# The Changing Landscape of the DNS

## or: the Battle for the Namespace

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RoN++ meeting

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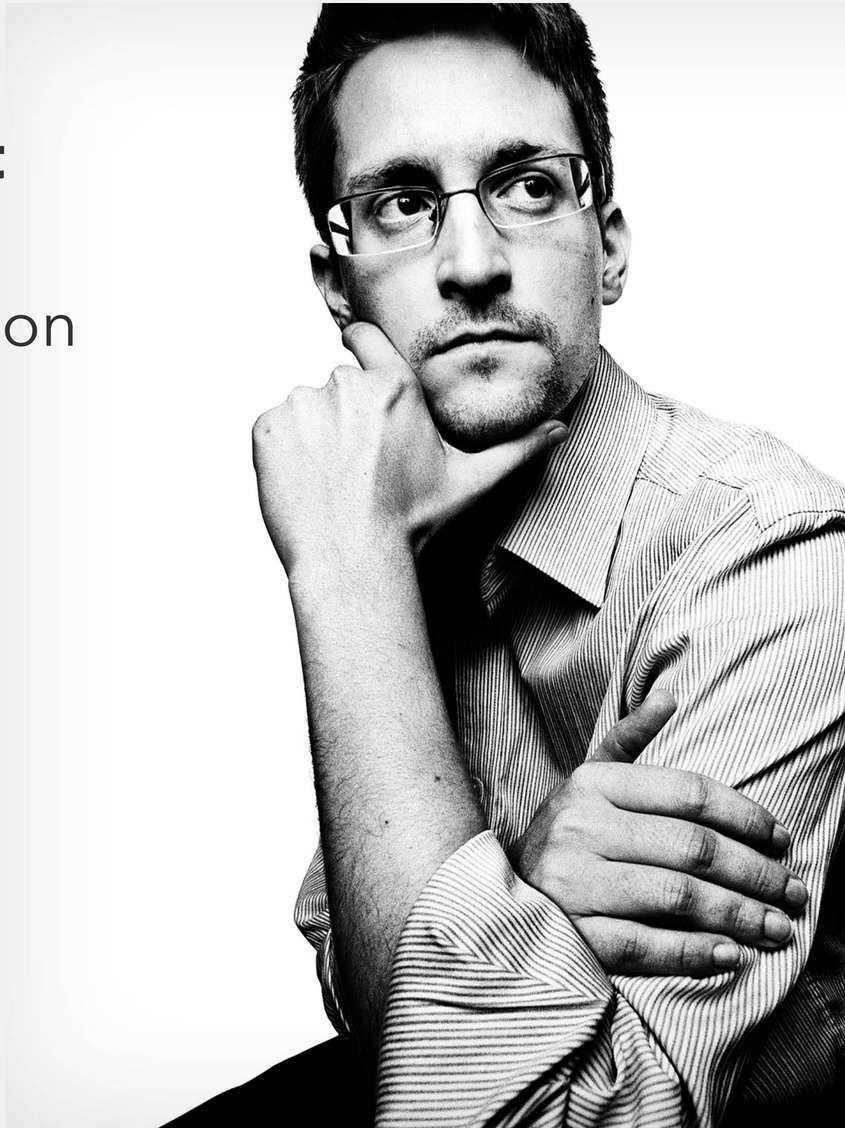
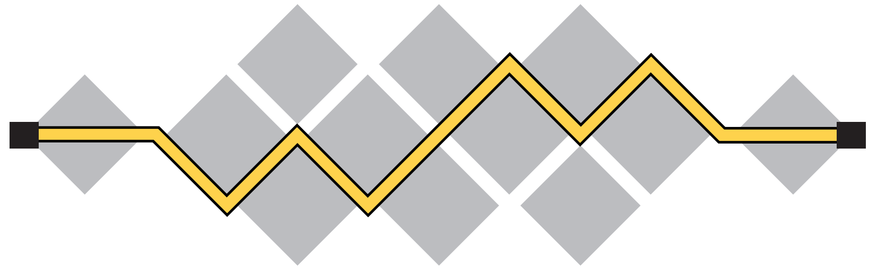
# Introduction

- That the **DNS** has **privacy issues** is a **public secret**
- **Protocol from 1980s** with **clear-text** communication over **UDP and TCP**
- **Snowden revelations** just made this public secret very painful, as it turned out this was one of the Internet vulnerabilities being **exploited en masse by intelligence services** of the "Five Eyes"



