The DoH dilemma

Impacts of DNS-over-HTTPS on how the Internet works

Vittorio Bertola, DNS Symposium 2019

1.

What does DoH do?

What is DoH?

DNS-over-HTTPS (RFC 8484)

New IETF standard by Web people (that also operate public resolvers)

Transmits DNS queries to the resolver over an HTTPS connection (encrypted)

Can be used by any HTTPS-speaking app, bypassing the OS and its settings

Requires upgraded DNS / Web servers

Three main changes to resolution

1. The device-to-resolver connection is encrypted and hidden inside Web traffic
2. Each application can use a different resolver (DNS becomes an application level service, not a network one)
3. Each application maker gains control of resolver choice and can hardwire a remote resolver list

Only one in common with DNS-over-TLS

Protocol design choices

Deployment and policy choices

2.

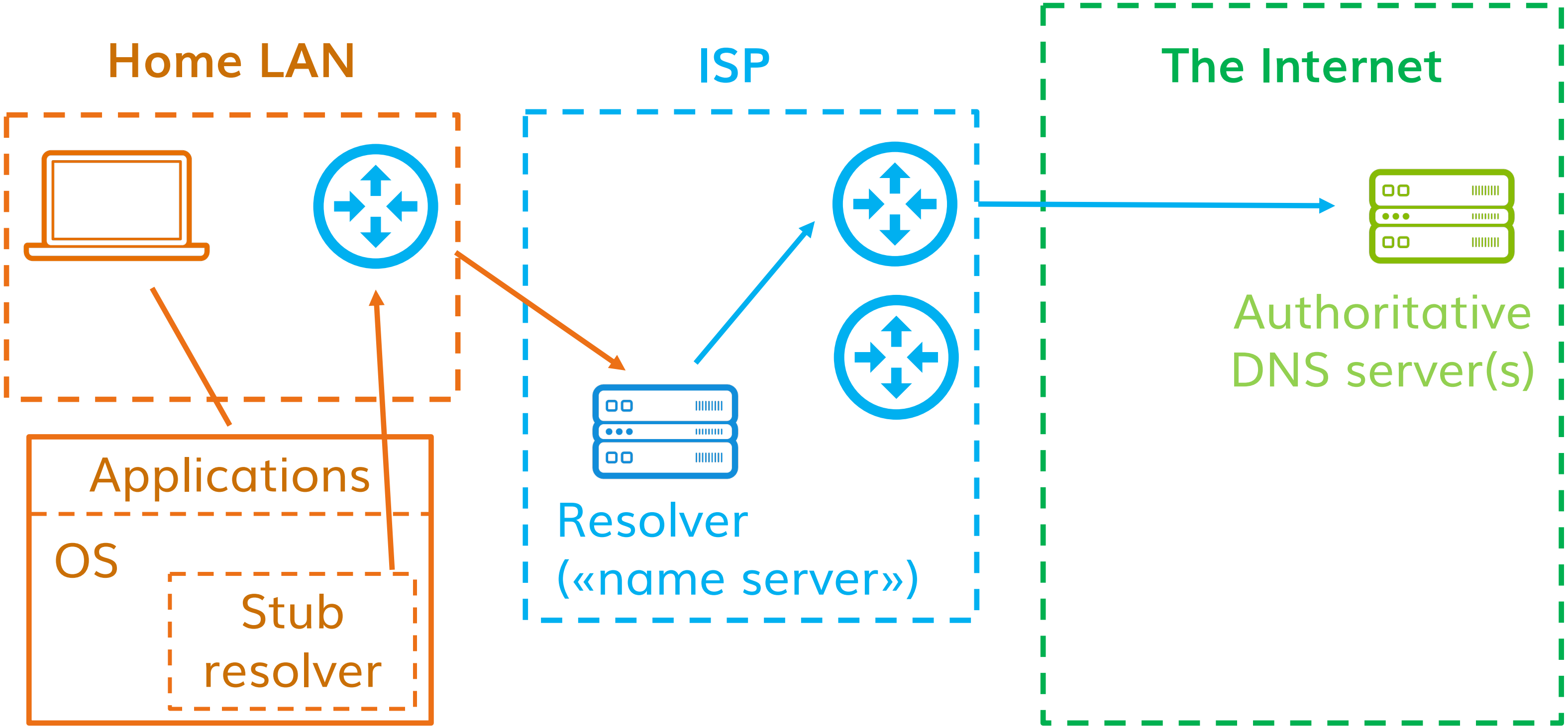
A note on terminology

A debate on words

Debate over which defining feature is the root of (most) issues, and how do we name it

- Unencrypted vs encrypted?
- Business model – ISP vs OTT?
- Concentrated vs distributed?
- «DNS-over-cloud»?

My choice is «local» vs «remote»



Home LAN

ISP

The Internet

Applications

OS

Stub resolver

Resolver («name server»)

Authoritative DNS server(s)

