It’s DNS Jim, but not as we know it!

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Stub to recursive

What this talk will cover

Overview: Summarise the most recent evolutions in how end-device DNS resolution is being done (~past 5 years)

- **New IETF standards:** Encrypted transports for DNS (TLS & HTTPS)
- **Deployment Status**: Clients and resolver services for encrypted DNS
- **DNS resolution directly from applications:** Browsers
  - **DNS resolution to third party providers:** Implications for operators

My Background

- Co-founder of Sinodun IT - small UK based consultancy
  - Focussed on DNS, DNSSEC and DNS Privacy
  - R&D, Open source dev, Standards dev

- **DNS-over-TLS:** involved in standards dev, implementation and deployment (we contribute to dnsprivacy.org).
- **DNS-over-HTTPS:** Not directly involved, no links to browser vendors

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Goal today is to bring awareness to this audience of fast moving changes: **The good, the bad and the ugly….**

The DNS is showing its age

- **Nov 1987** - RFC1034 and RFC1035 published!

No Security or Privacy in the original design!

DNS-over-TLS (DoT)

RFC7258:
Pervasive Monitoring is an attack

DPRIVE WG formed

Goals:
1) Encrypt Stub-Rec DNS
2) Think about Rec-Auth?

Snowdon Revelations

1987 2012 2013 2014 2016 2018

RIPE 77

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RFC7766:
DNS-over-TCP

RFC7858:
DNS-over-TLS

Port 853

Snowdon
Revelations

1987 2012 2013 2014 2016 2018

DNS-over-TLS (DoT) Status

Date	Event
2015 - 2018	**Implementations**: Clients: Android Pie, systemd, Stubby Servers: Unbound, Knot resolver, dnsdist, (BIND)
2015 - now	Set of 20 test DoT servers
Nov 2017	Quad9 (9.9.9.9) offer DoT
Mar 2018	Cloudflare launch 1.1.1.1 with DoT

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System stub resolvers:
Need native Windows
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System stub resolvers: Need native Windows & macOS/iOS support

Easy to run a DoT server

Encrypted DNS: the good… ✔

- Defeats **passive surveillance**

- Server **authentication** if a name is **manually configured** (PKIX or DANE - RFC8310)
  - Prevents redirects, can't intercept DNS queries
  - Increases 'trust' in service (DNSSEC, filtering…)

- **Data integrity of transport** - can't inject spoofed responses

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just need IP address
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Strict DoT: need a name too

- **Data integrity of transport** - can't inject spoofed responses

Encrypted DNS: the bad & ugly…

- **SNI still leaks** (but not for long! draft-rescorla-tls-esni)
- A dedicated port (853) can be **blocked** (443 fallback)
- **Resolver** still sees all the traffic (who do you ‘trust’?)

- If using a resolver NOT on the local network (not available)
  - Breaks Split horizon DNS (fallback possible),
    leaks internal names. Similar to e.g. using 8.8.8.8 but….

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For DoT, seen as short term or rare…


WHAT IF I TOLD YOU BROWSERS
ARE GOING TO DO THEIR OWN DOH
imgflip.com

…..to their own chosen cloud resolver service!

DNS-over-HTTPS (DoH)

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March 2017

IETF 98

First DoH draft published (query init)

May 2017

DoH WG formed

Goals: “This working group will standardize encodings for DNS queries and responses that are suitable for use in HTTPS. ”

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Specification differences

How is DoH different to DoT?

- **A Use case (of many): “**allowing web applications to access DNS information via existing browser APIs”
- **Discovery - MUST use a URI template (not IP address)**
- **Two models:**
  - **Dedicated** connections (only DoH traffic) - hard to block
  - **Mixed** connections (send DoH on existing HTTPS connections)
    - Better privacy? Not leaking queries
- **Increased tracking**: HTTP headers allow tracking of query via e.g. ‘User-agent’ (application), language, etc.

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New privacy concerns

DoH Status

	Standalone	Large Scale
Servers	• ~10 other test servers	• Cloudflare (https://cloudflare-dns.com/dns-query) • Google (https://dns.google.com/experimental) • Quad9 (https://dns*.quad9.net/dns-query) • 3 flavours of service

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	Client	Servers
Implementations	• **Firefox** config option • Chrome/Bromite • Android 'Intra' App • Cloudflared • Stubby (next release) • Various experimental	• **dnsdist (WIP)** • **Knot resolver (patches)** • Various experimental

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"**Moziflare**"

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DNS in Browsers

- Some already have their own DNS stub (e.g. Chrome)
- Some already use encrypted DNS (Yandex, Tenta)

- **Firefox had DoH since 61, not enabled by default**
- **Firefox experiment being performed….**

Dedicated DoH connections

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Browser vendors control the client and update frequently.

DoH in Browsers

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- Why DoH, not DoT? Mozilla's answer:

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OS's are slow to offer new DNS features (DoT/DoH)

Selling point: "we care about the privacy of our users"

Performance: "reduce latency within browser"

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HTTPS everywhere: "it works… just use port 443, mix traffic"

Cool stuff: "JSON, Server Push, 'Resolverless DNS'…."

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DNS 2.0?

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    - **“We’d like to turn this [DoH] on as the default for all of our users”**
    - **“Cloudflare is our ‘Trusted Recursive Resolver’ (TRR)”**

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“With this [agreement], we have a resolver that we can trust to protect users’ privacy. This means **Firefox can ignore the resolver that the network provides** and just go straight to Cloudflare.”