# IETF to the rescue!

- The **IETF took action** for many protocols **post-Snowden**
- **October 2014: establishment of** the DNS PRIVate Exchange (**DPRIVE**) working group
- **Goal**: **analyse privacy issues in** the **DNS and propose protocol changes** to alleviate these



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# First step: identifying problems

- **RFC 7626** gives a **comprehensive overview of privacy risks** in the whole DNS ecosystem
- Identifies all the points in the DNS ecosystem where privacy sensitive information can leak

# Behavioural measures

- There are **two behaviour changes for** DNS **resolvers** that help privacy
- **QNAME minimisation**, where resolvers limit what parts of a query string are sent to authoritative name servers
- **Caching measures**, where resolvers can run parts of the name space locally, to limit sending, e.g., queries to the root onto the Internet

# DNS over TLS

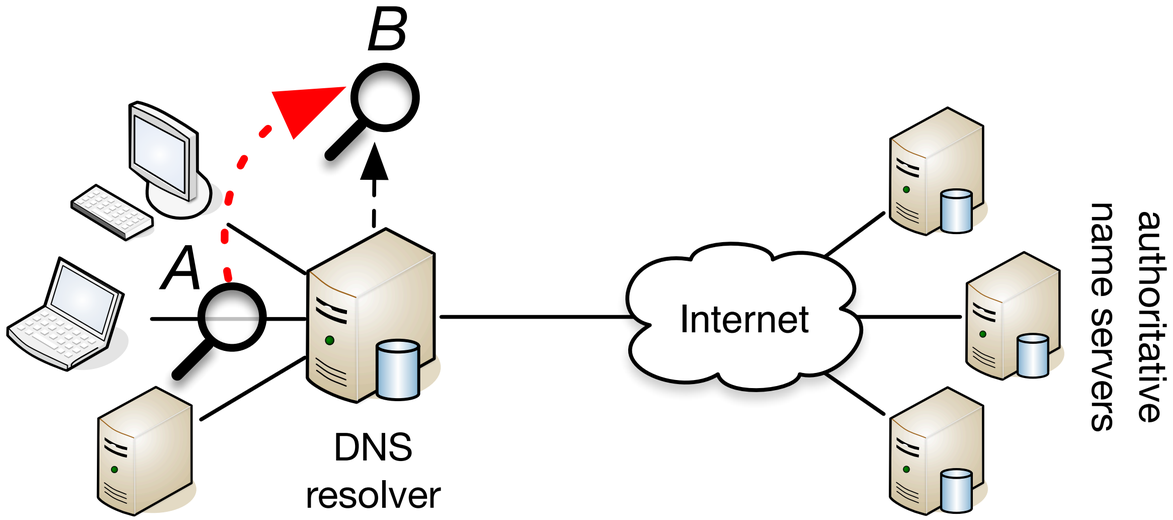
- **RFC 7858**: simple idea, let the **stub** talk **to** the **recursive over** a **TLS** connection

- Raises **some issues**:
  - TCP + TLS **handshake overhead**
    (partially alleviated by TCP Fast Open and TLS Session Resumption)
  - **Resource consumption** on the recursor is a potential issue
    (TCP buffers, TLS state, ...)

- **Generally** speaking, **though, works** quite **well**

# Issues in DNS over TLS

- Encrypting DNS traffic means some on-path **security monitoring** will no longer work; **requires a shift from on-path (A) to on-resolver (B)**




- **Little experience** in production **with resource requirements** of DoT

- **Dedicated** TCP **port 853 may be blocked** on networks, making DoT unavailable

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# DoT implementation status

- **DNS over TLS is** already **well-supported** in recursors; **all** the **popular resolver implementations** support it
  (Unbound, BIND, Knot Resolver, PowerDNS Recursor)

- **Client support** jumped with the advent of
  **Android P** (DoT support, enabled by default)

- Other end users can use, e.g. **getDNS Stubby**

- **Service providers** also **widely support it** (all cloud resolvers, but also, e.g., SURFnet DNS resolvers, which use Unbound)

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# Next steps in DoT

- **Improve performance** by supporting, e.g., out-of-order processing
- **More support** in built-in system **stub resolvers** (slowly arriving, e.g., systemd-resolved now has support)
- Also use **TLS on recursor to authoritative path**; but how do we make this work? How to build the trust relationship (is it even possible/ necessary?)