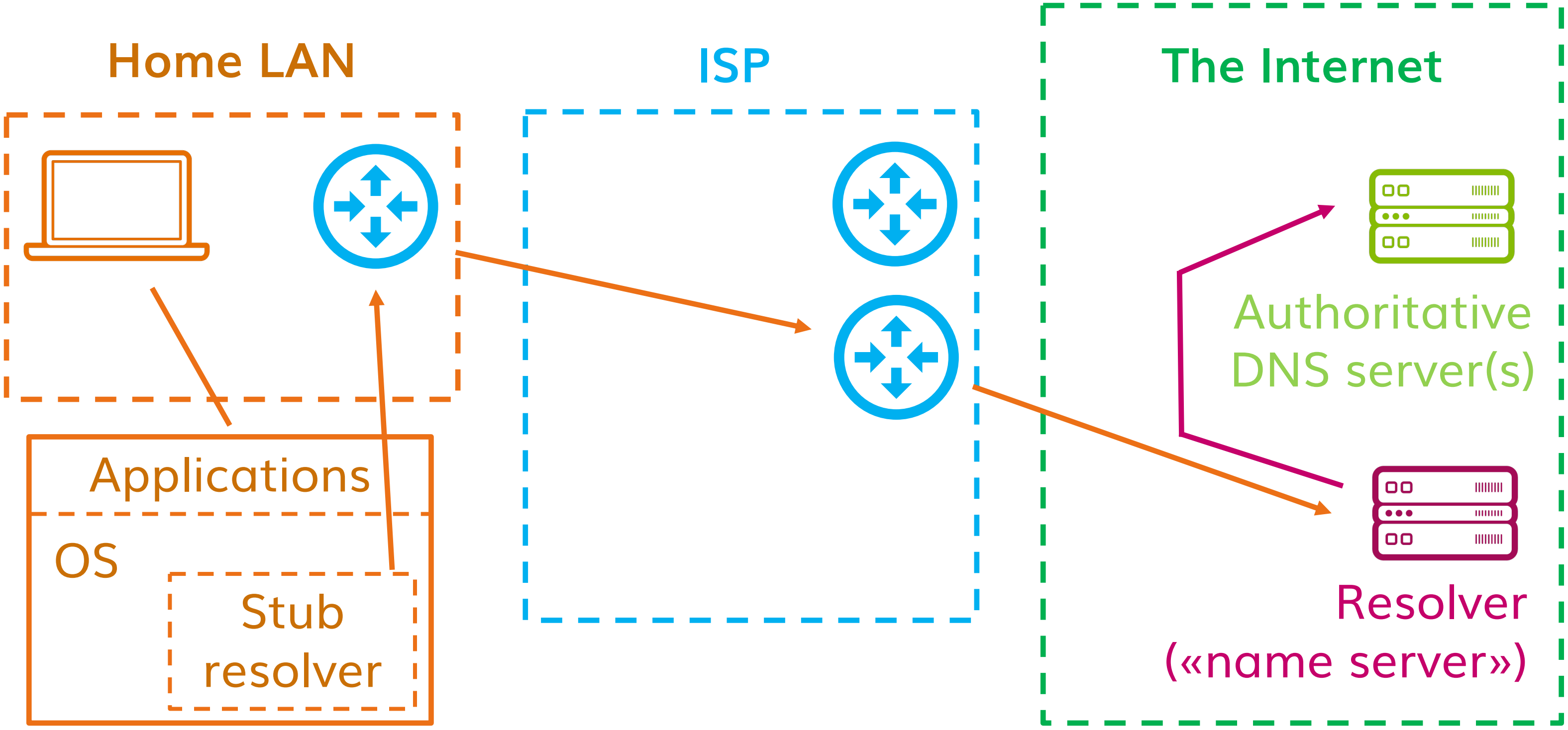
Local DNS resolution

Why «local»?

The ISP's network is the first that you traverse to get to the Internet, no matter where you go

The ISP is normally in the same country, usually in the same city

- □ Same jurisdiction
- □ Same language
- □ Maybe they suck, but you know how to reach them



