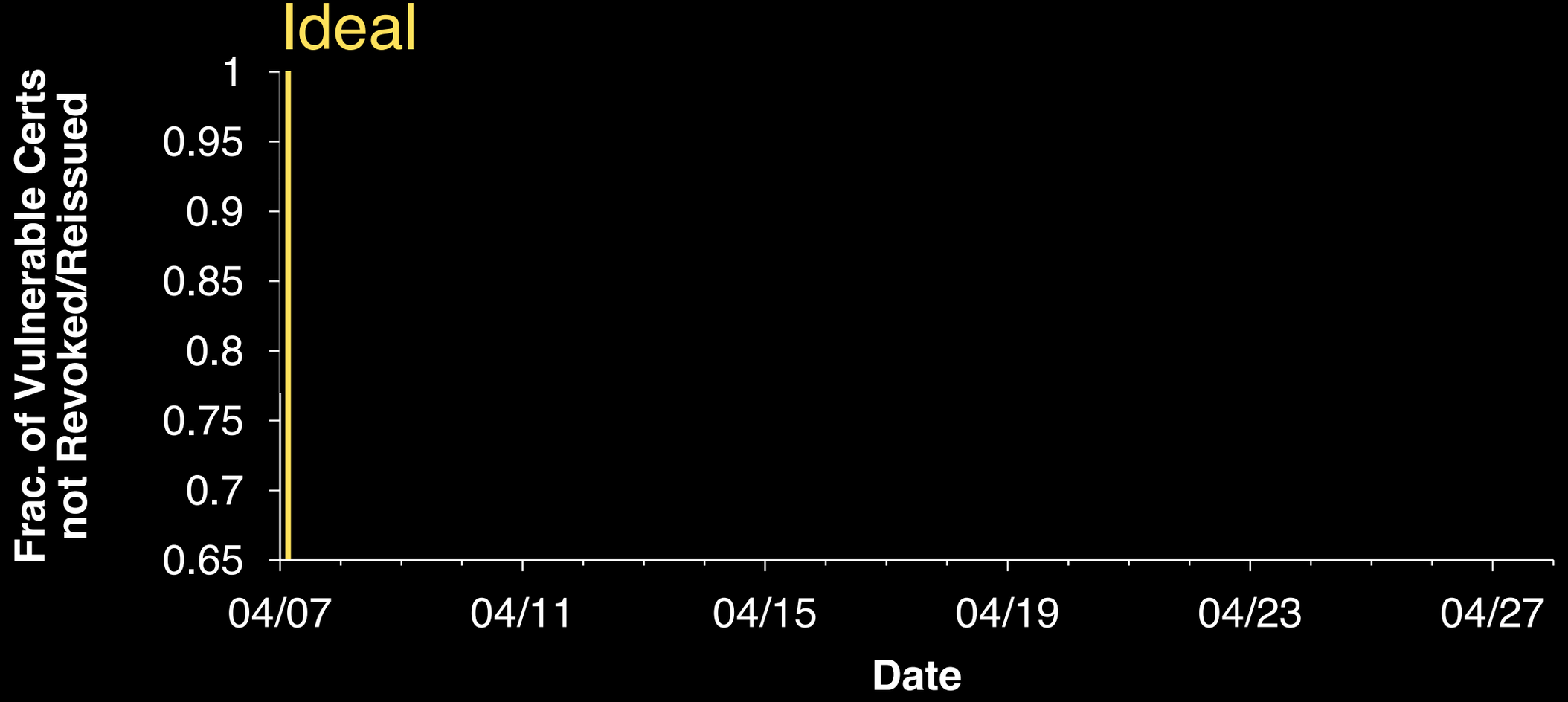

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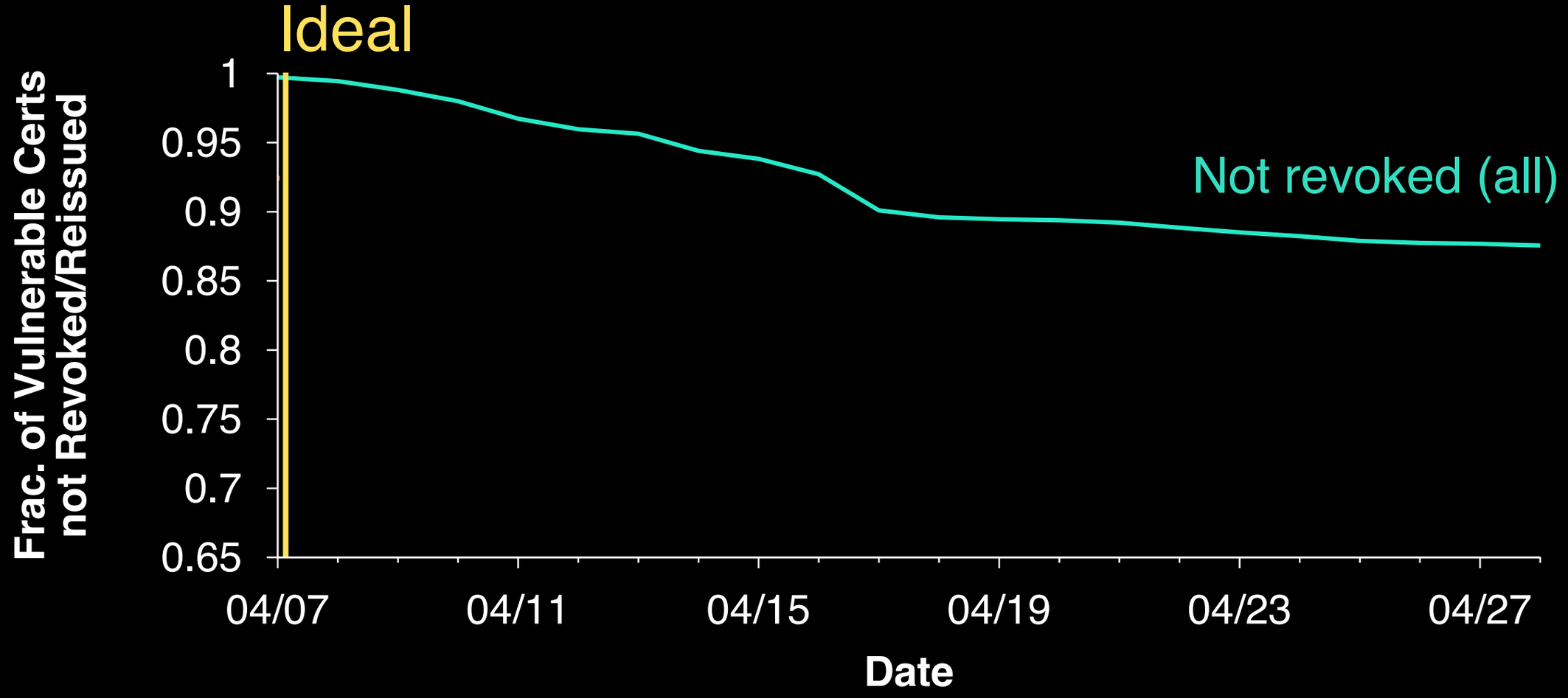

