DNS New World Order: QuadX! DoH! DoT! Da Fuq?

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@troutman

Who is this guy and why is he cranky?

- Internet "Old Timer" & Engineer, online via a “paper TTY” with a 300 bps acoustic coupler modem in 1982, user of the Internet & UNIX since 1987. Tasked with building and running Internet infrastructure off and on since the early 90s. Have held a wide variety of roles in Internet operations, engineering, and management at various regional ISPs, CLECs, ILECs, cable TV companies, web hosts, and in IT. Independent Consultant for hire.

Disclaimer

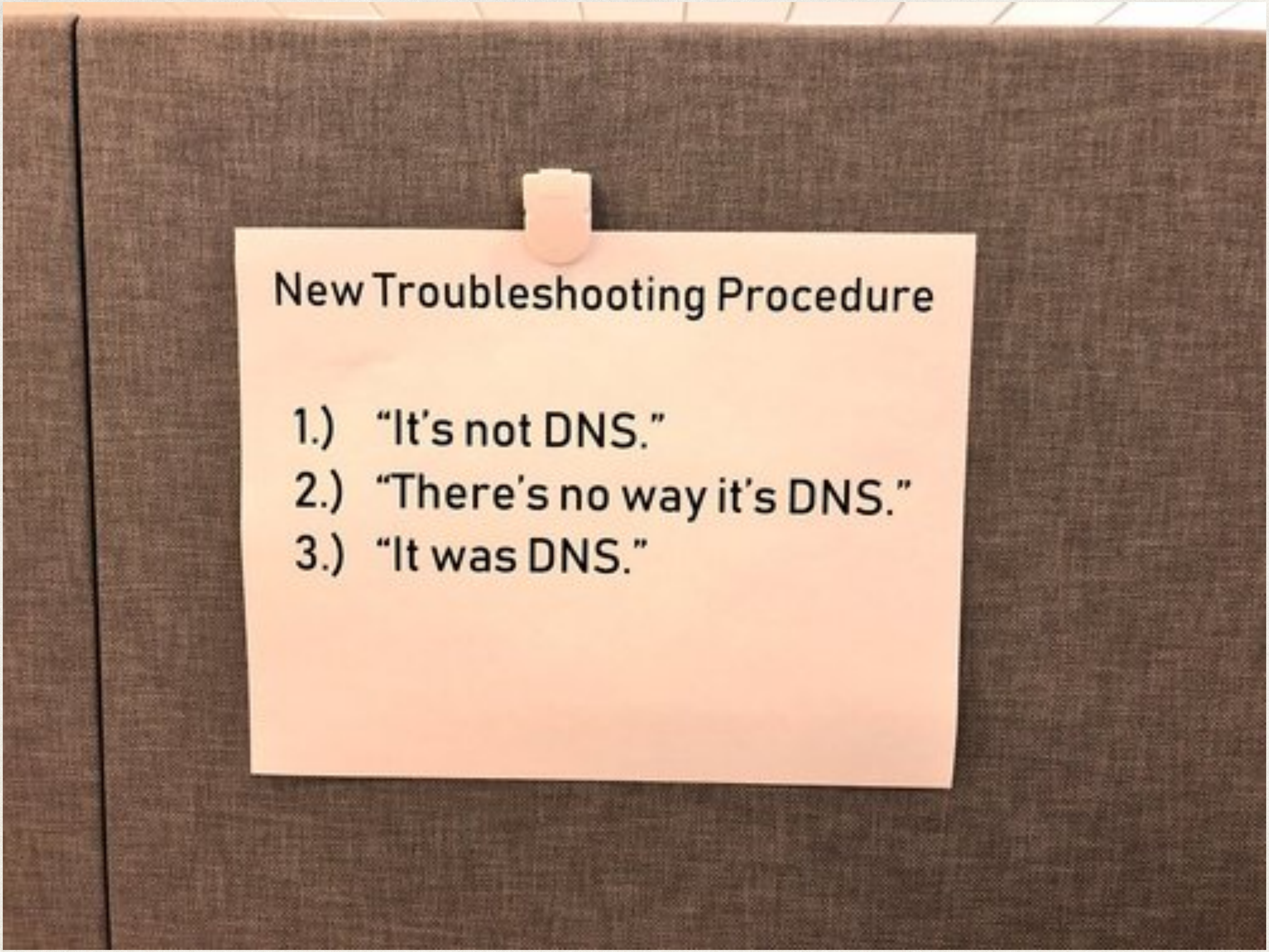
NNENIX

NORTHERN NEW ENGLAND
NEUTRAL INTERNET EXCHANGE

- I am also a Director & Co-Founder of the non-for-profit Northern New England Neutral Internet Exchange (NNENIX.NET)
- Disclaimer: NNENIX hosts servers for Quad9

Topics of Presentation

- Domain Name System (DNS) in general & new encrypted DNS methods like DNS over HTTPS (DoH), DNS over TLS (DoT).
- Operational reasons why you should monitor DNS
- Cloud services offering easy to remember DNS servers & why they would want to give such a gift to the world
- Privacy implications of Web Browser product decisions
- Recommendations to mitigate the impact of new DNS encryption methods



New Troubleshooting Procedure

1.) “It’s not DNS.”
2.) “There’s no way it’s DNS.”
3.) “It was DNS.”