Remote DNS resolution

Why «remote»?

It is topologically distant from you

- Often in another country

It is run by a third party

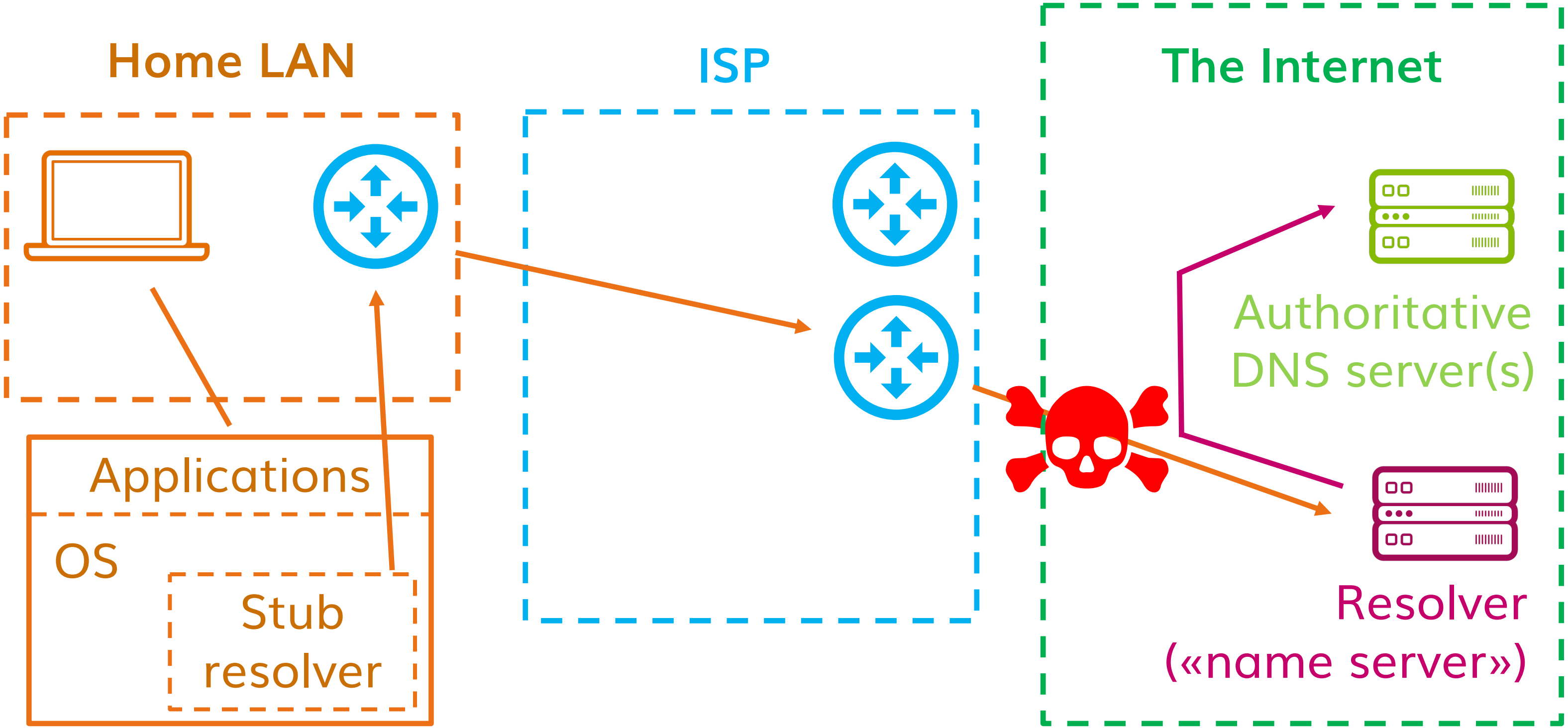
- For free («public resolver»)
  - E.g. 8.8.8.8, 9.9.9.9, 1.1.1.1
- Or as a paid premium service
  - E.g. Cisco Umbrella/OpenDNS