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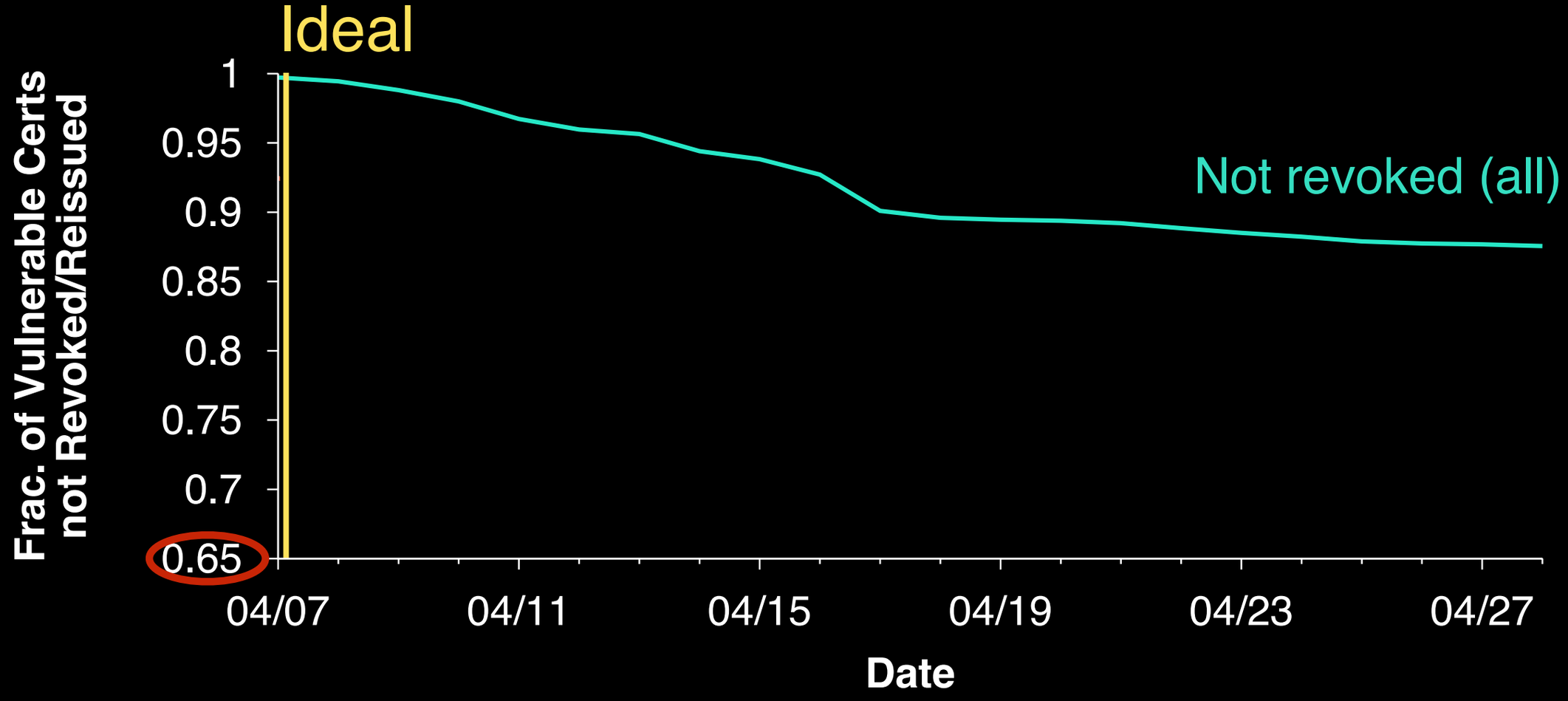
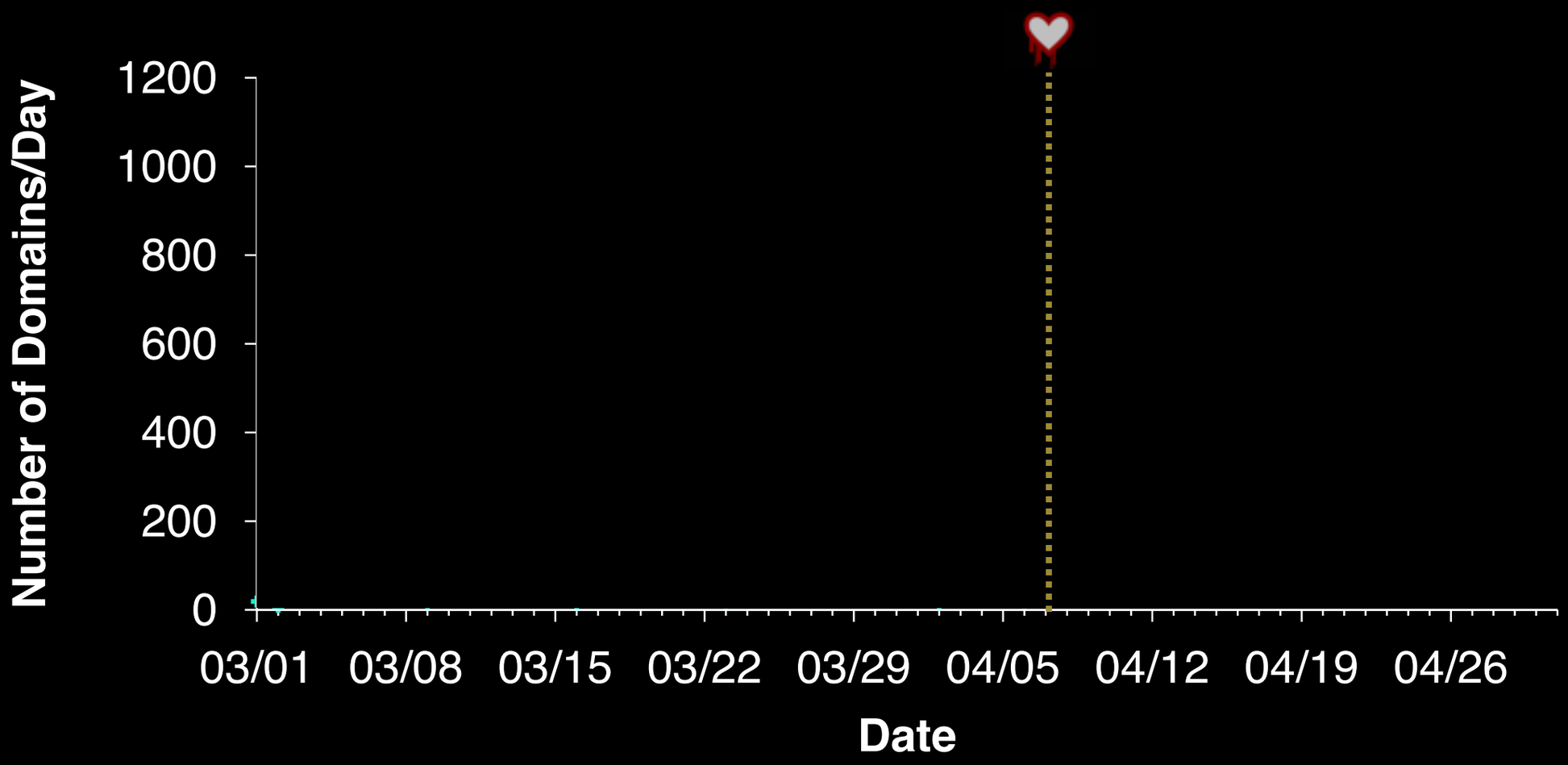


Exponential drop-off, then levels out

After 3 weeks: 13% Revoked

How quickly were certs revoked?



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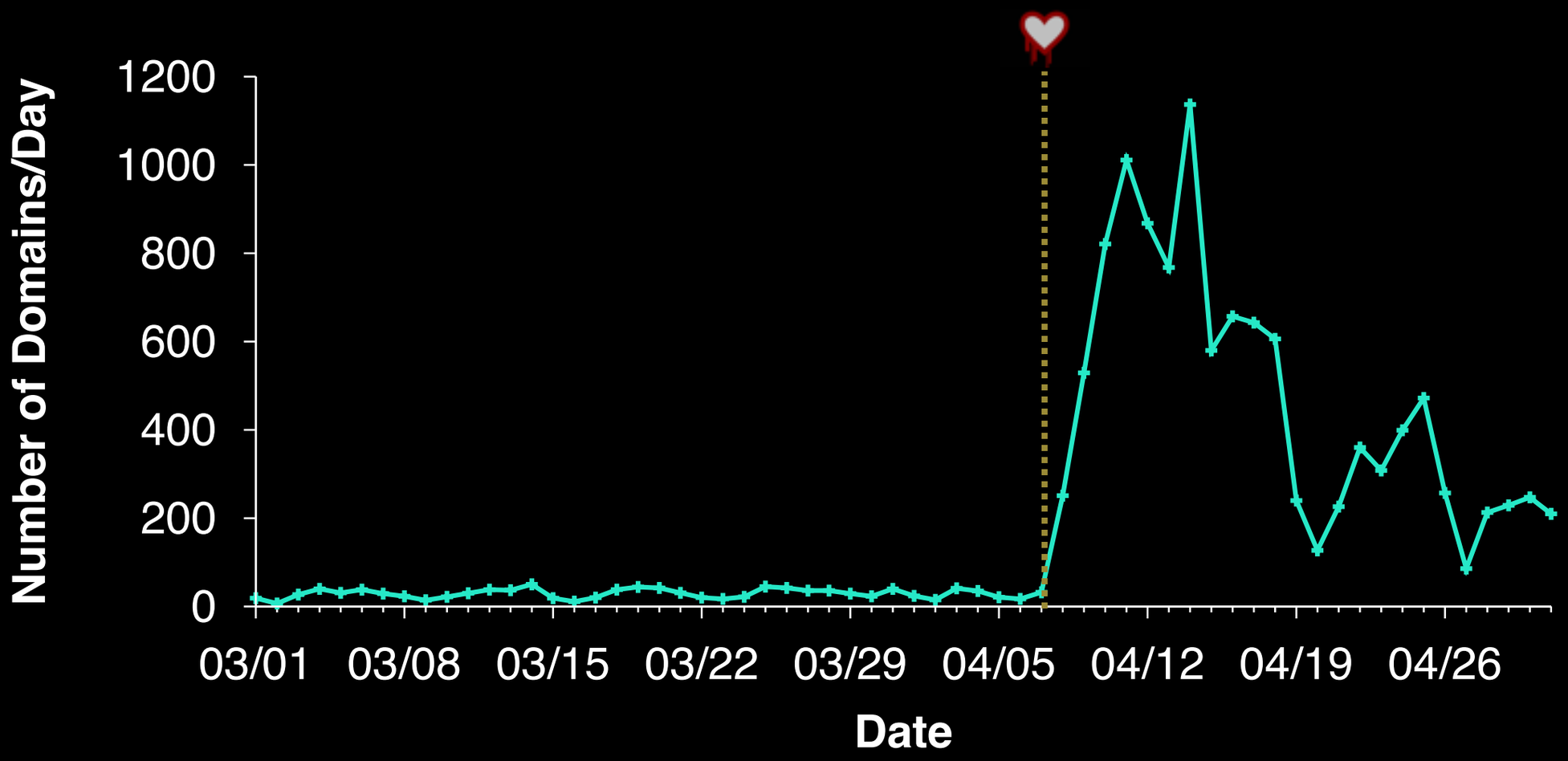