Domain Name System (DNS)

- One of the most important foundational technologies that makes the Internet work
- It works so well that you almost never think about
- Most end-users have no knowledge of it
- DNS “simply” converts names that humans can remember into numbers (network addresses)

Domain Name System (DNS)

- Also used internally by most organizations
- Microsoft Active Directory depends entirely on DNS working correctly and reliably

Domain Name System (DNS)

- Nearly 100% of everything you do on the Internet needs DNS to function.
- This is why when people say things like "the Internet it down" the Internet is usually just fine, but your DNS server is not working.
- DNS requests are usually called "queries"

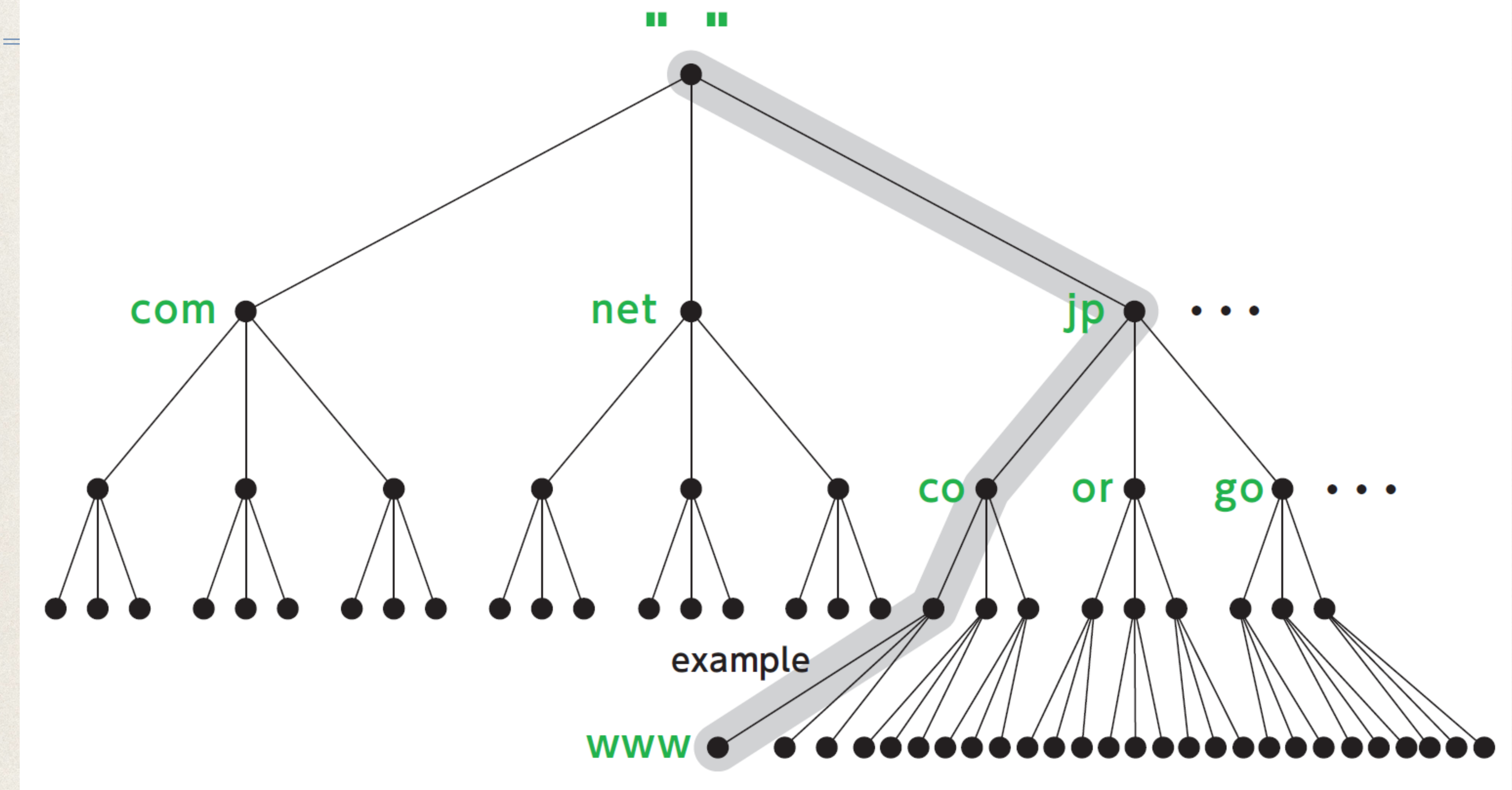
Domain Name System (DNS)

- Your DNS query history can reveal a lot about you and what you are doing online.
- Every every website you visit, your email client, the games you play, and most apps your run depend on DNS to work.

Domain Name System (DNS)

- Domain Names are hierarchical
- Starts at the root, or ".", then top level domains (TLDs) then second or more levels
- Generic TLDs (gTLDs) like .com, .gov, .net, or country code TLD (ccTLDs) like .us, .uk, .jp
- Use to be just a handful, now more than 1000 TLDs in existence (.bank, .coop, .horse)

Domain Name System (DNS)



@TROUTMAN

Domain Name System (DNS)

- Examples:
- google.com
- www.bbc.co.uk
- ixp.nnenix.net
- example.co.jp

Domain Name System (DNS)

- DNS is a network service that converts names in a hierarchical structure into IP protocol addresses that IP network use.
- www.cnn.com “A record”
  - IPv4 151.101.1.67
- www.cnn.com “AAAA record”
  - IPv6 2a04:4e42:200::323

Domain Name System (DNS)

- Initially created in RFC882 in 1983, superseded by RFC1035 in 1987
- BIND (Berkeley Internet Name Domain) created in 1985
- DNS is the last major plain text protocol on the Internet.

Root DNS Servers

- 13 Root servers (A through M), operated by 12 different organizations (root-servers.org)
- Not 13 individual servers! Clusters of servers, with load balancers, and many Anycast instances
- Some root servers have ~160 separate physical instances around the world
- Allows scaling of traffic volumes, increase resiliency and redundancy, especially against directed attacks

Root DNS Servers

- Each root server gets double-digit billions of DNS queries per day
- Trillions of DNS queries answered per month
- DNS has scaled over 9 orders of magnitude over 35 years, and will continue to so

IP Anycasting

- Anycast is a technique where a unique IP address block is advertised in multiple physical locations, to different sections of the Internet, at the same time via BGP routing.
- Routing decisions “steer” traffic to the “best” nearest instance of that IP address via BGP decision making.
- Use for massively distributed services like the DNS root servers & DNS Cloud Providers

Traditional DNS (Do53)

- RFC882/RFC1034 and others
- Plain text protocol
- UDP Port 53 for queries, TCP Port for 53 for Zone file transfer to secondaries
- Some call it Do53 now
- Largely the same since 1985: ~35 years!