3.

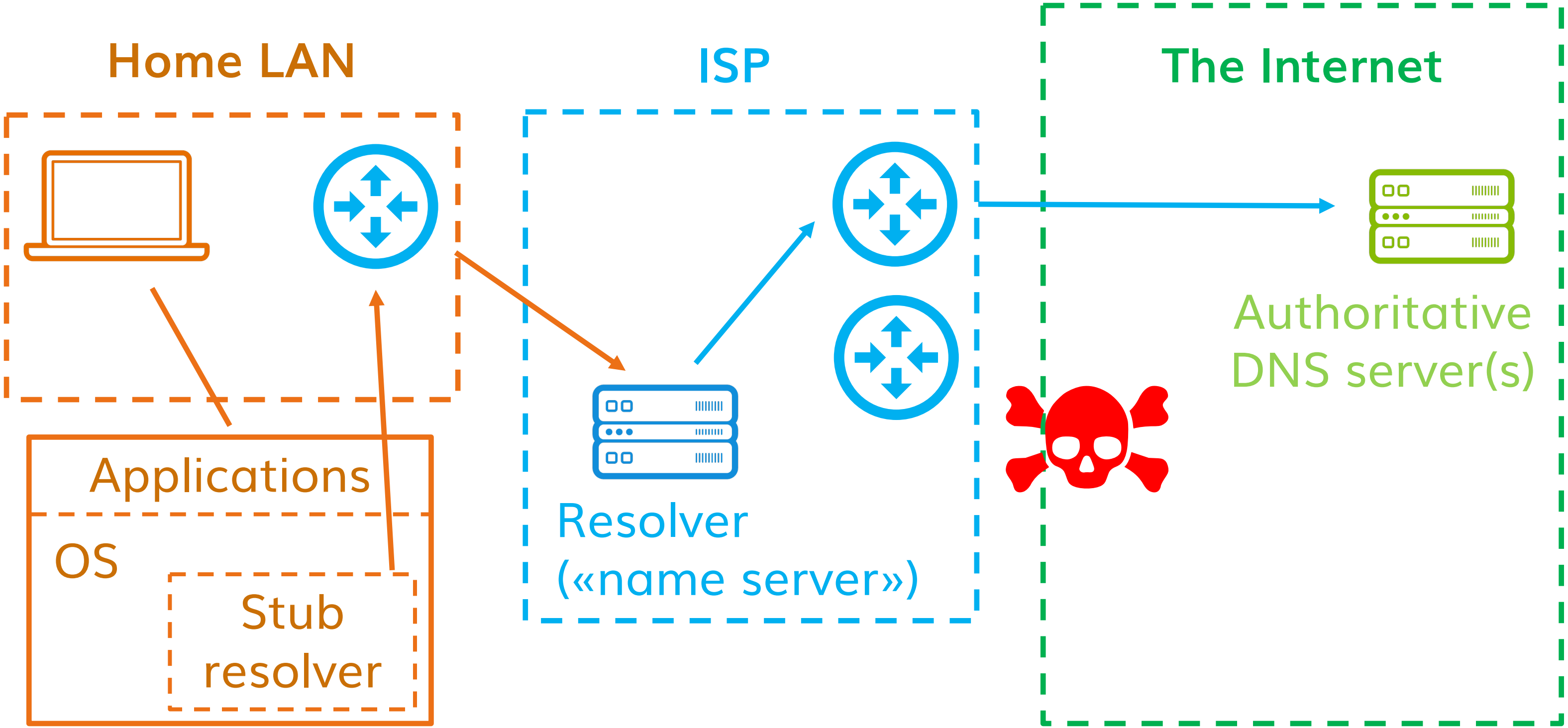
Consequences of DoH’s deployment

#1