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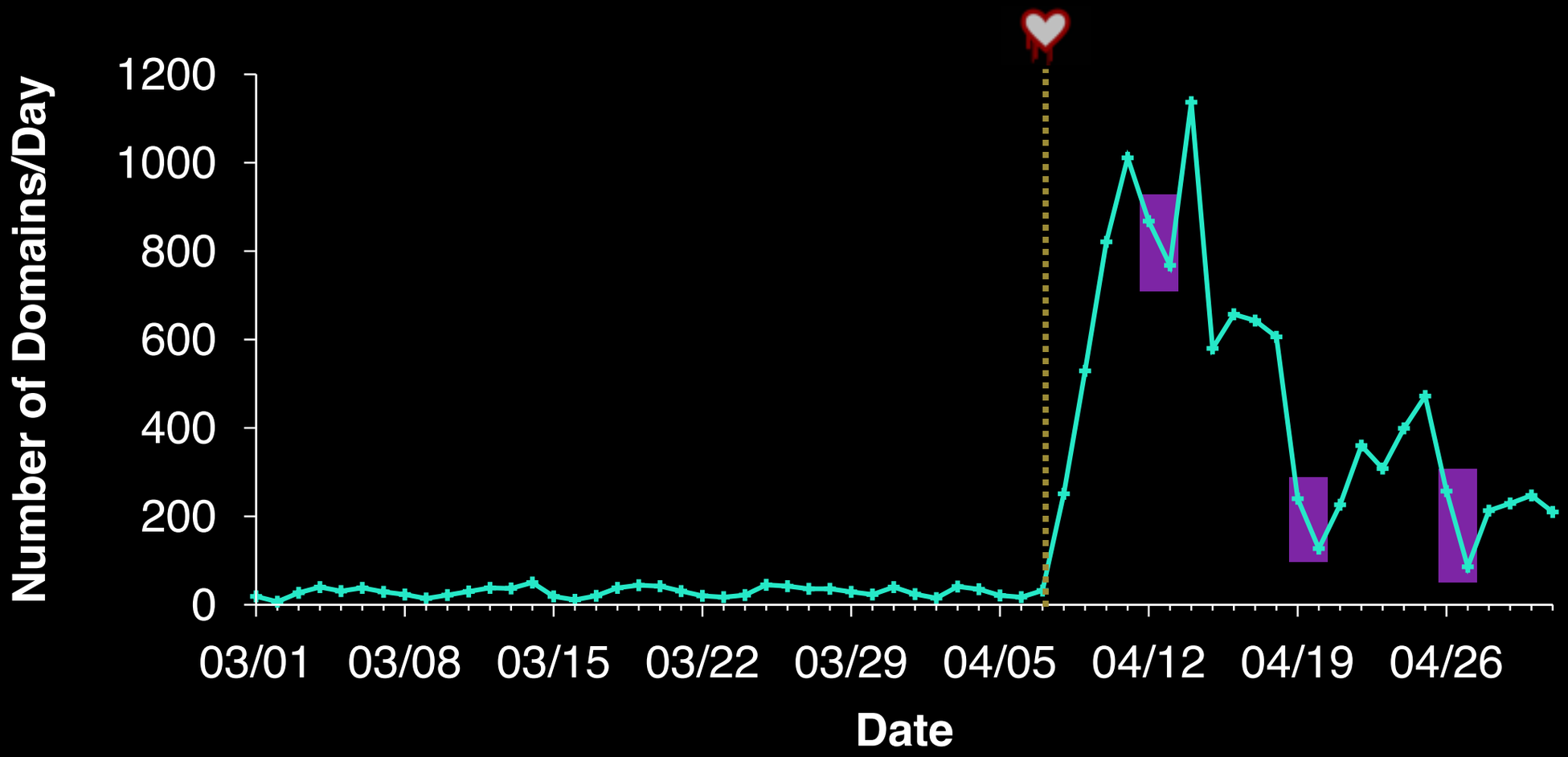

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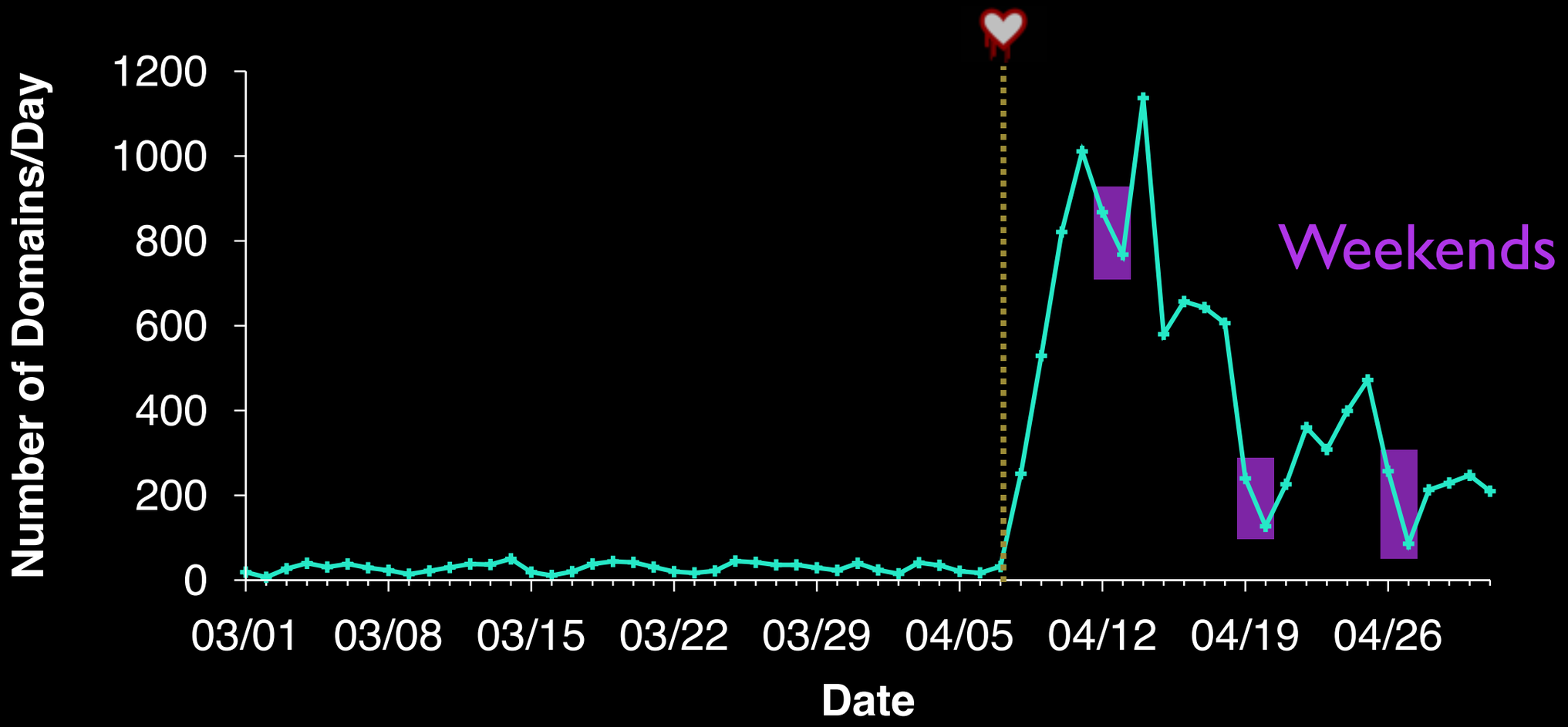
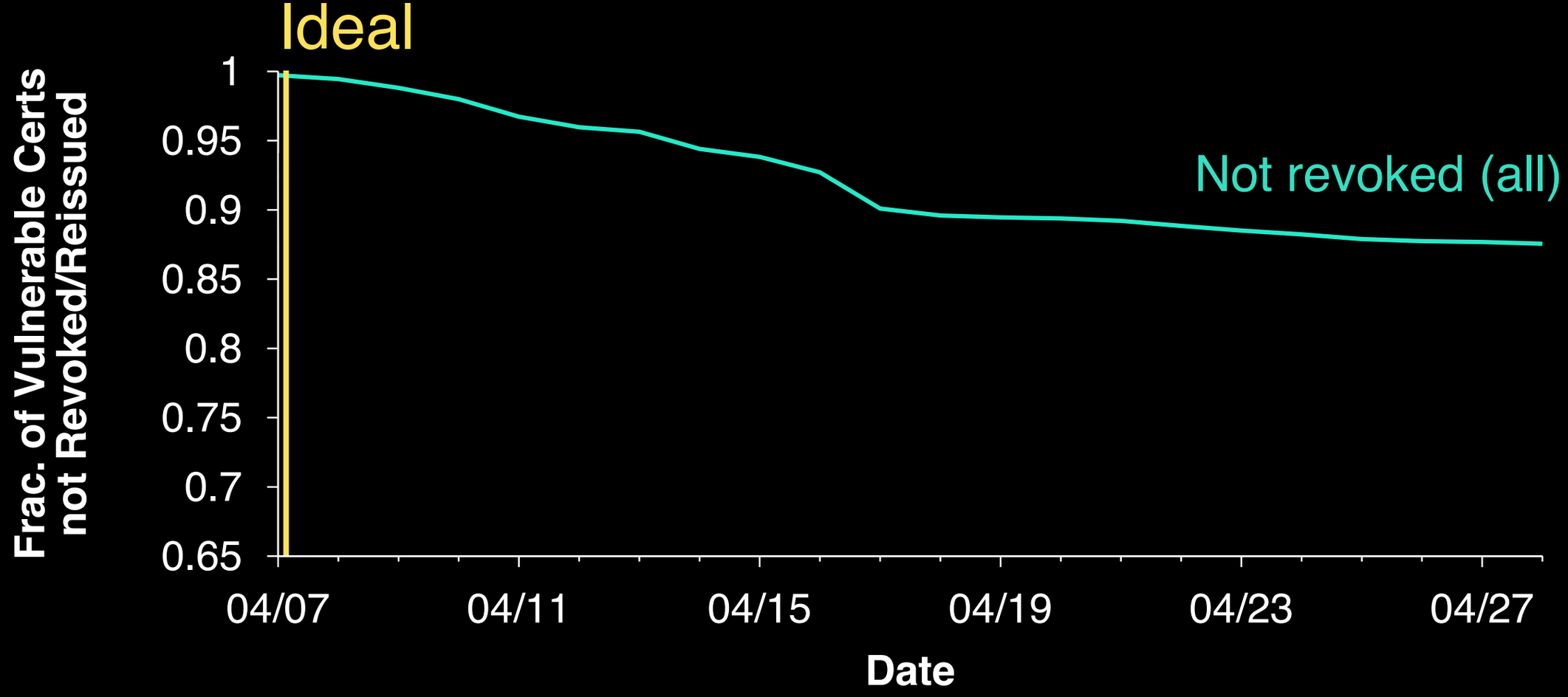