DoH in Firefox

Dedicated DoH connections

- Mozilla blogs:
  - Firefox Nightly ‘Experiment’ (June) & Experiment results (Aug)
    - Half of users opted-in: Send all DNS queries to system resolver **AND to Cloudflare**, compare the results.
    - “Initial experiment focused on validating:
  - Another experiment in Firefox Beta announced…(Sept)

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1. Does the use of a **cloud DNS service** perform well enough to replace traditional DNS?”

RESULTS: 6ms performance overhead is acceptable

“**We’re committed long term to building a larger ecosystem of trusted DoH providers that live up to a high standard of data handling.”**

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“Trusted recursive resolver”

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Impact of TRRs? Applications using default TRRs fundamentally change the existing **implicit** consent model for DNS:

- (Current) Log onto a network and use the DHCP provided resolver
- (New?) Use an app and agree to app T&C’s (including DNS?)

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Potential **centralisation** of DNS resolution to a few providers?

Reactions are mixed…

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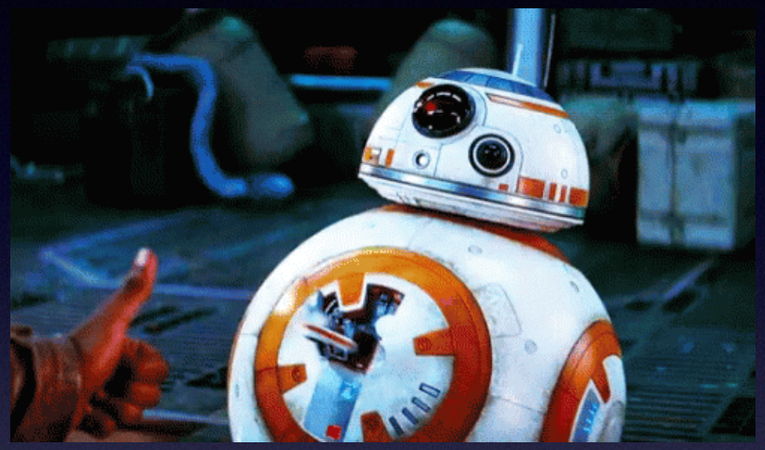

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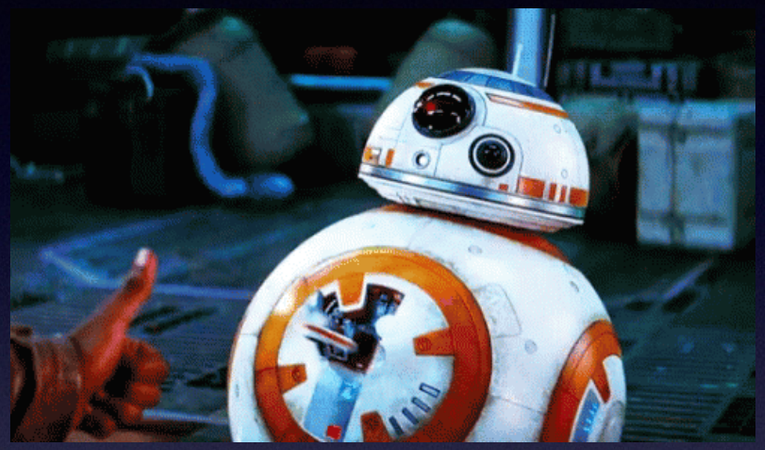

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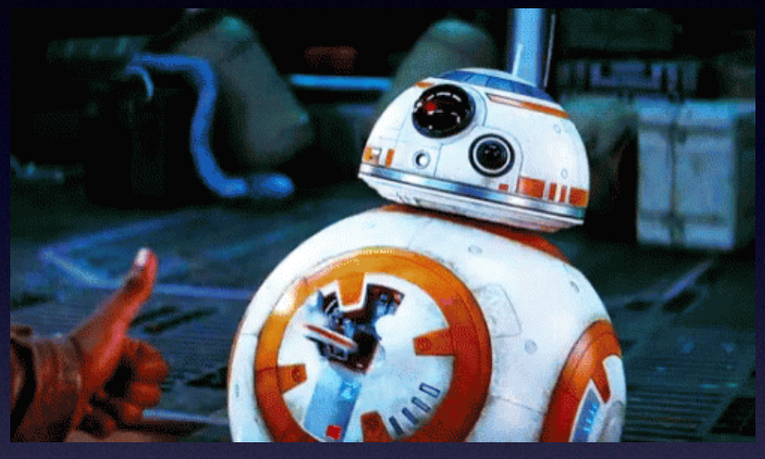

Reactions?

- Ban/Block/Intercept Moziflare - ‘My network, my rules’
  - Operators need visibility (TLS 1.3 deja vu)
  - Is it even legal?

- Threat model analysis needed:
  - TRR useful but only in untrusted networks?
  - Users need choice (US lack of net neutrality vs EU GDPR)
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  - Neutrality of DNS operators (CDN’s?)
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Lots of questions…

Managing many devices in enterprises

- What are **Chrome**, Safari, IE/Edge plans?

- What if **other apps** also do their own DoH/DoT?

- **Loss of central point of config on an end device?**
  - Loss of network settings as the default
  - DNS no longer part of the device infrastructure?

What to do?

- Think about running a **DoT server** in your network: for system level resolvers e.g. *Android, Stubby, systemd* it is the right thing!

- Think about running a **DoH server** in your network: gives users the option to use that, centralisation of DNS to a few players is a bad thing!

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