Where’s my DNS?

Sara Dickinson sara@sinodun.com

Stub to recursive

The DNS protocol is evolving

DoT: DNS-over-TLS
DoH: DNS-over-HTTPS (WIP)

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

- **DoH** draft-ietf-doh-dns-over-https is 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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End User
Application Dev
Network Op
Resolver Op

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Concentrate on this here

“What will I see?”

"…things that were… things that are…
and some things…
that have not yet come to pass."

Open Source Implementations Today

	Client	Recursive Resolver
DoT	• **getdns** library & **Stubby** (fwd) • Unbound/Knot resolver (fwd) • Android P: system config (dev) • **systemd** support	• **Unbound, Knot Resolver, dnsdist** • BIND on the way
DoH*	• getdns/Stubby (next release) • Android 'Intra' App • **Firefox Nightly** config option • Chrome/Bromite • Various experimental*	• **dnsdist** (WIP) • Various experimental*

* 10+ implementations (see DoH mailing list and IETF 101 Hackathon)

Recursive Resolver Deployment

	Standalone	Large Scale
DoT	• 20 test servers	• Quad9 (9.9.9.9) • Cloudflare (1.1.1.1)

DoH*	• Google
	https://dns.google.com/experimental
	• Few other test servers
		• Cloudflare
		  • https://cloudflare-dns.com/dns-query
		  • https://mozilla.cloudflare-dns.com/dns-query

* 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** ✓

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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

Probably not one on the local network…

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

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
imgflip.com

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.

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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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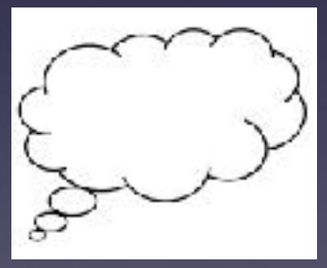
Integration: "leverage the HTTPS ecosystem"

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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  - **“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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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 opeators)?

- **Privacy increase plus individual apps see the gains, but will the overall 'user experience' suffer?**

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Or a huge mixture…

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End user perspective

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…)

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Fragmented system DNS

DNS is no longer part of the device infrastructure with a single point of configuration….?

- 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? ?

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Different failure mode than today.. Wireshark/dig can't help you here

Will users notice or care?

- If our muggle friends don’t then we should!
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Click to continue

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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…

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Trusted Recursive Resolver

‘TRR’

TRR

> “ 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.”

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

TRR

- Cloudflare are relatively good so far (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
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Mitigation/motivation for operators to deploy

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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!