Reaction ramps up quickly

Security takes the weekends off

Certificate reissue rates



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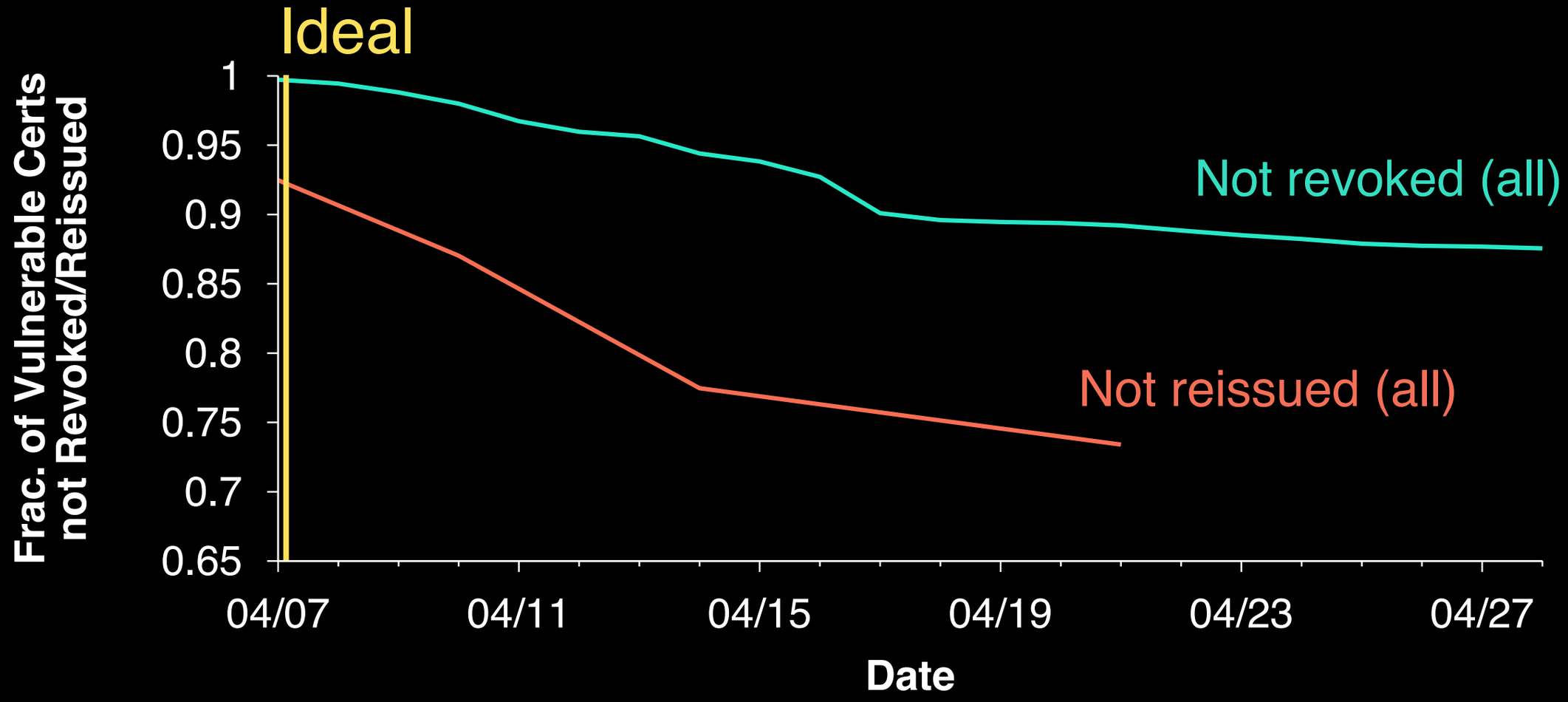

Compared to revocations:
Similar pattern but better reissue rate

After 3 weeks: 27% Reissued

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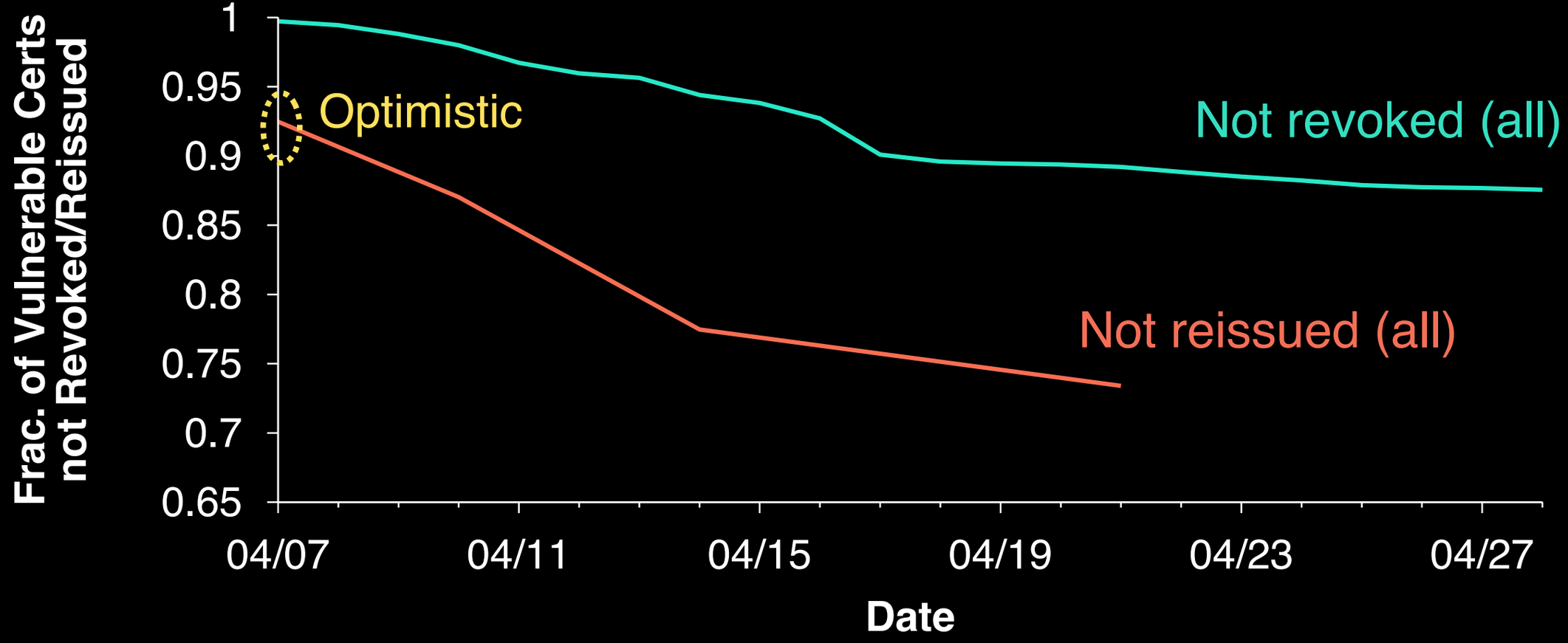

