Where’s my DNS?

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The DNS protocol is evolving

- **DoT** [RFC7858] standard May 2016
  - Implemented to-date in ‘standard’ open source DNS software

- **DoH** [draft-ietf-doh-dns-over-https] is in (through?) WGLC
  - Draft deals mainly with protocol, not
    - That DoH facilitates specific use cases: “via existing browser APIs”
    - Discovery of DoH servers (DRUI) - must have a URL
What will this change?

• DoT/DoH will change stub to recursive DNS….
  • Use of encrypted DNS transports
  • System-wide resolution or per app?
    • Multiple resolvers per device?
  • Resolver: choice, discovery or defaults?
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“What will I see?”

"...things that were... things that are... and some things... that have not yet come to pass."
## Open Source Implementations Today

<table>
<thead>
<tr>
<th>DoT</th>
<th>Client</th>
<th>Recursive Resolver</th>
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<tr>
<td></td>
<td>• <strong>getdns</strong> library &amp; <strong>Stubby</strong> (fwd)</td>
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<td>• BIND on the way</td>
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<td>• Android P: system config (dev)</td>
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<td>• <strong>systemd</strong> support</td>
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<td>• <strong>dnsdist</strong> (WIP)</td>
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<td>• Android ‘Intra’ App</td>
<td>• Various experimental*</td>
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<td>• <strong>Firefox Nightly</strong> config option</td>
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* 10+ implementations (see DoH mailing list and IETF 101 Hackathon)
# Recursive Resolver Deployment

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<th>Standalone</th>
<th>Large Scale</th>
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<tr>
<td><strong>DoT</strong></td>
<td>• 20 test servers</td>
<td>• Quad9 (9.9.9.9)</td>
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<td></td>
<td></td>
<td>• Cloudflare (1.1.1.1)</td>
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<tr>
<td><strong>DoH</strong></td>
<td>• Google</td>
<td>• Cloudflare</td>
</tr>
<tr>
<td></td>
<td>• Few other test servers</td>
<td>• <a href="https://mozilla.cloudflare-dns.com/dns-query">https://mozilla.cloudflare-dns.com/dns-query</a></td>
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* Experimental, some support JSON as well as wireformat
Encrypted DNS, what’s not to love?

- Defeat *passive surveillance* ✓
- Can *authenticate* the server ✓
  - Prevents redirects
  - ‘Increases’ trust
- DoH - less susceptible to port and traffic *blocking* ✓
Encrypted DNS, what’s not to love?

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Encrypted DNS, reality check...?

- Increased **tracking** of user
  - Fixed resolver & connections, session resumption
  - DoH headers….? (e.g. user-agent)

- **Limited choice** of resolvers right now:
  - Breaks VPN/Split horizon DNS
  - SNI still leaks to network

- **Resolver** still sees all the traffic (Oblivious-DNS anyone?)
  - Choice of 1 resolver better than many (which one?)

Probably not one on the local network...
System or App?

If in App…

system or own settings?

“…allowing web applications to access DNS information via existing browser APIs"
System or App?

- **Always been technically possible** for apps to do their own DNS but has:
  - largely been the **exception** (except some browsers)
  - have typically used the **system resolver** (8.8.8.8?)
  - **not been encrypted** (so still fully visible to user)

- Nothing to say an app ‘must use system library and/or resolver’
  - Just traditional architecture of end user devices
  - Easy for simple apps: one library call, no frills, reliable
WHAT IF I TOLD YOU BROWSERS ARE GOING TO DO THEIR OWN DOH
DNS in Browsers

- Some have always had their own DNS stub (e.g. Chrome)
- Some already use encrypted DNS
  - Yandex (DNSCrypt), Tenta (DNS-over-TLS)
- Firefox Nightly already does DoH
- Firefox 62 (Sept 2018) will support DoH (by default?)
- Chrome has a DoH implementation (not exposed)
  - Used in Bromite
DoH in Browsers

- Why encrypt directly from the browser?

- Why DoH, not DoT? [Mozilla’s answer](#).
DoH in Browsers

- Why encrypt directly from the browser?
  - 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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• Why DoH, not DoT? Mozilla’s answer.
  - Integration: “leverage the HTTPS ecosystem”
  - HTTPS everywhere: “it works… just use port 443, mix traffic”
  - Cool stuff: “JSON, Server Push, ‘Resolverless DNS’….”
DoH in Browsers

• Makes sense from a purely browser (application) view point
• But… bigger shift from ‘traditional’ DNS (including DoT)
• Unlikely browsers will change direction now….