Traditional DNS (Do53)

- Because of plaintext, can be monitored over the wire easily
- Incredibly useful for knowing what your endpoints are up to, and finding malware traffic and AUP violations on your network.
- If your IT security staff isn't monitoring DNS, they should be!

DNSSec

- Domain Name System Security Extensions - work started in 1999
- extensions to DNS which provide cryptographic authentication of DNS data and integrity
- does nothing for confidentiality
- Not the topic of this presentation

DNSCrypt

- 2011 - no RFC process, not done through IETF
- DNS over TCP/UDP Port 443, but not TLS
- Solved a lot of problems, but didn't get much traction at the time

DNS over TLS (DoT)

- RFC7858 May 2016, updated by RFC8310 March 2018
- Uses TCP Port 853 with TLS encryption
- Keeps network control traffic separate from application data traffic

DNS over TLS (DoT)

- Supported by Android 9+ for the whole OS, just works if supported by server.
- Microsoft now has support for DoT in latest Windows 10 preview releases

DNS over HTTPS (DoH)

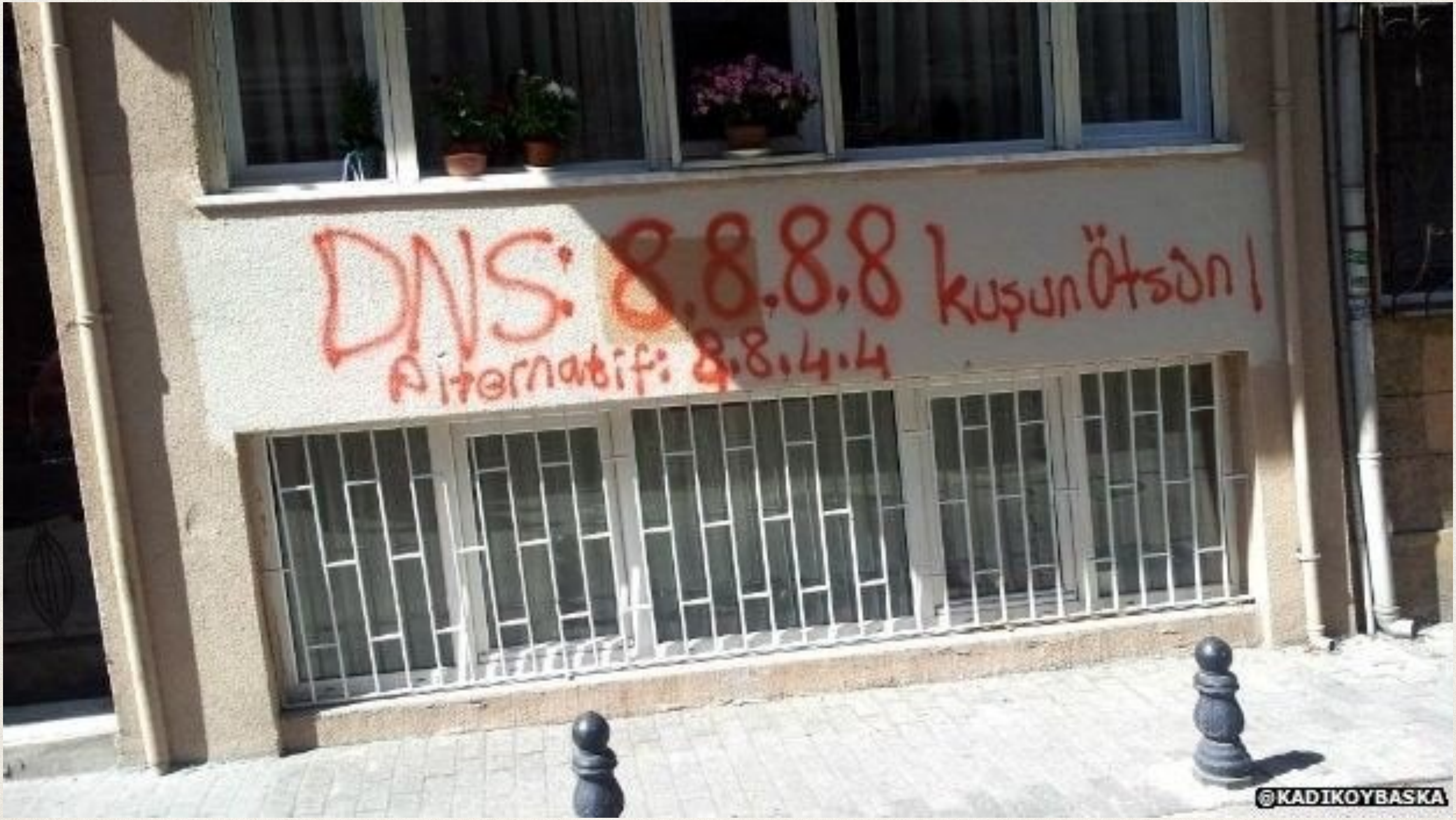
- RFC8484 December 2018
- Uses TCP Port 443 with TLS encryption
- DNS queries over a special HTTP GET with JSON responses
- Can be several milliseconds slower than Do53

DNS in the Cloud (DoC)

- For many years there have been “public” resolver DNS servers, operated mostly by ISPs as a public resource.
  - 4.2.2.2
  - 75.75.75.75
  - lots of others

DNS in the Cloud (DoC)

- Google launched their service of 8.8.8.8 in December 2009
  - To improve speeds and user experience verses old broken ISP DNS
  - Also useful to work-around censorship issues at the time


DNS: 8.8.8.8 kuşun Ötsün !
Alternatif: 8.8.4.4
@KADIKOYBASKA

DNS in the Cloud (DoC)

- Now there are several others
- Cloudflare 1.1.1.1
- Quad9 9.9.9.9

DNS in the Cloud (DoC)

- OpenDNS (Cisco Umbrella) 208.67.222.222
- CIRA Canadian Shield 149.112.121.10

HE WHO CONTROLS DNS
CONTROLS
EVERYTHING

DNS is great for tracking

- If you can monitor DNS queries, you can know everywhere someone goes online
- Shopping, entertainment, work, medical sites, apps, etc.
- Even what devices you may have in your house or business