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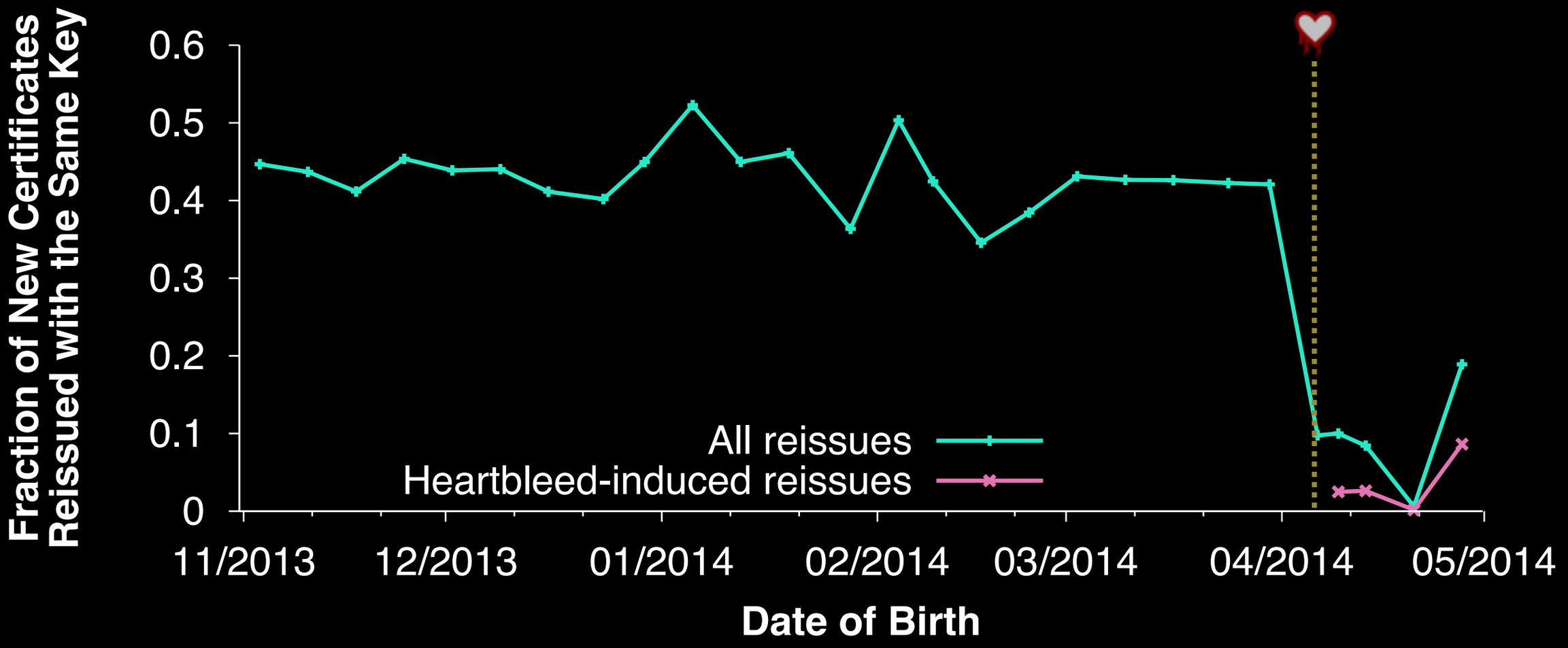

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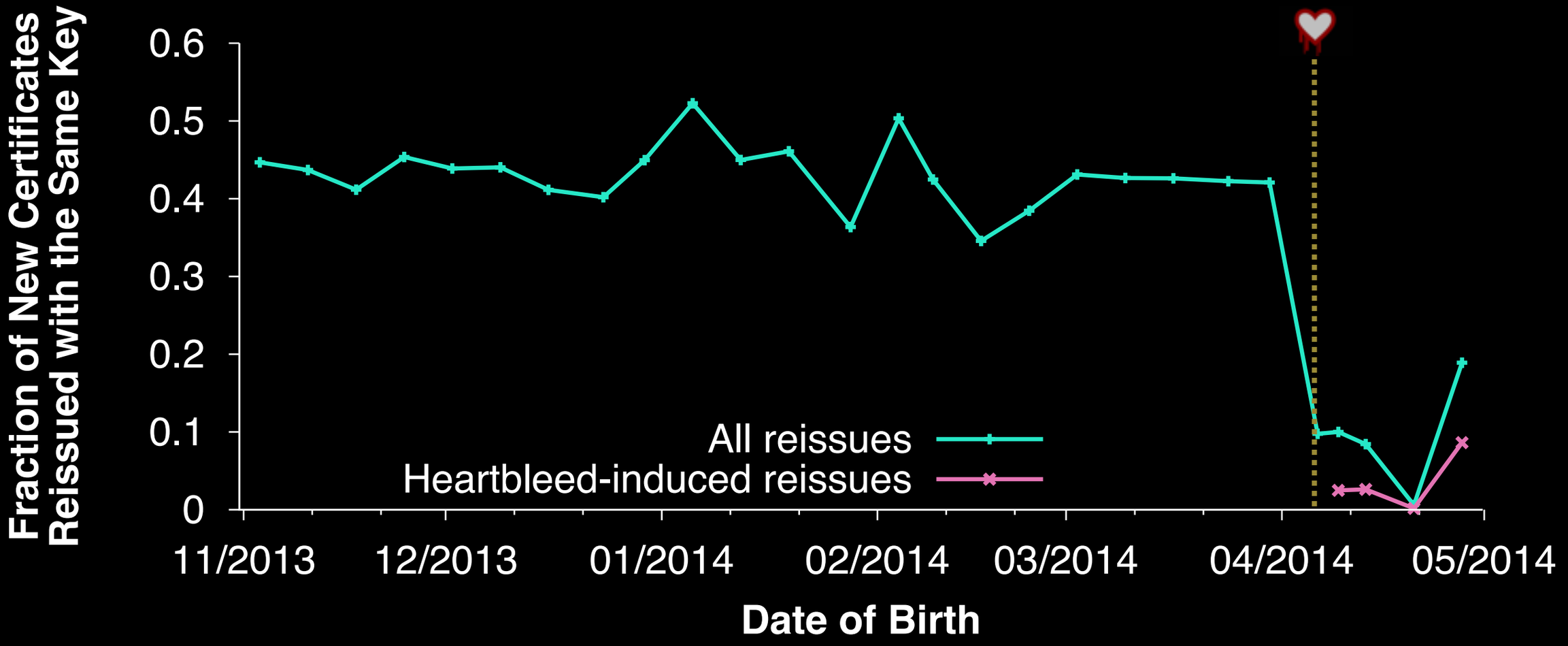
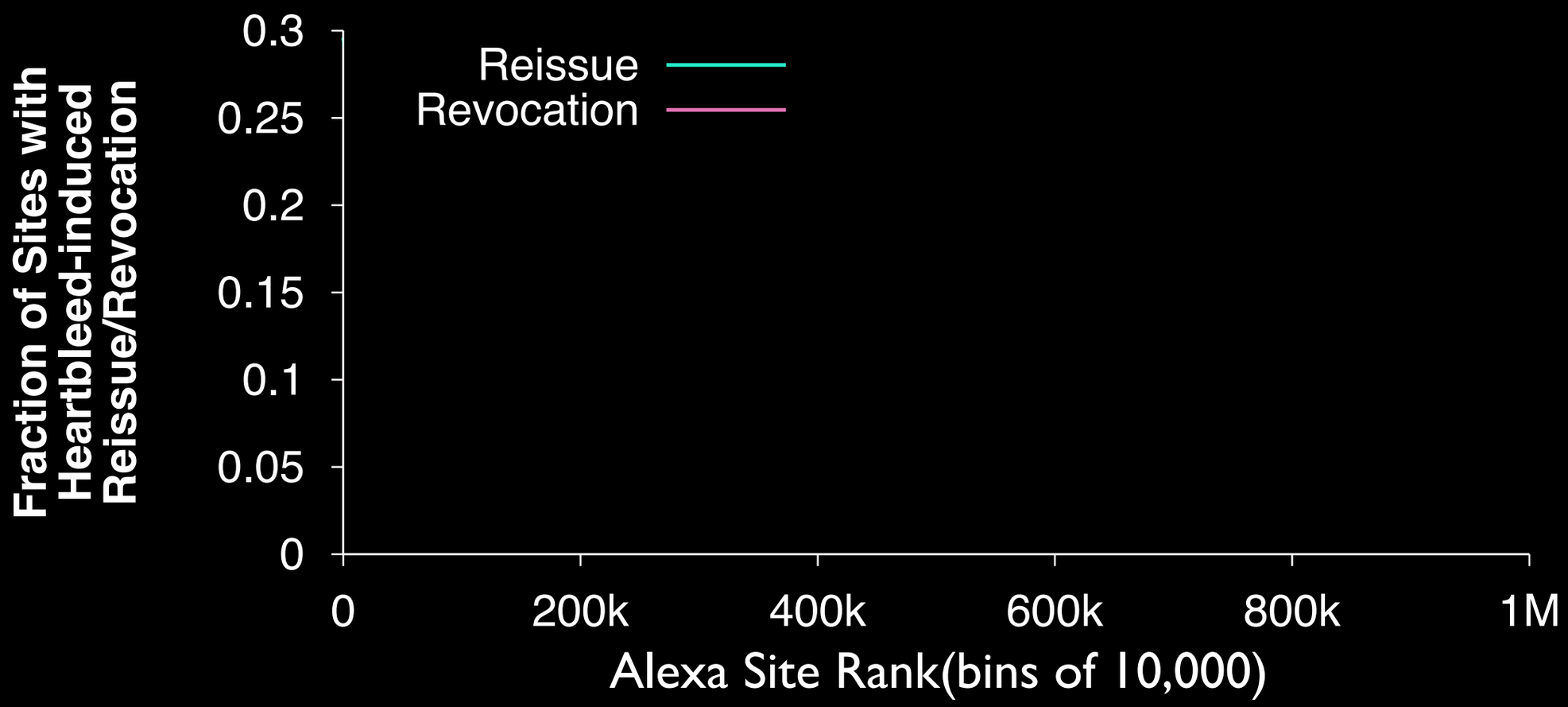


Reissuing the same key is common practice

4.1% Heartbleed-induced with same key

Popularity ⇒ Better reaction?