D'OH...
NUTS!
DONUTS
Mmm...

# DNS over HTTPS

- **Google had experimental "DNS over HTTPS" for ages**; using their own REST protocol, **seemed abandoned** (nobody used it)
- Then an **IETF draft** was published, and **things started moving... FAST!**
- **DoH working group** formed in **September 2017**, **draft** adopted **October 2017**, **RFC 8484** officially **published October 2018**
- **Incredibly fast for the IETF**; lot of momentum behind this idea

# DoH basic outline

- DoH simply sends **Base64-encoded wire format DNS datagrams** over either **HTTP GET or HTTP PUSH**
- **Two modes** of operation:
  - **Dedicated:** the service end point **only** functions as a **DoH DNS resolver**
  - **Mixed: DNS** traffic is **mixed into other HTTP traffic**
- DoH **server configured as** a **URI** end point in the client


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# DoH, where did it come from?

- **Browser community want**ed a **web-style API to** access **DNS**
- **Argumentation** browser community uses to push for it:
  - **Enhance privacy** of browser users (encrypted transport, mixing with HTTP traffic), arguing that **adoption of e.g. DoT is too slow**
  - **Port 443 does not get blocked**, so can circumvent traffic filtering
  - **Improve user experience** by reducing latency **(really?!)**
  - **Longer term: new features** (JSON, Server Push, **"resolverless"**)

# Issues with DoH

- The **rest of** this **talk will focus on issues with DoH** in several dimensions

- **Why? Because DoH may have far-reaching consequences for the DNS and the Internet**

- Dimensions we will look at:
  - Issues with privacy
  - Issues for network operators
  - Impact on the DNS name space


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# DoH and privacy

- **Proponents push** DoH **arguing privacy**; there are **issues with** that **claim**

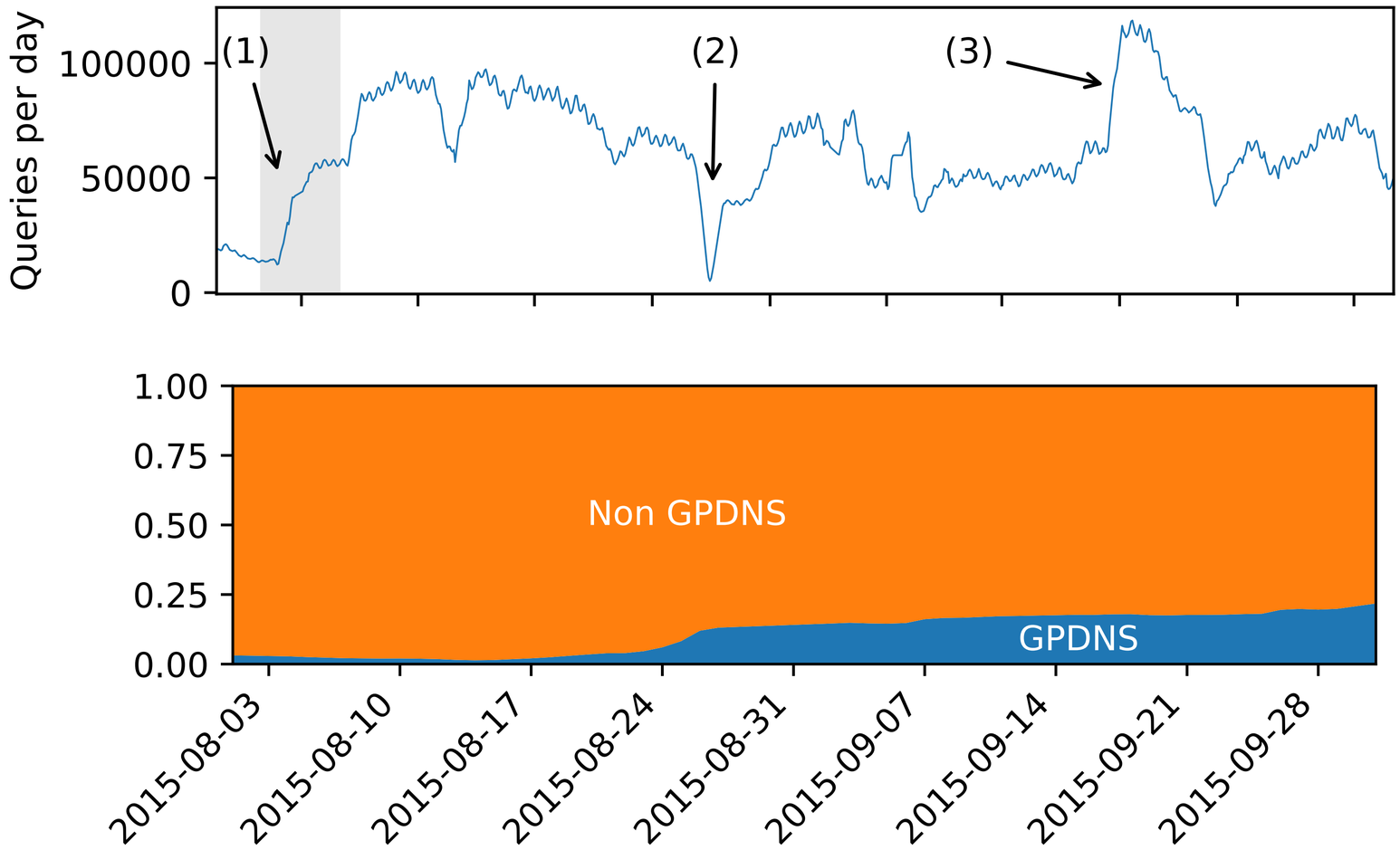
- **DoH imports** all of the **privacy issues of** the **HTTP** ecosystem into the DNS resolution process (**e.g. user agent profiling**), which has sparked a new Internet draft to address this