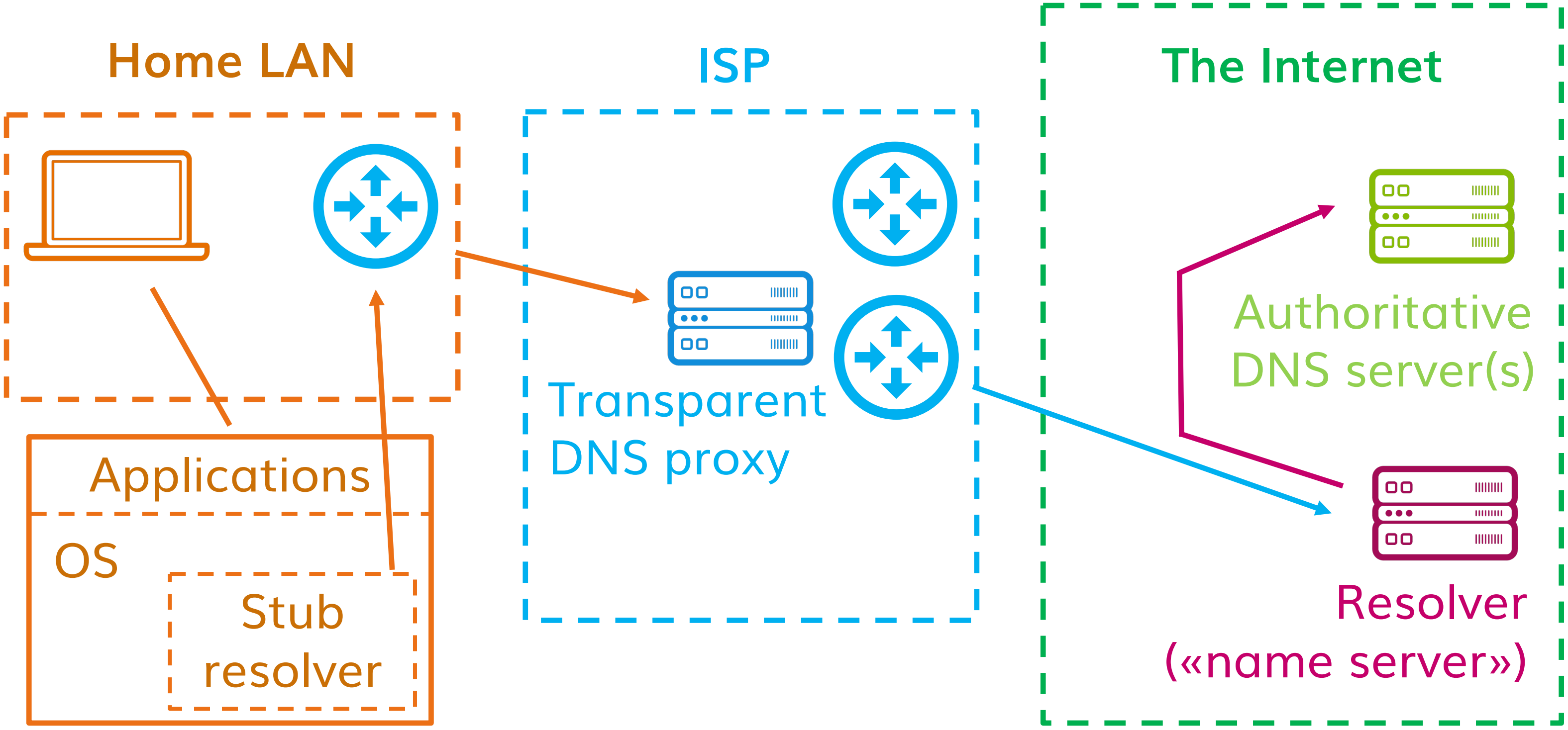
The device-to-resolver connection is encrypted and hidden inside Web traffic