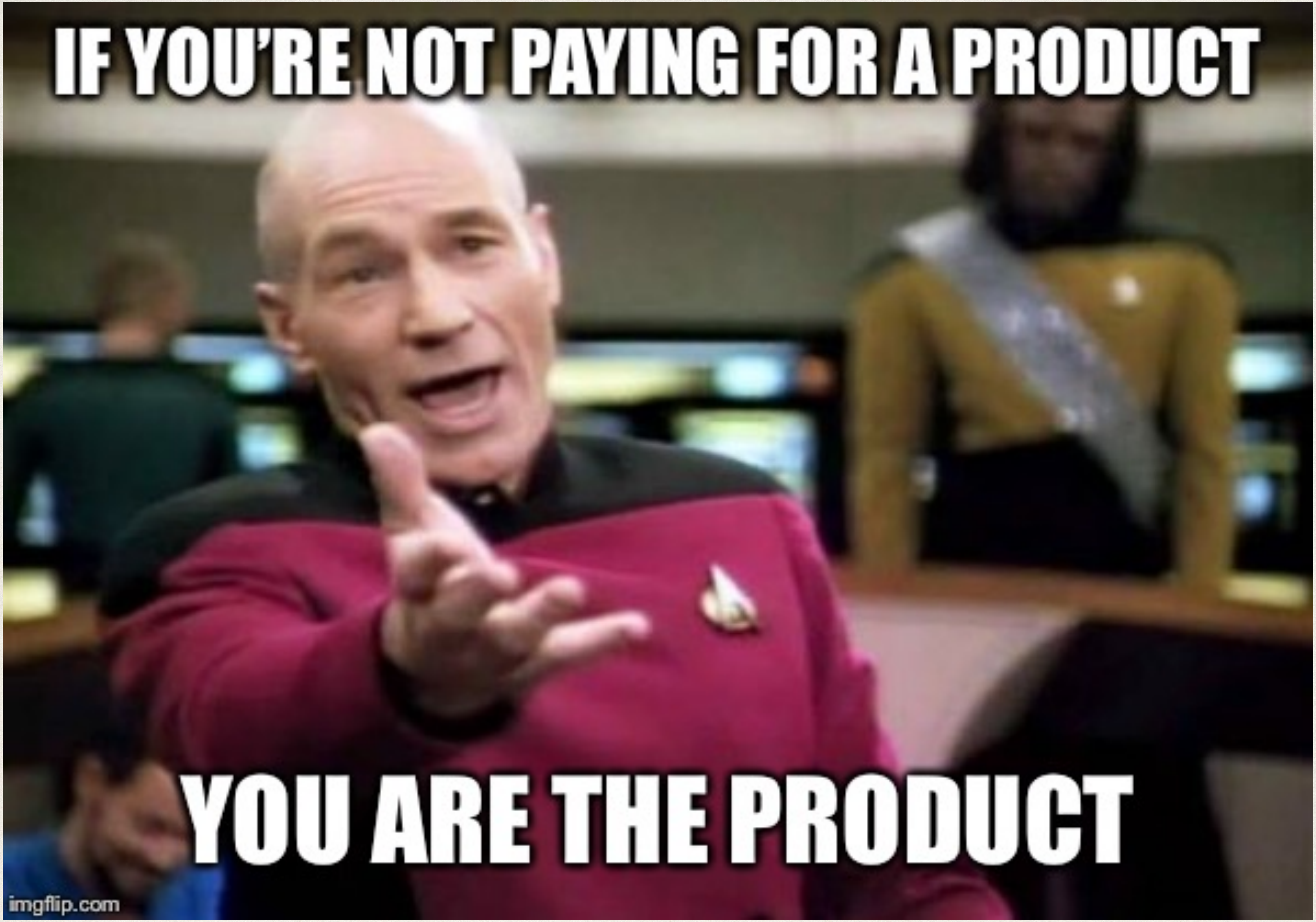
DNS comes with great power

- If you control DNS, you can control where users go or don’t go.
- Of course, DNS monitoring is great for fighting malware and intrusions
- Essential for blue team network defense & monitoring

DNS = $$$ for ISPs

- Many (most?) large ISPs, CATV, ILECs, are selling their customer’s DNS information to a variety of data brokers, advertising and tracking companies. Or own one themselves

- And they can tie that data directly to YOU at your house or your to cellular phone account


IF YOU'RE NOT PAYING FOR A PRODUCT
YOU ARE THE PRODUCT
imgflip.com

Web Browsers Pushing DoH

- Firefox 62, released in September 2018 added support for DoH through flags
- Firefox 72 (January 9th, 2020) has DoH as option in Network Settings
- Now enabled by default for all Firefox users in the USA.