- DoH **proponents** appear to **advocate** that a **"public trusted recursive resolver" (TRR) is always better**. This is **simply not true** in many cases, **consider e.g. EU citizens** who are **protected by** the **GDPR** in relation to their ISP.

# DoH and privacy

- **Browsers** appear on the cusp of **forcing DoH** on users
- Mozilla has **DoH** support **in Firefox since version 61**, **still disabled**, but... **considering** to **enable** it **by default**, and their **default TRR is** currently **CloudFlare**
- **Other browsers will** surely **follow** (I'm betting it's only a matter of time before Chrome will start using DoH towards 8.8.8.8 by default)
- **Users** are **highly unlikely to turn** this **off if** it's the **default**, experience with users switching to 8.8.8.8 illustrates user inertia on this

# Side step: user inertia viz. DNS




Graphs show Google Public DNS use in Ziggo's AS after a DoS attack on their resolvers

**Takeaway: once users change their config, they never go back**

(graph from [1])

[1] W.B. de Vries, R. van Rijswijk-Deij, P.T. de Boer, A. Pras. Passive Observations of a Large DNS Service: 2.5 Years in the Life of Google. In Proceedings of the 2018 Network Traffic Measurement and Analysis Conference (TMA 2018), Vienna, Austria, 26-29 June 2018.

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# DoH and performance

- Remember DoH proponents cite **"performance" as reason to deploy?**
- **Firefox** put **"classic DNS" and DoH side-by-side** (blog here)
- Here are the **weasel words from the blog**:
  *"The **slowest 20%** of DNS exchanges are **radically improved** [...], while the **majority** of exchanges **exhibit a small tolerable amount of overhead** when using a cloud service. **This is a good result**."*
- A "small tolerable amount of **overhead**" is an **average of 6ms per query!**