Remote DNS resolution, intercepted



Local DNS resolution, not intercepted unless the ISP is hacked



Remote DNS resolution, proxied by the ISP

Is this good or bad?

Good

If you use remote resolution and are attacked or tracked

If you don't trust your ISP / it does bad things to you

Indifferent

If you use local resolution and are attacked or tracked, unless the attacker is on the ISP's network

Bad

If you trust your ISP / it does good things for you

It depends.

But mostly good.

#2

Each application can use a different resolver (DNS becomes an application level service, not a network one)

Is this good or bad?

Good

If the application maker is smarter than the user, and is honest

If you don't trust your OS

If the OS's DNS implementation is not good enough

Indifferent

If all DoH applications used the OS settings

Bad

If the application maker is smarter than the user, and is dishonest

If the user is smarter than the application maker

Is this good or bad?

Bad

If the application doesn't let you configure the DoH server

If the remote DoH server provided by the application maker fails

Bad

If the application maker's interests and the user's interests are opposite

Bad

If each application starts pointing you to different IPs for the same name

If each application starts using its own (augmented) namespace

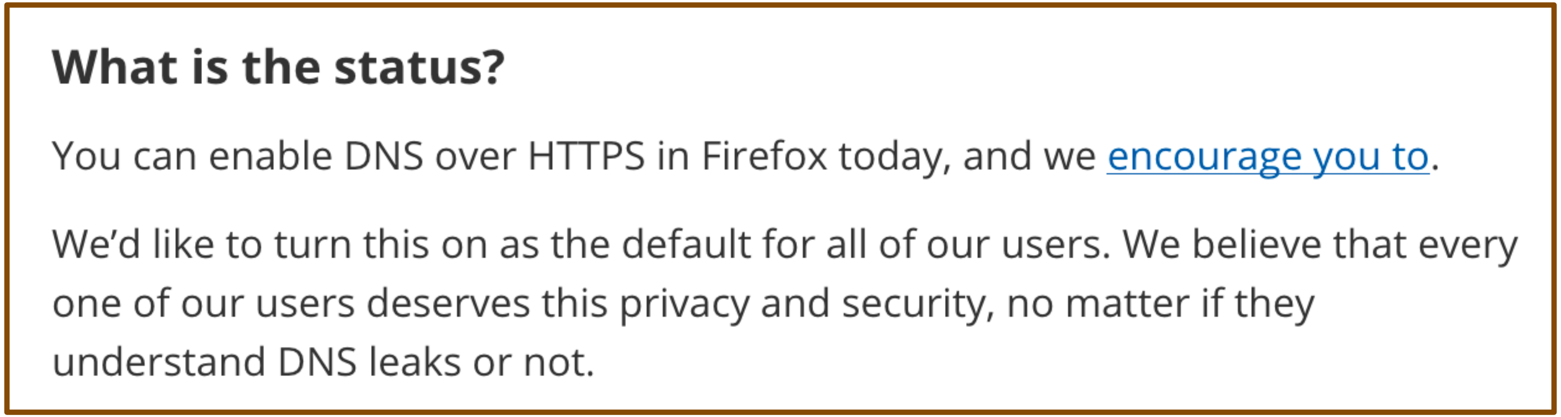
Bad.