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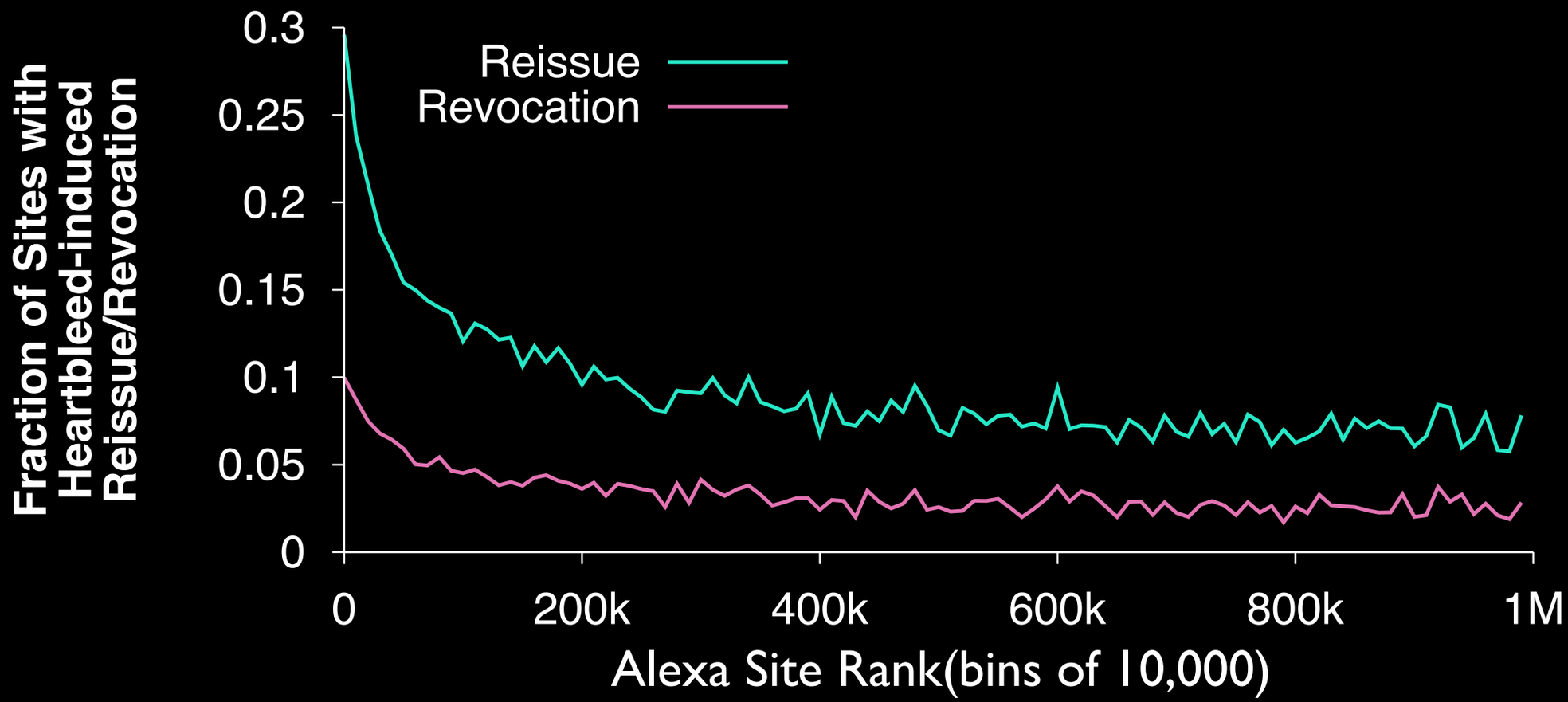

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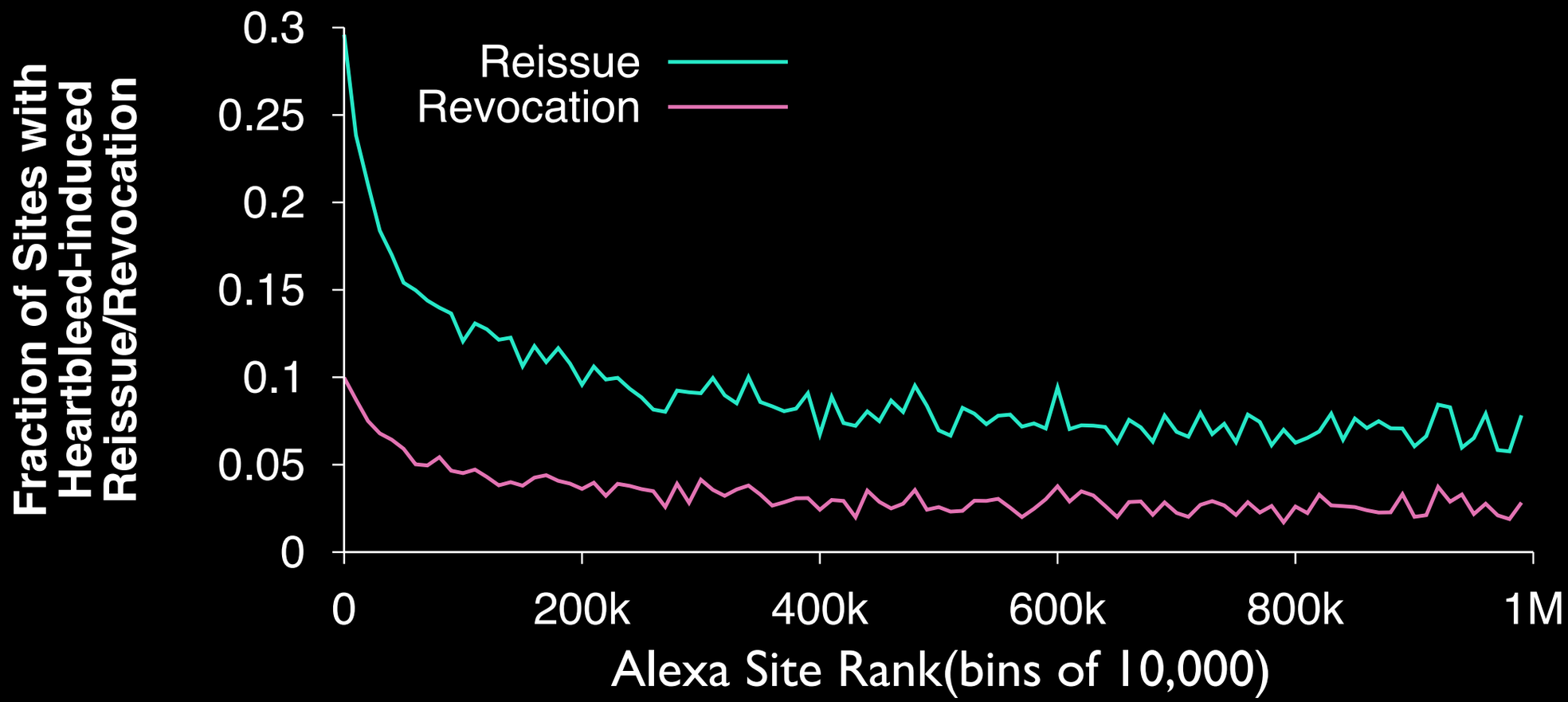


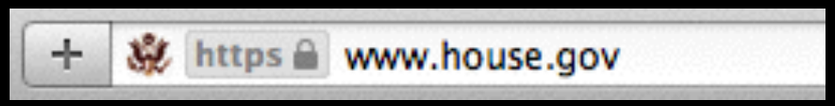
Administrators of even highly popular websites aren't doing what the PKI needs them to do