Web Browsers Pushing DoH

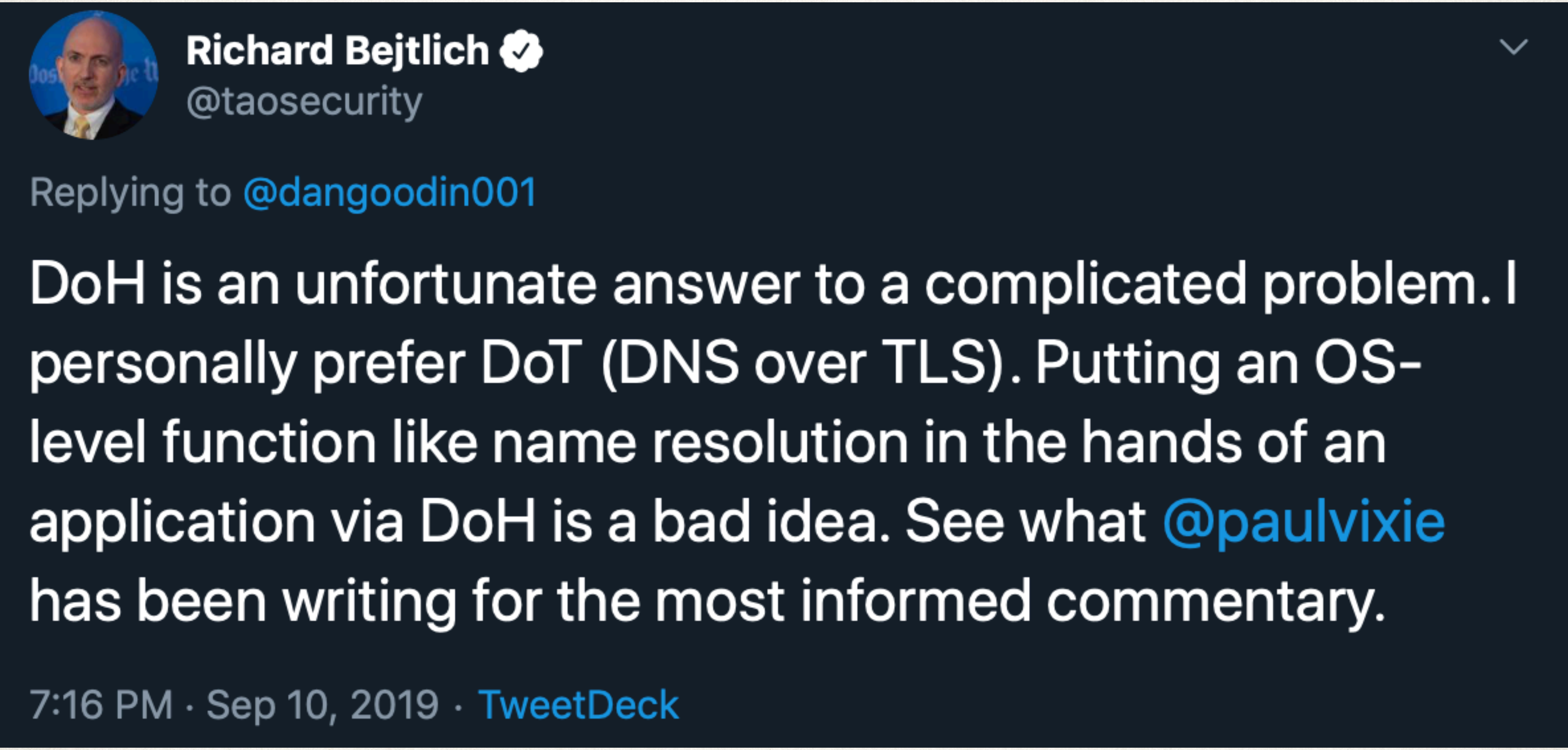
- Mozilla picked CloudFlare as first and default DoH provider. Requirements to honor and a contract
- Domain Name canary to disable if you control your DNS (so ISPs can disable DoH in Firefox, unless you override)
- A second non-CloudFlare DoH option is NextDNS.io

Web Browsers Pushing DoH

- Chrome supports DoH, not enabled by default - yet!
- Chrome will have a GPO to disable DoH entirely
- Microsoft chromium Edge browser supports
- Opera supports, not enabled by default

DoC = Surveillance

- Not all of the cloud providers have clear privacy policies.
- Data retention can be 24 hours to 2 years, if spelled out at all.
- Aggregate data trends kept for long time
- However…

