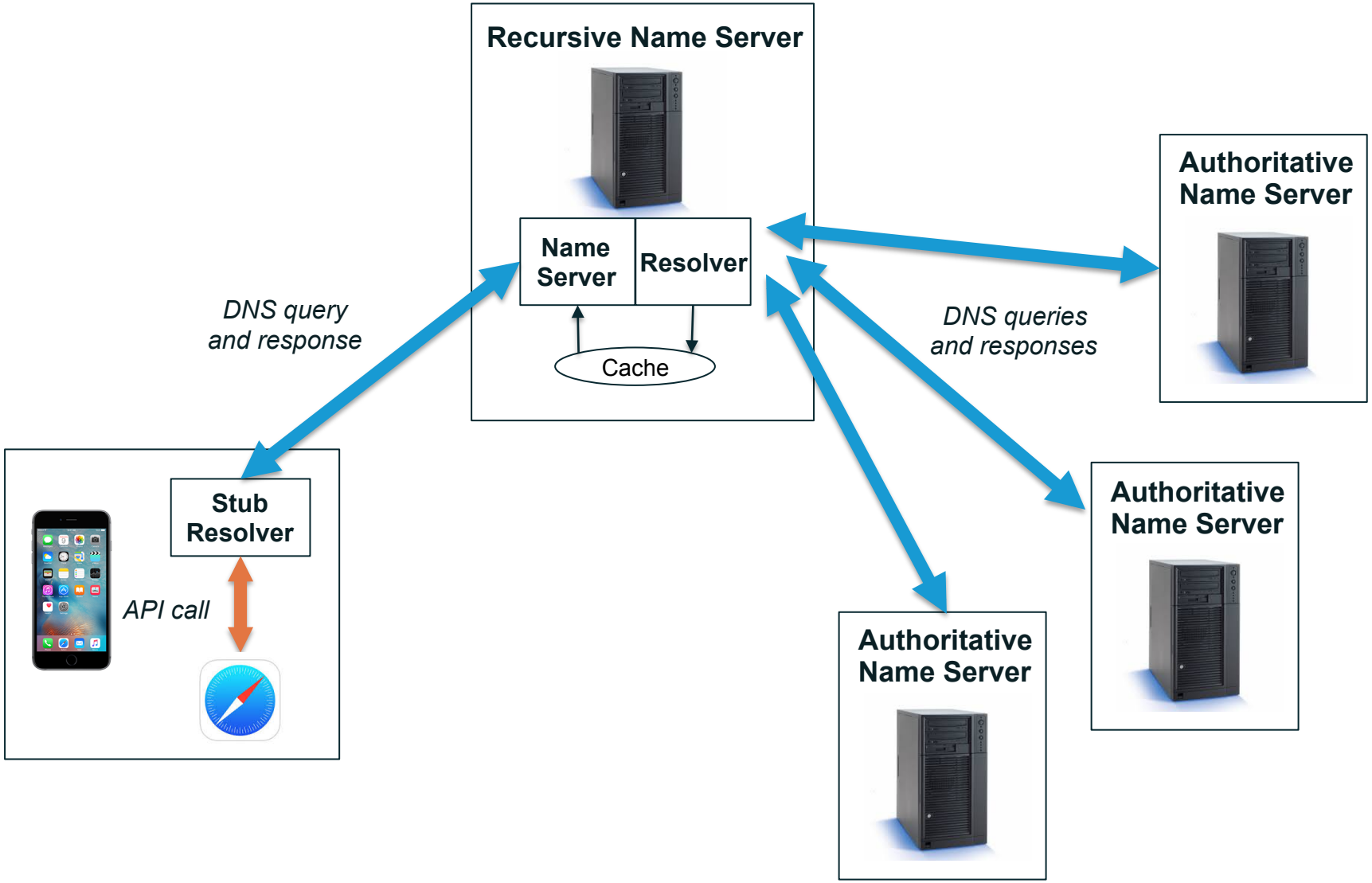
Strengthening the DNS service (security & privacy)"

John Crain
ICANN's Office of the CTO

Sept 2019

DNS Resolution Components at a Glance



DNS Resolution's Traditional Model

Recursive resolvers are typically run by the service provider:

- The ISP
- The University
- The Company

Increasingly, recursive resolvers are operated by public DNS providers:

- Google: 8.8.8.8
- Cloudflare: 1.1.1.1
- TWNIC: 101.101.101.101
- … and many, many others