EV Certificates

More thorough vetting process of CAs and clients

Extended Validation

Normal



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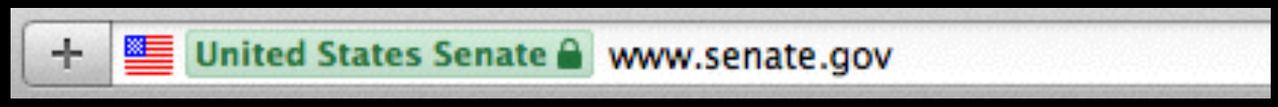
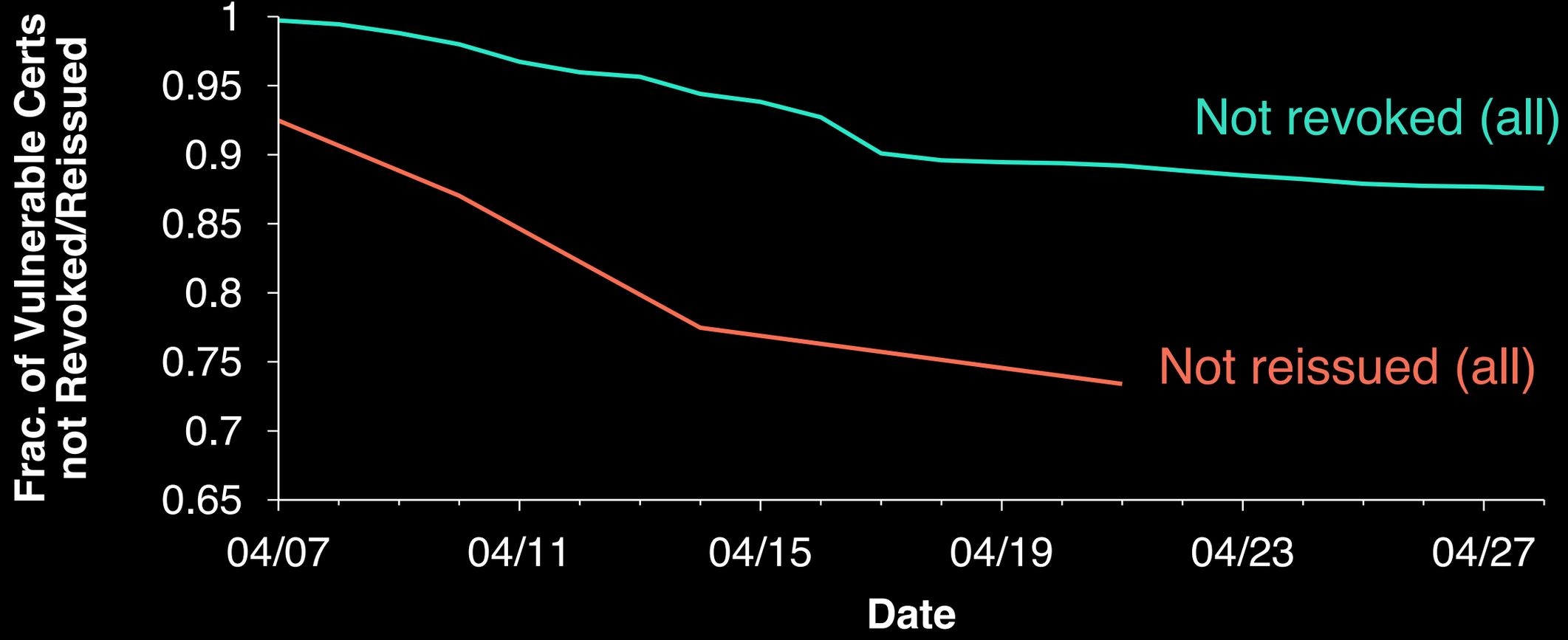


Normal

Does the more thorough vetting process translate into better *security practices*?

Are EV certs better managed?



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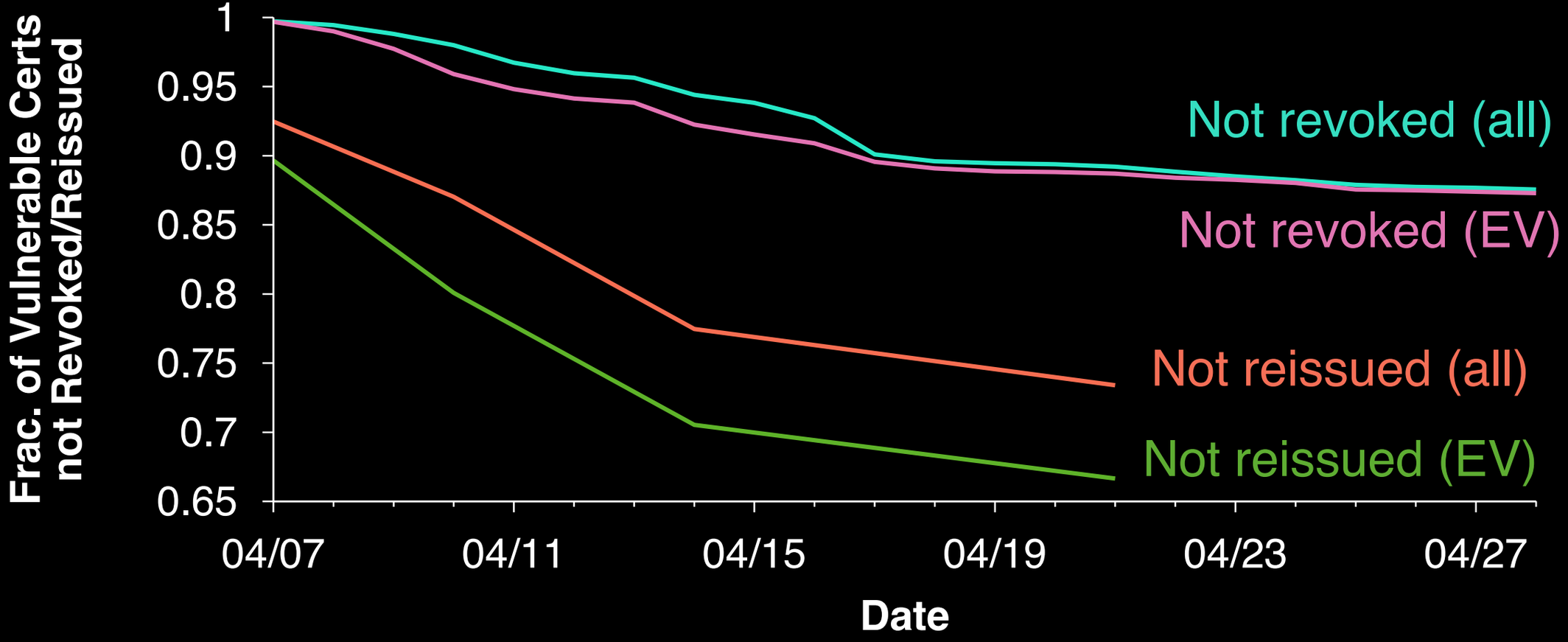
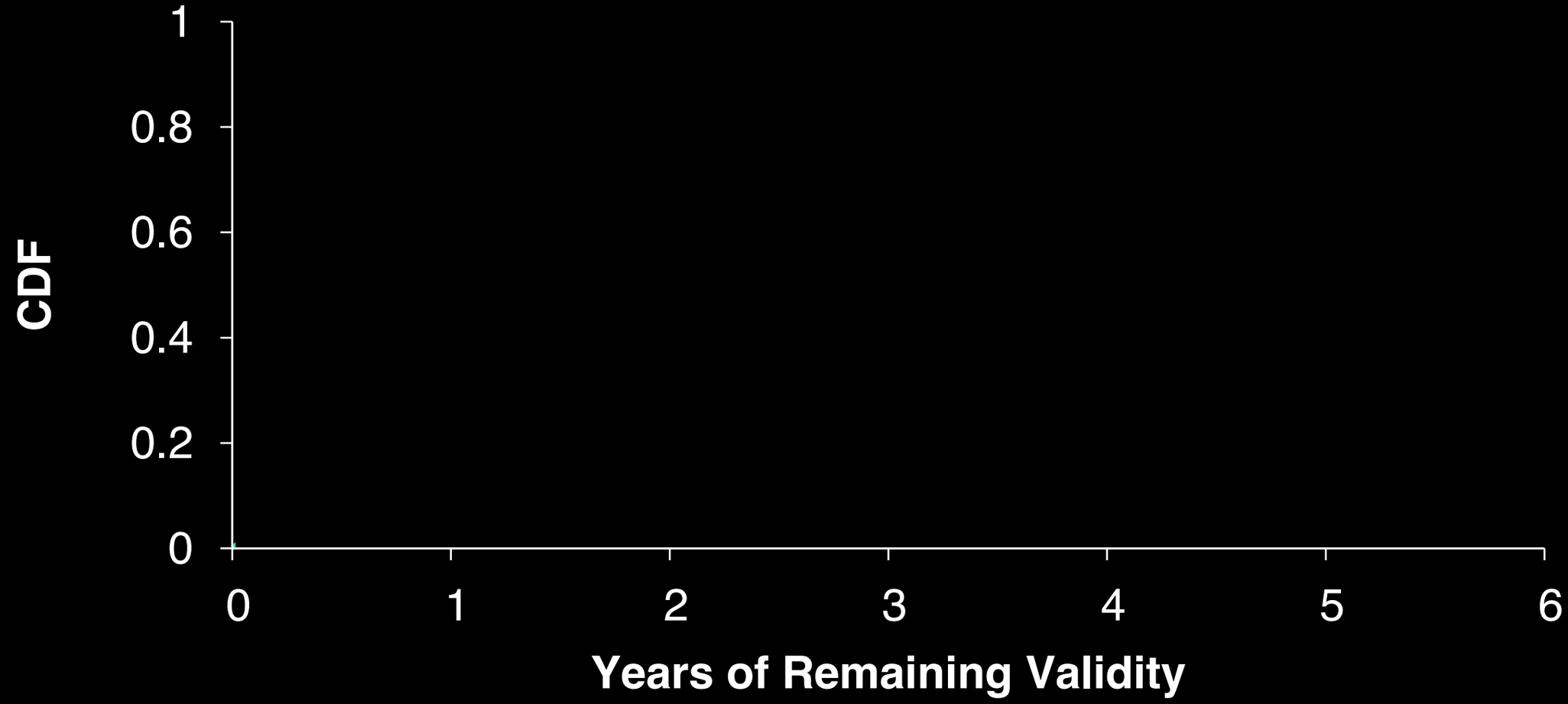


EV certs exhibit slightly better rates (8% reissue)

Can we wait for expiration?