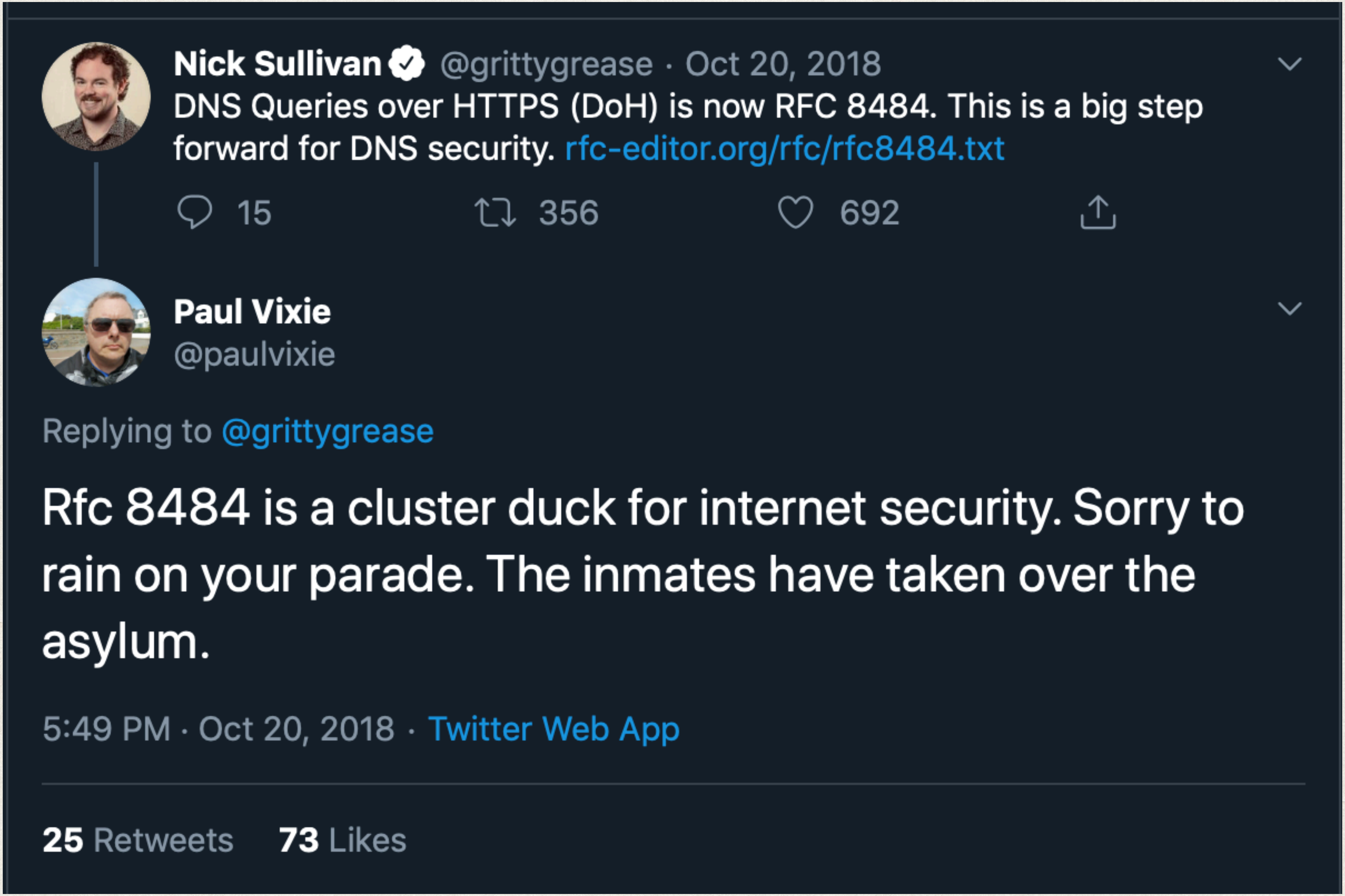


Richard Bejtlich
@taosecurity

Replying to @dangoodin001

DoH is an unfortunate answer to a complicated problem. I personally prefer DoT (DNS over TLS). Putting an OS-level function like name resolution in the hands of an application via DoH is a bad idea. See what @paulvixie has been writing for the most informed commentary.

7:16 PM · Sep 10, 2019 · TweetDeck



Nick Sullivan @grittygrease · Oct 20, 2018

DNS Queries over HTTPS (DoH) is now RFC 8484. This is a big step forward for DNS security. rfc-editor.org/rfc/rfc8484.txt

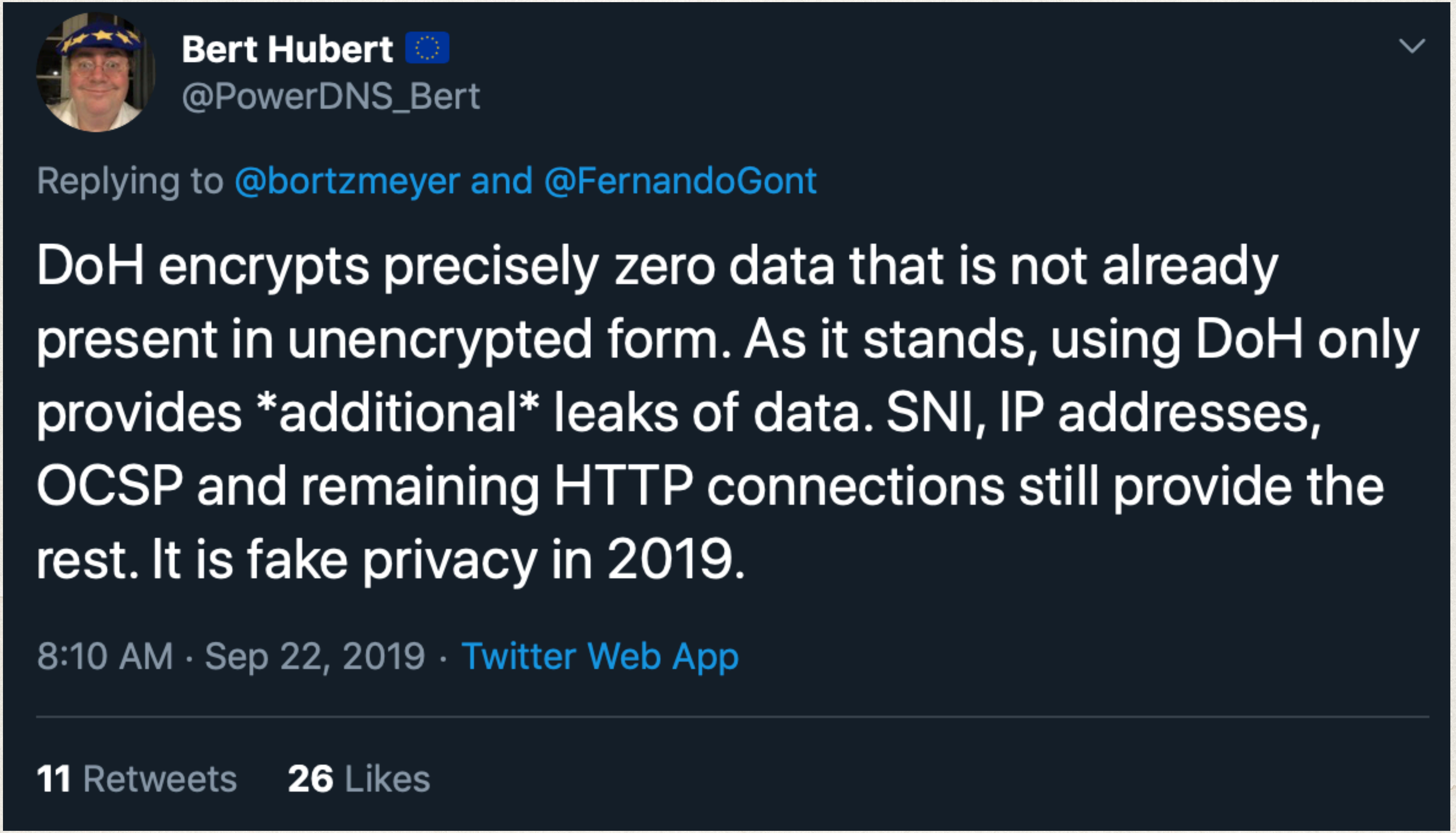
Paul Vixie
@paulvixie

Replying to @grittygrease

Rfc 8484 is a cluster duck for internet security. Sorry to rain on your parade. The inmates have taken over the asylum.