«Crossing the streams» bad!

#3

Each application maker gains control of resolver choice and can hardwire a remote resolver list

A consequence of deployment policies

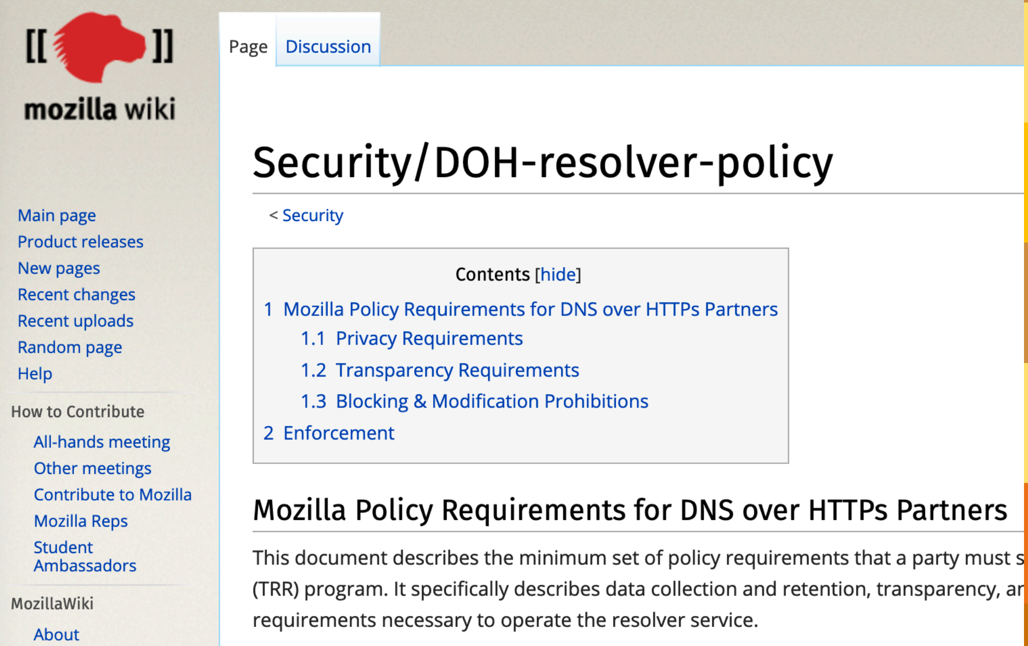


What is the status?

You can enable DNS over HTTPS in Firefox today, and we encourage you to.

We'd like to turn this on as the default for all of our users. We believe that every one of our users deserves this privacy and security, no matter if they understand DNS leaks or not.

Mozilla's announcement from May 2018



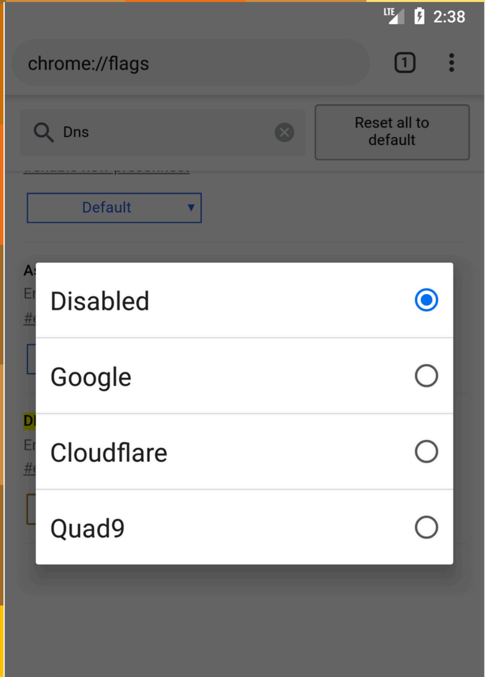
Security/DOH-resolver-policy

< Security

Mozilla Policy Requirements for DNS over HTTPs Partners

This document describes the minimum set of policy requirements that a party must s
(TRR) program. It specifically describes data collection and retention, transparency, ar
requirements necessary to operate the resolver service.