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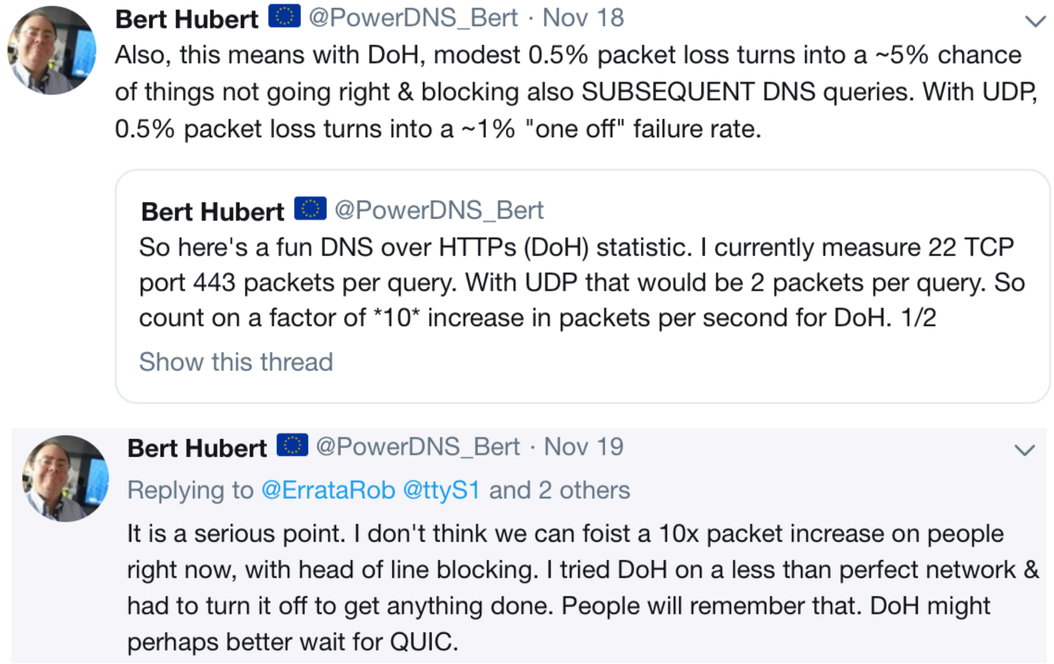
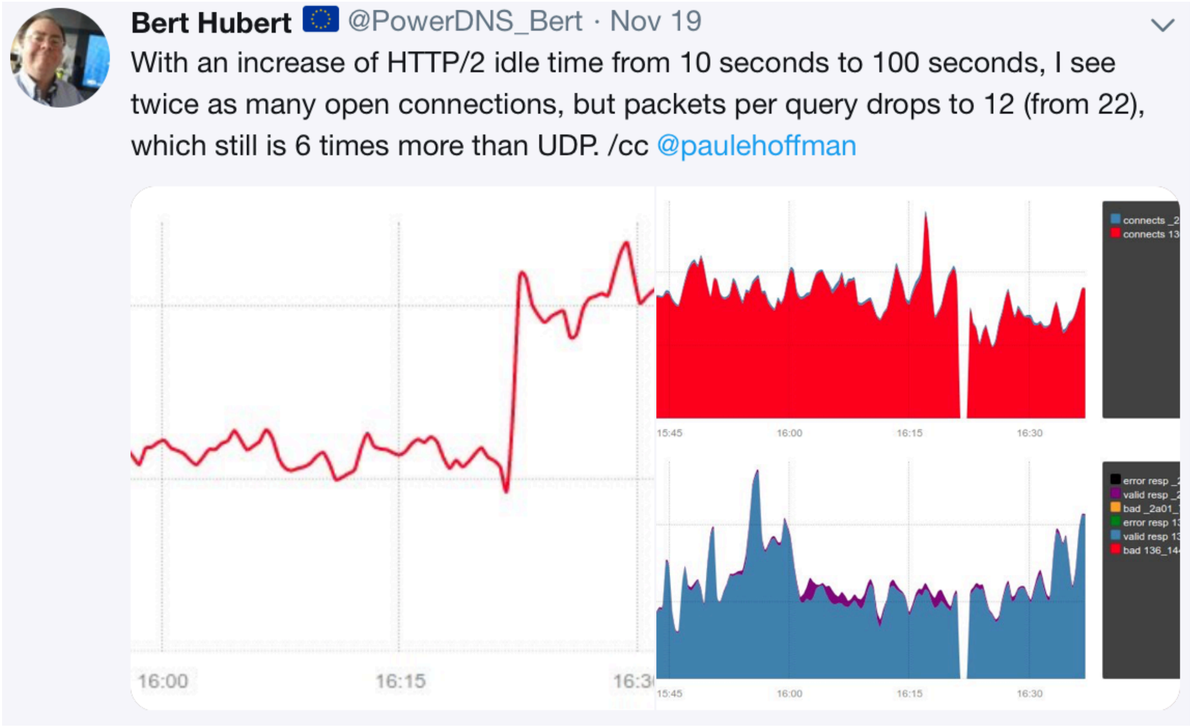
# DoH and performance

- Bert Hubert (@PowerDNS_Bert) is running an experimental DoH service and regularly tweets about performance




- Guess how he feels about DoH at the moment...