• Thought experiment:
  • If DoH had been proposed in DPRIVE back in 2014… where would we be now (many solutions were considered)?
DoH in Firefox

- Right now: Firefox Nightly ‘experiment’ (half of users, opt-out)
  - Use DoH to send all queries to Cloudflare as well as default resolver, compare the results

- Overview of future plans, details of config & how it works

- Plan:

  - Chrome, Safari, IE/Edge plans?
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- Plan:
  - “We’d like to turn this [DoH] on as the default for all of our users”
  - Cloudflare is our ‘Trusted Recursive Resolver’ (TRR) - more later

- Chrome, Safari, IE/Edge plans?
Short term vs long term

- **Short term DoH in browsers:**
  - In reality, Cloudflare are the only large scale DoH provider today
  - Need ISPs, etc. to catch up

  - Cloudflare might be the default but user can configure their own resolver if they know where to look (Google, Quad9?)

- No **discovery mechanisms** for DoH servers available
  - Pre-defined list/default/user override is only option
Short term vs long term

- Consider end user workflows (on different devices):
  - **Browser** based *desktop* workflow (for cloud based data)
  - **App** based *mobile* workflow

- Split: **Browser/the rest?**
  - What will the default resolver model be for browsers?
  - ‘Opportunistic/Resolverless DNS’ Discover a DoH server within a domain (browser tab) and use that… *minimised leakage*
    - Change of trust model or more?
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- Change of trust model or more? DHNS?
Short term vs long term

• **Most other apps** also do their own DoH/DoT?

  • If OS’s remain slow to update DNS (as with DNSSEC), this is likely…
  
  • Quality and range of DNS libraries improves e.g. getdns, Javascript libraries this is more likely….

  • Wide enough deployment of DoH/DoT servers (available everywhere or just a few big operators)?

• **Privacy increase plus individual apps see the gains, but will the overall ‘user experience’ suffer?**
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Or a huge mixture…
Dude, where’s my DNS?

• In an ideal world all apps that do their own DNS would consistently

• Implement all DNS options
  (all transports, DNSSEC support, etc.)

• Respect system settings
  (DHCP/user resolver, search domains, DNSSEC, etc.)

• Be highly transparent about DNS settings
  (defaults, DoH headers, cookie use, etc..)

• Expose low-level debugging of DNS queries
  (current debug in Firefox is limited…)

End user perspective
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Can’t enforce

End user perspective
Fragmented system DNS

- If not...
- Just another form of content? Possibly multiple name systems?
- Multiply config issues by number of devices a user has

- Multiple config points (transport, authentication)
  - Importantly DNSSEC
  - Multiple recursive resolvers (privacy gains)
    - Scatter queries/reduce leakage
    - What if some fail, get blocking or attacked
  - Multiple points for monitoring/debugging?

DNS is no longer part of the device infrastructure with a single point of configuration....
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Will users notice or care?

- If our muggle friends don’t then we should!
- They won’t notice if apps don’t even expose that they do this…..
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Click to continue

(Terms & conditions)
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Welcome to my_app version X!

In this release we are protecting your DNS
- aren’t we fab!

Click to continue

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Welcome to my_app version X!

We are trying to improve the privacy of your DNS but do this we need to re-route all your DNS queries to a company based on Mars you probably haven’t even heard of.

- Don’t know what DNS is? Just click here to blindly accept our T&C’s!
- Total geek? Click here to see the gory details…

(Terms & conditions)
Trusted Recursive Resolver
‘TRR’
Implicit consent model:
- (Current) Log onto a network and use the DHCP provided resolver
- (New?) Use an app and agree to app T&Cs (including DNS?)

“With this, 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.”
TRR

- **Cloudflare are good** (not perfect) - not all TRRs will be!
- Might end up with a few ‘big’ TRR providers
- Development companies set up own server (quality?)
- Applications be persuaded to use a certain ‘TRR’ in return for money?
- Work in progress on [Best Current Practices for Operators](#)...

- Bypassing network resolver (enterprise/user issue):
  - Breaks VPN, split horizon, leaks internal queries
  - Can use fallback but slow and still leaks queries
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I’m not judging…
I’m just saying…

Mixed, uncertain future for the camel (1, 3, 30 yrs?)…
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It’s DNS Jim, but not as we know it
Thank you!