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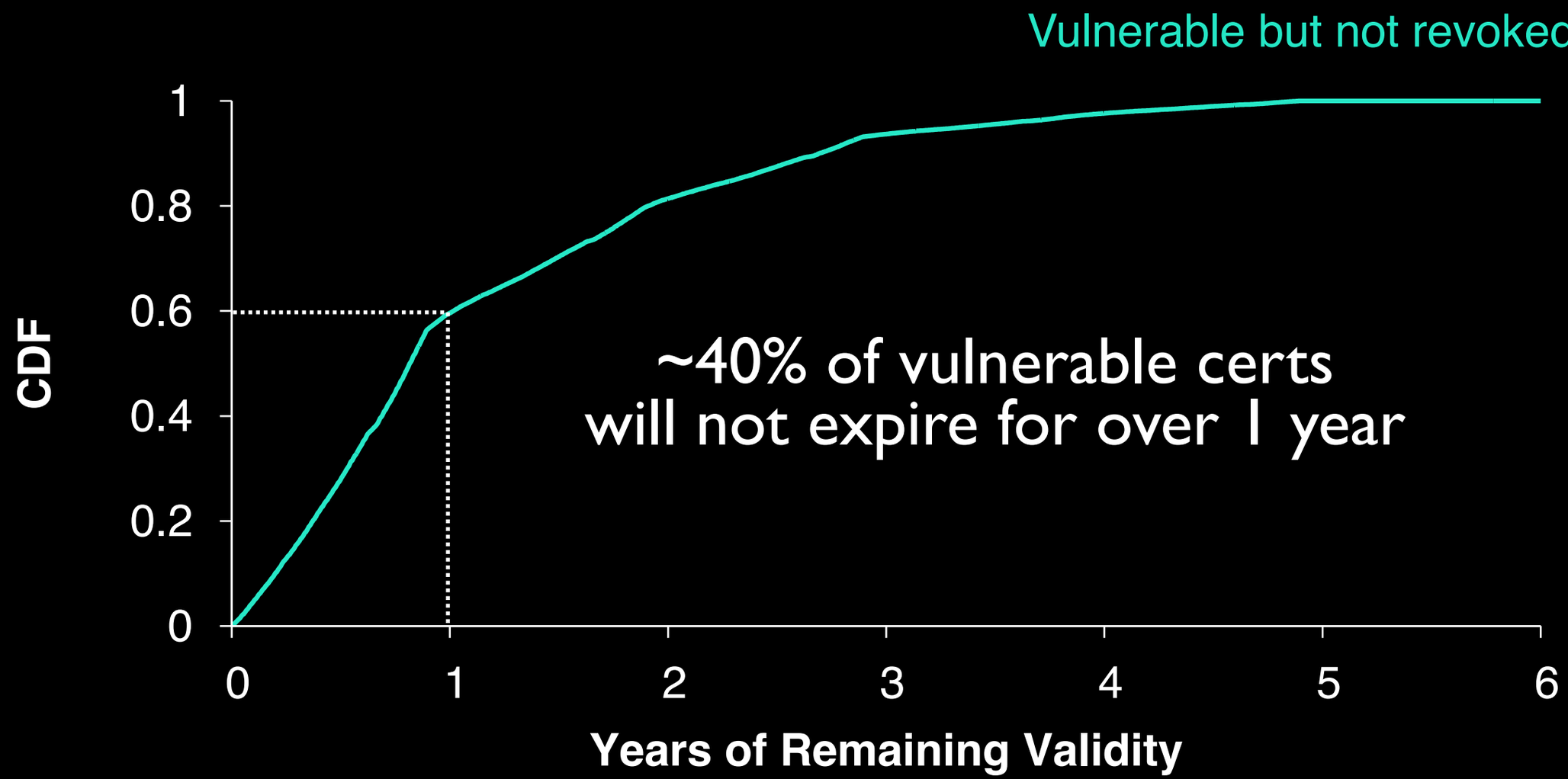

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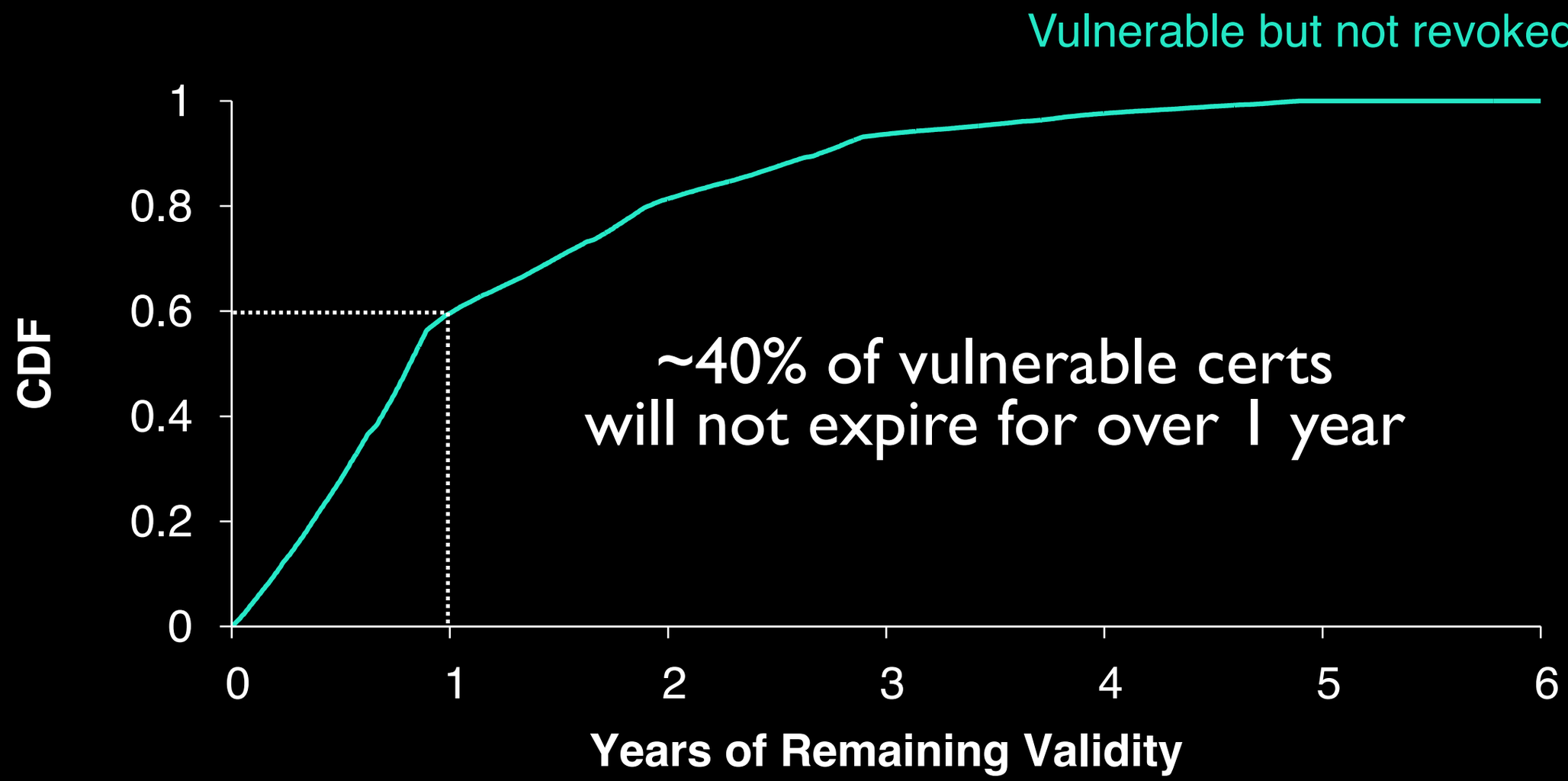

We may be dealing with Heartbleed for *years*

In the paper

- Most reason codes are incorrect
- Revocation and reissue are not simultaneous
- CAs update CRLs in hours
- Heartbleed induce more retired certificates revocations

  and more …

Summary

- First study focus on certificates reissues and revocations
  - Large-scale measurements
  - Developed new methodologies and heuristics

- Key findings
  - After three weeks, only 13% revoked and 27% reissued
  - Security takes the weekends off
  - Live with Heartbleed for years

- Problem: low revocation rates and long expiration dates
  - Techniques for automate revocation
  - Set reasonably short certificate expiration dates

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Questions?

securepki.org