5:49 PM · Oct 20, 2018 · Twitter Web App

25 Retweets **73** Likes



Bert Hubert 🇪🇺

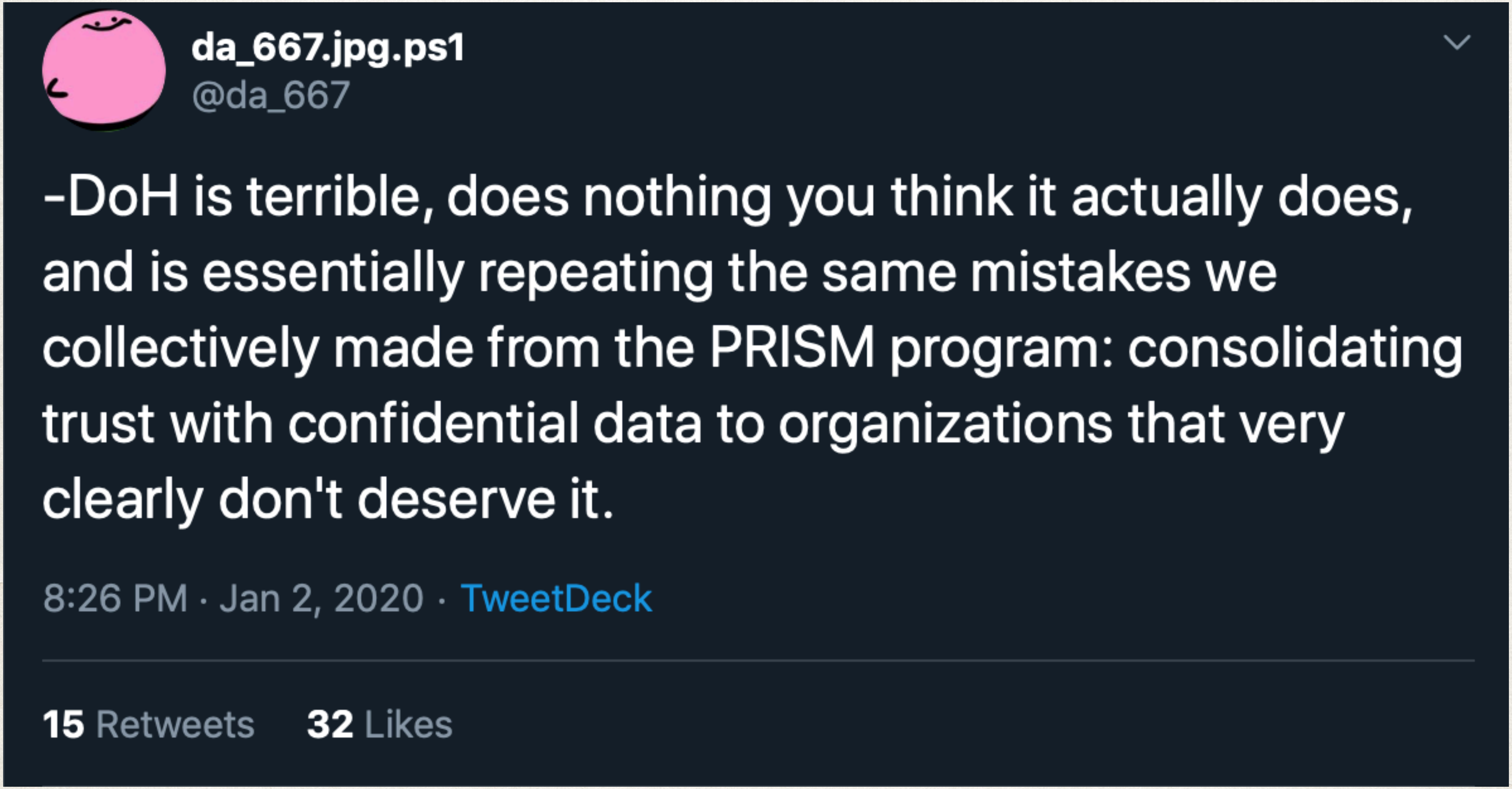
@PowerDNS_Bert

Replying to @bortzmeyer and @FernandoGont

DoH encrypts precisely zero data that is not already present in unencrypted form. As it stands, using DoH only provides *additional* leaks of data. SNI, IP addresses, OCSP and remaining HTTP connections still provide the rest. It is fake privacy in 2019.

8:10 AM · Sep 22, 2019 · Twitter Web App

11 Retweets **26** Likes

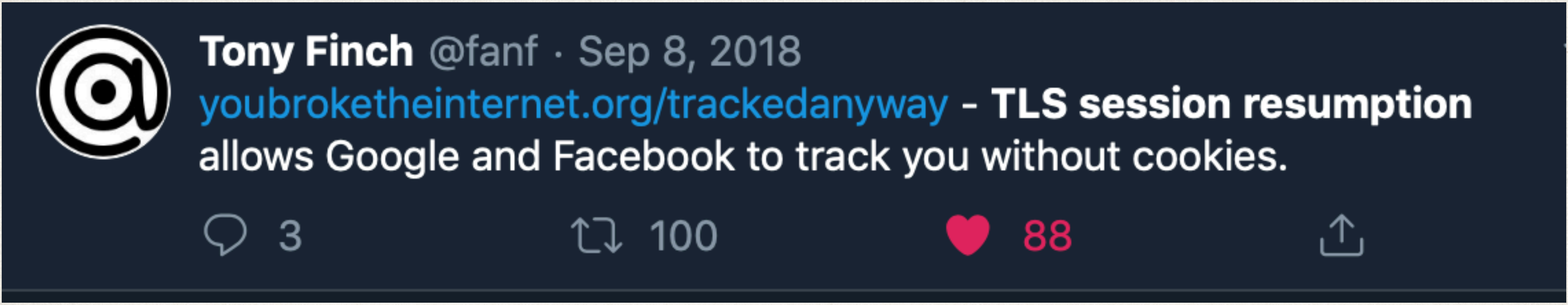


da_667.jpg.ps1
@da_667

-DoH is terrible, does nothing you think it actually does, and is essentially repeating the same mistakes we collectively made from the PRISM program: consolidating trust with confidential data to organizations that very clearly don't deserve it.

8:26 PM · Jan 2, 2020 · TweetDeck

15 Retweets 32 Likes



Tony Finch @fanf · Sep 8, 2018
youbroketheinternet.org/trackedanyway - **TLS session resumption** allows Google and Facebook to track you without cookies.

