When DNS goes dark: Understanding privacy and shaping policy of an evolving protocol

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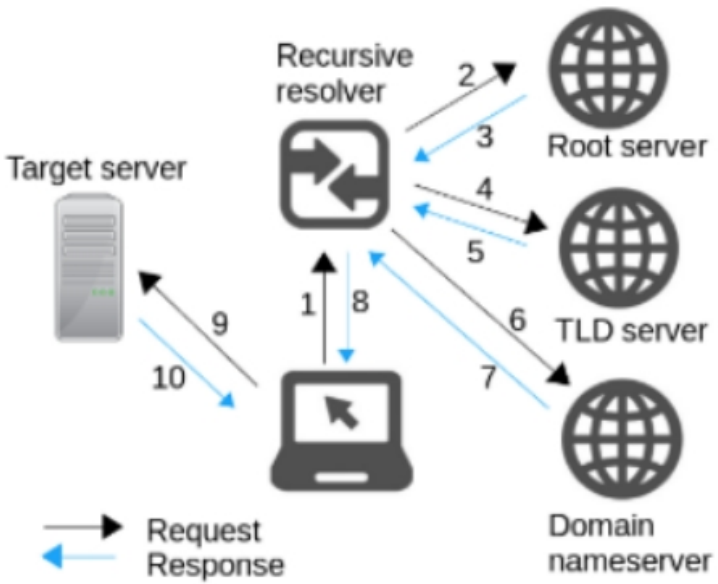
Photo by NASA on Unsplash.com

Introduction



Gurbani, Vijay and Hood, Cynthia and Nikolich, Anita and Schulzrinne, Henning and State, Radu, When DNS Goes Dark: Understanding Privacy and Shaping Policy of an Evolving Protocol (December 16, 2020).
Available at SSRN: https://ssrn.com/abstract=3749764 or http://dx.doi.org/10.2139/ssrn.3749764

- DNS: What it is and how it works.
- Traditionally, DNS traffic has been cleartext, recently encrypted.
- Protocol is evolving.
  - Early work on security focused on infrastructure
    - DNSSEC (March 1999)
    - EDNS0 (August 1999)
  - Later (current) on privacy:
    - DNSCrypt (not standardized)
    - DoT (2016)
    - DoH (2018)
    - ODoH (2020, Internet-Draft)
    - Resolver-less DNS (not standardized)

We are interested in ...

- **As the protocol evolves, do the privacy-preserving extensions enhance user privacy?**

Why protect DNS queries?

- DNS has a privileged position in the network.
- Traffic analysis: prevent tracking.
- Ads: Make it harder for ISPs to sell user data.
- Increase faith in the system: Protect against destination re-targeting.

Despite DoH, DoT, ODoH, *someone* has access to a user's DNS lookups!
The main aim is to untangle the DNS querier from the request itself.

DNS and PII: Privacy of the user

- Is an IP address PII?
  - US FTC 2016: “...when it can be reasonably linked to a particular person, computer or device.”
  - CCPA: “… [if it] identifies, relates to, describes, is reasonably capable of being associated with, or could reasonably be linked, directly or indirectly, with a particular consumer or household.”
  - Article 2(a) of Directive 95/46/EC EU Directive: IP address can be considered PII if “directly or indirectly”, the IP address can be correlated with contextual information to allow the identification of an individual.
    - Breyer v. Germany, 2016 upheld this view on the ground that the ISP had enough contextual information to link IP address to individual.

User privacy and DNS providers

- Examined 12 DNS providers:
  - Google Public DNS, Cloudflare, Quad 9, OpenDNS, NextDNS, Comcast, Yandex, Comodo, Verisign, OpenNIC, Free DNS, dnswatch.info.

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    - Of 9 that had privacy policy, 6 had DNS specific policies.
- Next, examine the providers under the lens of 6 GDPR articles.

User privacy and GDPR

- GDPR Article 5(b): Purpose Limitation
- Taxonomy of reasons for collecting data:
  1) Security and visibility into DNS traffic. (OK)
  2) Improving services. (OK)
  3) Data sharing with affiliates for
     (i) profit (??)
     (ii) research in the public good (OK)
  4) Marketing (??)
  5) Contractual and legal obligations (OK)

User privacy and GDPR

- GDPR Article 5(c): Data minimization.
  - DNS specific policies fare better than general policies.
    - Enumerated what is being collected or logged.
    - NextDNS: no data logged, but retention (of what?)
  - General policies:
    - Too broad, as they cover all services, not only DNS.
    - Defer to third party privacy policies if a third party feature used in a service.