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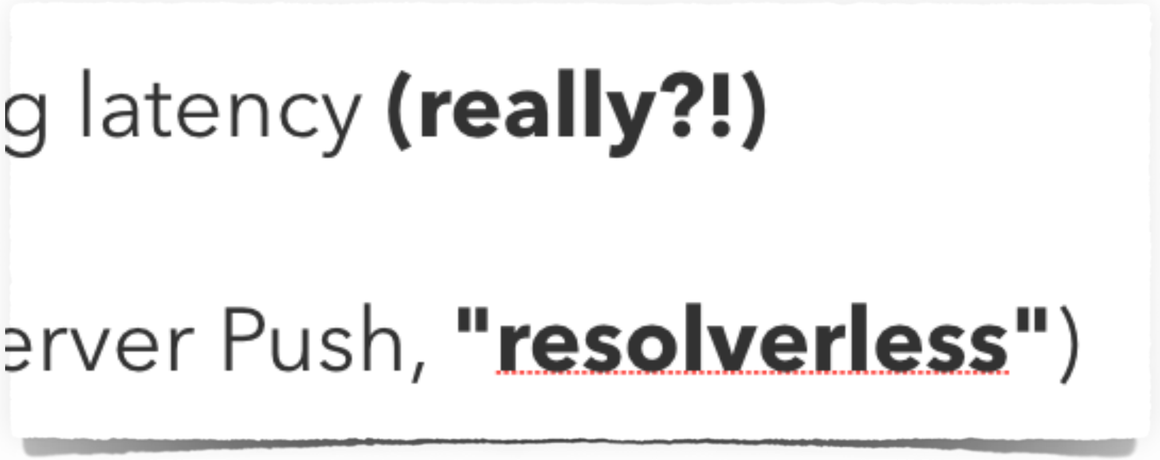
# DoH and network operators

- Where **DNS over TLS may require** operators to **re-think security monitoring, DoH makes it impossible**
- Use of **DoH circumvents any local security policy** for the DNS
- Use of **DoH is (almost) impossible to track**, especially in mixed mode
- **Security officers** can look forward to **having to wrangle browser configs for managed desktops** to disable DoH and stop users from turning it back on

# DoH and the DNS name space

- The **biggest** expected **impact may not be** the most **obvious**
- **Remember** that word **"resolverless"** a few slides back?
- Deployment of **DoH may radically change the DNS name space** as we know it
- **Why?**

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# DoH and the name space

- **Browsers vendors** and others have **floated** the idea of a **"repository of TRRs" for** looking up **specific parts of the name space**
- **Imagine a cabal** very much **like** the **CAB Forum** for the X.509 Web PKI **deciding on** a common **TRRs** in browsers (and in the future OSes too)
- Suddenly, they **decide how names are resolved**
- **Who ever gave** these folks **the right to** make **this decision?**
  **What about** the **multi-stakeholder** model for **Internet governance?**

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# DoH and the name space

- **Imagine** what this might mean!
- **Parts of the name space** are directly **resolved through** browser-**embedded TRRs**, **circumventing** the current **DNS** hierarchy
- **Next step: ICANN** and the current DNS hierarchy become **obsolete**
- What about the **"level playing field"?** How do I claim my name?
- Facilitates **further centralisation of the Internet**, and even **stronger monopolies for** certain **big players**

# DoH and the name space

- **Current DNS operators** are **heavily invested in** an infrastructure that does **UDP** really well, **and** also handles **a bit of TCP**
- For **resolver operators**, it is relatively **simple to** also **support DoT**
- **DoH is a game changer**, it has a relatively **low bar of entry for players** that are already heavily **invested in** the **HTTP** ecosystem, but requires **major re-engineering for "traditional" DNS players**

# What will the future look like?

- **No reason to attribute malice** to the browser folks, they are **probably** just **trying to do** what they think is **"the right thing for privacy"**
- That **"right thing"** may have **unintended and irreversible side effects**
- Because it is **tilting thinking about** how we view **the name space**
- This has **not happened** in earnest **for over 30 years**
- So we should be **pay**ing **close attention!**

# What can/should you do?

- If you do not **support DNS over TLS** on your resolver: **turn it on!**
- **Consider running** a **DNS over HTTPS server**, to at least offer some diversity
  - This is **not simple**; there is **insufficient open source code available** to do this (we have plans, but DoH is a beast when you're used to implementing "regular" DNS)
- **GET INVOLVED IN THE DEBATE!** If you agree DoH has issues, speak up!

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# Thank you! Questions?

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