- TLS Session Resumption Tickets
- A nearly unblockable “cookie” that can be used to track you everywhere when resuming previous TLS sessions (all HTTPS apps including DoH) over a long period of time (up to 7 days with TLS 1.3)

DoC = Surveillance

- All these providers and cloud services are USA based and subject to National Security Letters, FISA 702, and other ways
- logs with detailed information about your Internet sessions can be grabbed by governments and law enforcement without disclosure

Recommendations

- Run your own internal recursive DNS server - best performance by far!
- If using MS AD in your corporate enviroment, you are already doing this, but probably poorly
- Your logging/monitoring goes here

Recommendations

- On your firewall
  - Block all outbound TCP/UDP Port 53 for all endpoints for regular DNS
  - Force endpoints to use internal DNS
  - Block TCP 853 to block DoT

Recommendations

- On your corporate firewall
  - If you have HTTPS/TLS/SSL interception and inspection via a MITM proxy on your firewall, you can likely enable rules to block DoH depending on your vendor.

Recommendations

- Set your endpoint configuration standards to disable DoH in browsers
- Point endpoint DNS servers to internal recursive only (via DHCP, GPO, static configs, regkeys, etc.)

Recommendations

- Configure your internal recursive servers to talk to the outside world only via a known set of resolvers using DoH, DoT or dnscrypt.
- Will prevent ISP & easy gov data collection
- use a server with enough traffic to get "privacy mixer" herd protection for queries - located in a GDPR country

Recommendations

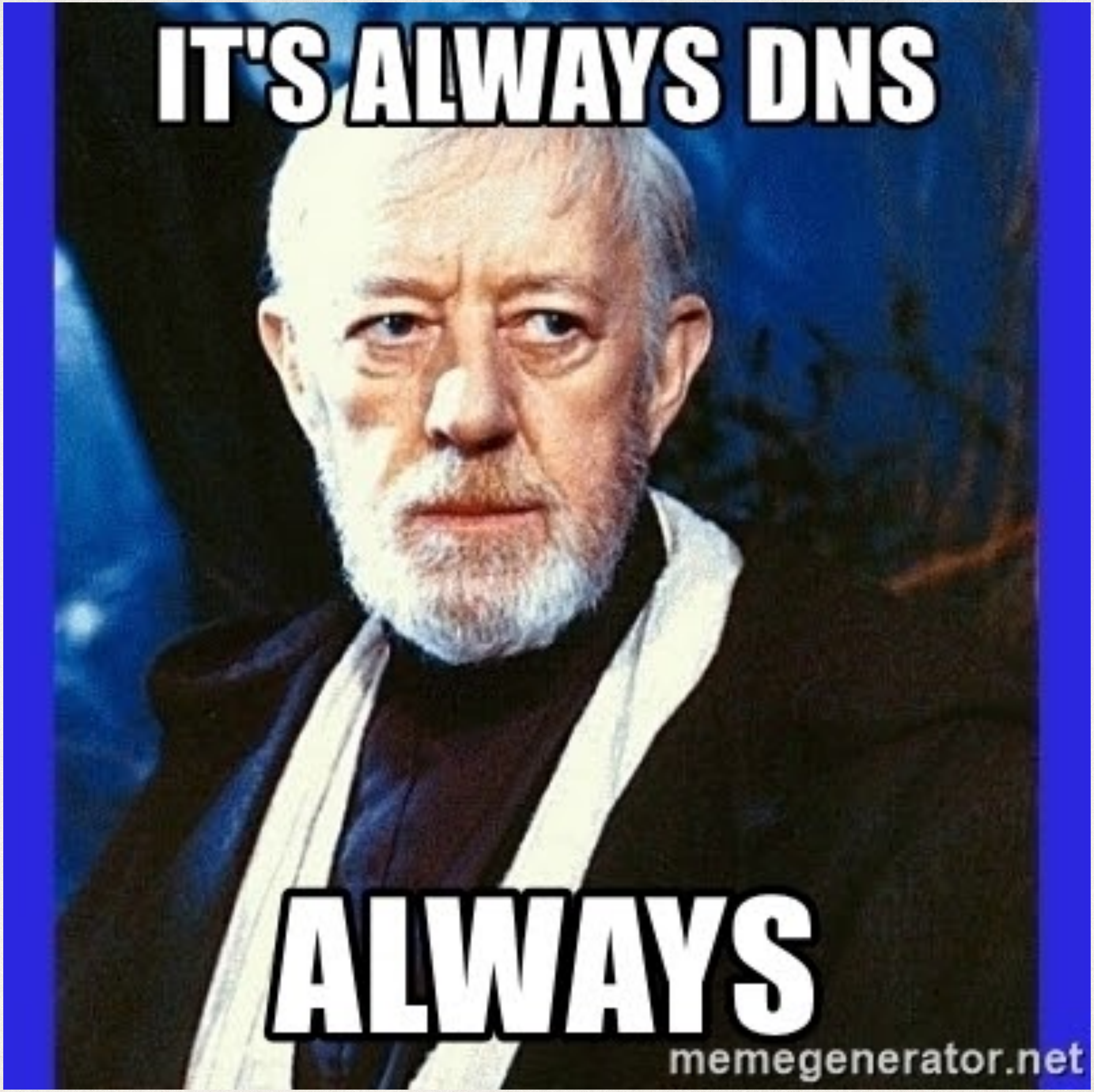
- Consider internal network IP capture of all of the well known public DNS resolvers in addition to universal block at the edge
- Many IoT devices use hardcoded DNS
- Many, many ISPs and hotel networks do this already now — you don't always talk to the actual server you think you are

Recommendations

- You can use DNS to block advertising and known fraudulent websites with malware.
- Malware blocking - Cisco Umbrella, Quad9, Canadian SHIELD

Recommendations

- Run Pi-Hole to block most advertising locally, can chain to external resolving servers
- https://pi-hole.net
- Linux based, or run a container


IT'S ALWAYS DNS
ALWAYS
memegenerator.net

Thank you!

- This slide deck will be available to download on the MTUG website.
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- Twitter: @troutman

Selected Bibliography & Resources

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