No domain left behind: is Let’s Encrypt democratizing encryption?

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Disclaimer

- None of the authors is in any way affiliated with *Let’s Encrypt*
- In other words: we do not speak for them
- But if you like their work, you may consider supporting them
The Encryption Rush

Ed Snowden NSA’s revelations

- Massive, widespread surveillance
- Worst nightmares came true
The Encryption Rush

Ed Snowden NSA’s revelations

Consequences:

- For many, it was a wake-up call (and panic)
- Market distrust in vendors
- Provided a great momentum for better security

Reactions:

- Massive, widespread surveillance
- Worst nightmares came true
- IETF: RFC 7258, RFC 7624
- iOS/Android: mobile phone encryption by default
- Cloud providers enabling encryption everywhere
- ...
More than half of web traffic is encrypted nowadays
Yet that leaves out a lot of people without HTTPS

Firefox telemetry\(^1\)

Chrome telemetry\(^2\)

\(^1\) [https://telemetry.mozilla.org/](https://telemetry.mozilla.org/), based on *Let’s Encrypt* stats page
\(^2\) [https://www.google.com/transparencyreport/https/metrics/](https://www.google.com/transparencyreport/https/metrics/)
Certificates are required for encryption on the web

Barriers to ubiquitous web encryption (X.509 cert):

▶ **Cost**: purchase, deployment and renewal
▶ **Complexity**: request, deployment (at scale)

*Let’s Encrypt*\(^3\) aims to make encrypted traffic ubiquitous

▶ Issue and re-issue costs: **$0.00**
▶ Complexity mitigated by **automation**
  1. ACME protocol\(^4\)
  2. and clients, e.g. Certbot\(^5\)

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\(^3\) [https://letsencrypt.org](https://letsencrypt.org)
\(^5\) [https://certbot.eff.org/](https://certbot.eff.org/)
No domain left behind
Is Let’s Encrypt democratizing encryption?

Research question
“In its first year of certificate issuance, has Let’s Encrypt been successful in democratizing encryption?”

Approach: measurements
- Analyze issuance in the first year of Let’s Encrypt
- Show adoption trend from various perspectives
- Analyze coverage for the lower-cost end of the market
Methodology

- Period covered: Sept. 2015-2016 (1st year)
- Results based on FQDNs reduced to 2LD/3LD form
  - a.b.c.d.com → d.com

Datasets

<table>
<thead>
<tr>
<th>Certificates →</th>
<th>Certificate transparency[^6]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain to IP mapping →</td>
<td>Farsight DNSDB[^7]</td>
</tr>
<tr>
<td>Organization mapping →</td>
<td>Methodology from previous work[^8], using whois data &amp; Maxmind GEOIP2</td>
</tr>
<tr>
<td>Registration info →</td>
<td>.nl registry (SIDN)</td>
</tr>
</tbody>
</table>

[^6]: https://www.certificate-transparency.org/known-logs
[^7]: https://www.dnsdb.info/
Let’s Encrypt Adoption Rate

- Steady growth
Who’s using *Let’s Encrypt*?

▶ 98% of certificates are issued outside Alexa 1M . . .
Who’s using *Let’s Encrypt*?

- ...yet issuance is not restricted to lower end of the market
  - meaning: big players also use in their subdomains
Growth is attributed to adoption by major players
3 hosting providers are responsible for 47% of the Let’s Encrypt certified domains

November 2015

Let's Encrypt domains

organisations

known domains

Let's Encrypt domains

organisations

14K
0
60K
127M
Growth is attributed to adoption by major players
3 hosting providers are responsible for 47% of the Let’s Encrypt certified domains

November 2015

September 2016
Growth is attributed to adoption by major players
3 hosting providers are responsible for 47% of the *Let’s Encrypt* certified domains

November 2015

September 2016

Automation works!!
Issuance is dominantly for web hosting
So far, no surprises
Over 90% of domains in hosting are on shared hosting

Issuance is dominantly for the lower-cost end of the market

- Shared hosting = 10 domains/IP

- *Let’s Encrypt* reaches those with less incentive to encrypt

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Let’s Encrypt certificates are valid for 90 days
The majority of certificates are correctly renewed after their first expiration

![Graph showing the fraction of FQDN coverage against days since initial issuance of certificate. The graph includes two lines: one continuous and one with a gap ≤ 1 week.]
Let’s Encrypt: domain age use

- Case study: .nl
- Determine the age of the domain when the cert was issued

Median, Q25, Q75 and number of monthly new certificates for .nl domains
Let’s Encrypt: deployment

- https scans + cert processing (lower bound)
- 25K randomly chosen Let’s Encrypt FQDN
Conclusions

We show that

- *Let’s Encrypt* has been a success
  - Reduces costs & complexity
- Democratize encryption by covering low cost end of the market (shared hosting)
  - but big players also use it
- Automation works: *Let’s Encrypt*’s allows for bulk issuing
  - 3 hosting providers are responsible for 47% of the *Let’s Encrypt* certified domains
- The majority of certificates are correctly renewed after their first expiration (90 days)

And find that

*Let’s Encrypt* has indeed started to democratize encryption.
Future work

- extend measurement period
- issued versus deployed
  - active scans on shared hosting require prior knowledge of domains served (SNI)
- use by malicious actors

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Download our paper at:
https://arxiv.org/abs/1612.03005