User privacy and GDPR

- GDPR Article 5(e): Storage limitation.
  - DNS only privacy policies far more stringent than general privacy policies.
    - Most delete data after 24-48 hours.
    - Some sample data for permanent storage, but anonymize IP addresses or keep data at “city/metropolitan area” level.
    - OpenDNS and NextDNS allow user to delete their data, but not clear how user will exercise this preference.

User privacy and GDPR

- GDPR Article 7: Conditions for consent.
  - Genuine consent should put user in charge, allowing user to withdraw consent at any time.
  - “Notice and consent” does not work for DNS
    - Does configuring host to use Cloudflare’s resolver constitute consent?
  - Most all of the providers do not require explicit consent to collect user’s DNS information.
    - Consent is given when service is used.
    - NextDNS allows account to be created, and associate policies with collection.
  - Withdrawal of consent ambiguous still.
    - Some policies allow withdrawal of consent, but don’t specify the means of withdrawal.
    - Verisign allows “written notification”.

User privacy and GDPR

- GDPR Article 15: Right of access by data subject.
  - Broad rights to user about purpose limitation and storage limitation (covered earlier).
  - Article 15(e): rectification or erasure of personal data, or restriction of processing of personal data.
    - May impose a burden on the DNS provider, not clear consent is well defined to allow a specific user’s records to be traced and purged.
    - IP address may change over time, making tracing time consuming.

User privacy and GDPR

- GDPR Article 45: Data transfers on the basis of adequacy.
  - What are the obligations of a DNS provider when user's reside outside of the provider's jurisdiction?
  - Primary framework for cross-Atlantic data protection (Privacy Shield) is now invalid (July 16, 2020, EU Court of Justice ruling).
    - Signed signatories must still adhere, new signatories will need bi-lateral agreements.
  - None of the providers had any data transfer information in their DNS-specific policies.
    - Google Public DNS, Cloudflare, OpenDNS, and Verisign — cite the Privacy Shield framework in the general privacy policies.

Policy & standard recommendations

- Standardized disclosure of DNS privacy policies
  - Jurisdiction, data residency, retention, delete data on request, …
- Make it easy for users to configure the DNS service.
- Enhance regulatory clarity:
  - Should ISP-provided resolver service be treated as an adjunct service?

Policy & standard recommendations

- Role of standards bodies, especially IETF.
  - Unique position to specify protocol behaviour.
    - The Raven document (RFC 2804).
  - Should continue to engage in more robust user-centric privacy threat modeling.
    - RFC 8932 is a laudable step.
      - Recursive operator Privacy Statement (RPS) forces DNS providers to focus on user-centric privacy.

Policy & standard recommendations

- User centric privacy policies.
  - RFC 8932 good example.
  - Simplified purpose limitation statement.
  - Transparency on retention.
  - Transparency on consent.
    - Re-configuring */etc/resolv.conf*: Is this consent?
    - Should DoH be opt-in?
    - How to stop consent?
  - Transparency in adequacy decision.

Policy & standard recommendations

- Shaping the protocol evolution.
  - Early DNS extensions aimed at infrastructure privacy (DNSSEC).
  - Later ones improved user privacy: DNSCrypt → DoT → DoH → ODoH → ??
  - If viewed as a game between rational actors (privacy advocates and market forces), does the user benefit?
    - Pursuing dominant strategy will result in user privacy being the casualty (Resolverless-DNS).
  - What's the answer?
    - Light hand of regulations?
    - Industry regulations (Mozilla TRR Program)?

Conclusions

- DNS has a privileged position in the network ecosystem.
- Most users unaware of DNS.
  - “Privacy by default” should be the de-facto mode.
- Public resolvers gaining traction.
  - A single public resolver could achieve monopoly status under certain conditions.
- Data privacy regulations or self-regulation.
- Above all, user’s privacy should be the centerpiece.