Mozilla's resolver accreditation policy



- ● Disabled
- ○ Google
- ○ Cloudflare
- ○ Quad9

Bromite's configuration screen

The real change

Now (and for the last 20 years)

Local resolution is the default

You get the nearest resolver when you connect

You can set your resolver once for all in your OS

In the DoH future

Remote resolution with multiple servers is the default

You get the application maker's resolver when you install the app

You have to set your resolver for every new application

What does this mean?

New gatekeepers + Concentration

Now

DNS traffic is spread across hundreds of thousands of servers

And they are everywhere across the world

And you can easily pick the server you want

In the DoH future

Four browser makers that have 90% of the market control 90% of the world's Web traffic resolutions

And they are all in the same country and jurisdiction

How easily can you choose?

Privacy ?

Now	In the DoH future
Your queries can be sniffed	Your queries cannot be sniffed
You are covered by your own country's privacy, law enforcement and neutrality rules	Your DNS data will be subject to the resolver's privacy, law enforcement and neutrality rules
Your DNS is normally supplied by a company that does not live off targeted advertising	Many of the likely DNS providers live off data monetization (and use cookies / fingerprinting)

Freedom from censorship ?

Now

You get the DNS-based content filters mandated by the law of your country

In the DoH future

You get the DNS-based content filters mandated by the law of the remote resolver's country

And your country may start mandating IP address filters as a response

Network neutrality ?

Now

Your ISP may break network neutrality, unless there are laws to prevent this

In the DoH future

Your application maker or resolver operator may break network neutrality, unless there are laws to prevent this

Performance ?

Now

The application has to wait for the OS

Your local resolver is near, though it can be slow and unreliable

Your local resolver gets the topologically better result from CDNs

In the DoH future

The application doesn't have to wait for the OS

Your remote resolver is far, but it could still perform better

Your remote resolver cannot get the topologically better result from CDNs unless it violates your privacy

Security ?

Now

Your ISP can block botnets and malware with localized DNS filters

Your ISP can detect network problems and infections via the DNS

Your ISP can use split horizon, local names...

In the DoH future

Will your remote resolver get real-time threat feeds for your country?

Your ISP will be blind

Local names won't work any more

DoH can be used for data exfiltration

User empowerment ?

Now

You can easily pick a different server

You can get DNS-based services (parental control...) from whomever you want

You can easily know where all your queries go

Smarter users expect things to work this way

In the DoH future

You have to change the server in each app, and not all apps may let you

All other DNS-based services stop working

Your queries go wherever the app wants

No one expects or understands the change

Privacy in transport != Privacy

Concentration + Less user control
= Surveillance point

Changing the entity in charge !=
More freedom

Is this good or bad?

Good

If you are a dissident without a clue

If you trust Google/Apple/Mozilla/Cloudflare more than your ISP

If you trust the U.S. government and laws more than yours

If you don't care about centralization

Bad

If you are ok with your current resolver

If you like to control DNS

If you trust your ISP more than Google etc.

If you trust your own government and laws more than the U.S. ones

If you are worried about the centralization of the net

It depends.

But mostly bad.

Especially without appropriate policies.

4.

The DoH dilemma(s)

Who should choose the device’s resolver?

The user?

The ISP?

The browser?

Who should be entitled to apply policies to your DNS?

The government?

The resolver?

The network administrator?

Where should the issues be discussed?

At IETF?

At ICANN?

By regulators?

Work to do

EuroDIG workshop
June 20,
The Hague

Technical

- Discovery protocol
- Pending IETF drafts: server BCPs, client BCPs…
- Missing pieces
- Monitoring and research

Policy / Community

- Independent trusted resolver accreditation
- Deployment promotion and user education
- Ex post analysis on IETF process shortcomings

Regulatory

- Jurisdiction issues
- Law enforcement mechanisms
- Content control responsibilities
- Service liabilities

Thanks!

Any questions?

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