But These Resolution Models have Security Concerns

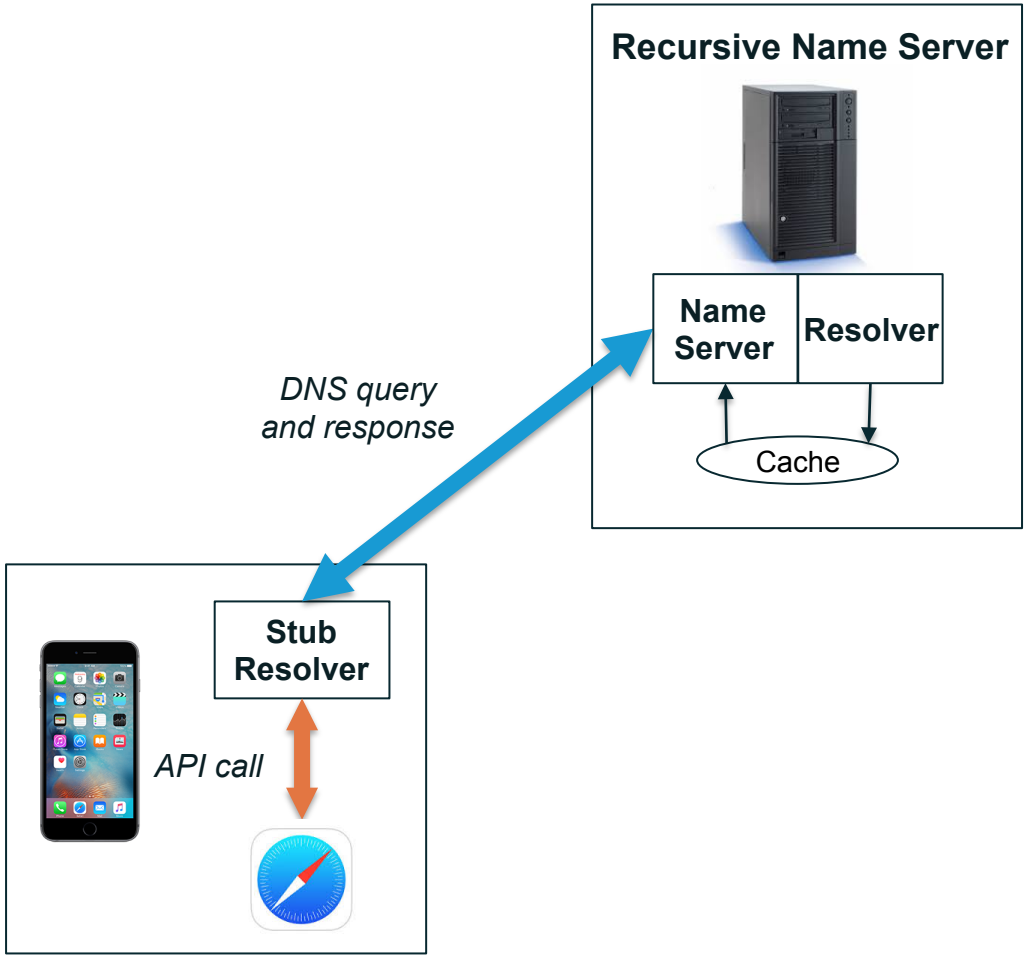
"The DNS is one of the most significant leaks of data about an individual's activity on the Internet."
– Sara Dickinson, Sinodun

- DNS queries are sent in cleartext (UDP or TCP) which means anyone doing passive monitoring of our DNS learns everything we are asking
- Queries contain the domain names being asked about, but also contain *metadata* about domains for things like the chat services we are using and the domains of our email contacts
- Some VPNs don't include the resolvers the user might have chosen, and in that case the DNS traffic will be exposed in unencrypted channels
- DNS responses from the recursive to the stub are the most vulnerable to being censored or re-written

From the Stub to the Recursive

(Applications Doing DNS - ADD)

DNS Resolution Components at a Glance



One Solution is to Encrypt

- Encryption provides assurances:
  - Queries cannot be surveilled
  - Eliminates man-in-the-middle attacks

- In 2017 and 2018, the IETF standardized two encryption technologies for DNS:
  - DNS-over-TLS (DoT)
  - DNS-over-HTTP (DoH)

DNS-over-TLS (DoT)

- TLS is Transport Layer Security
- TLS is used by applications like email or mobile apps to keep our data secure
- DoT takes advantage of TLS to encrypt DNS traffic between the stub resolver and the recursive resolver, giving users authentication and confidentiality for their DNS queries
- Runs on TCP/853 instead on UDP/53 (making it easy to discover and filter)

DNS-over-HTTPS (DoH)

Protocol Goals (RFC 8484)

- Who do you trust?
  - “I trust my bank to give them my money.”
  - “I trust my bank enough to do online banking with them.”
  - “Maybe my bank is the most trusted vendor I should use for recursive resolver service.”
- The user decides who she trusts the most with her DNS traffic, and she configures the DoH application to use a trusted DoH resolver
- Runs on TCP/443 and is co-mingled with *web traffic* in a single HTTPS connection, making it much harder to discover and filter

But This New Model Prompts Some Concerns

Service providers have a new paradigm to negotiate: *No longer able to rely only on DNS to meet regulatory compliance requirements and/or filtering goals*

- ISPs do significant business working with parents on parental controls. When applications do their own DNS, a lot of these parental controls no longer work.
- ISPs protect users by denying access to malware sites. DoH/DoT circumvent this protection.
- ISPs often receive court orders to block certain sites. DoH/DoT resolvers may not know about these court orders, and still resolve these sites.

Many Questions

- Who gets to determine the resolver?
  - The DoH protocol was designed to allow the end user to decide who they trust most for recursive DNS service. But nothing stops the application maker from deciding *for the user* what resolver will be used.
  - Applications are likely to ship with their own chosen Trusted Recursive Resolver (TRR)
    - Firefox ships with Cloudflare 1.1.1.1. as default TRR
  - Will this mean different behaviors dependent on app?

Taking a Further Step Back: Policy Concerns

Stepping back from the service provider concerns, ADD introduces all new challenges for broader public policy:

- Where do we discuss these broad public policy issues?
  - ICANN?
  - LACTLD?
  - Network operator forums?
  - IETF?
  - Regulators?
- The answer is probably all of the above. Through community consultation and collaboration we can identify issues and find resolutions.

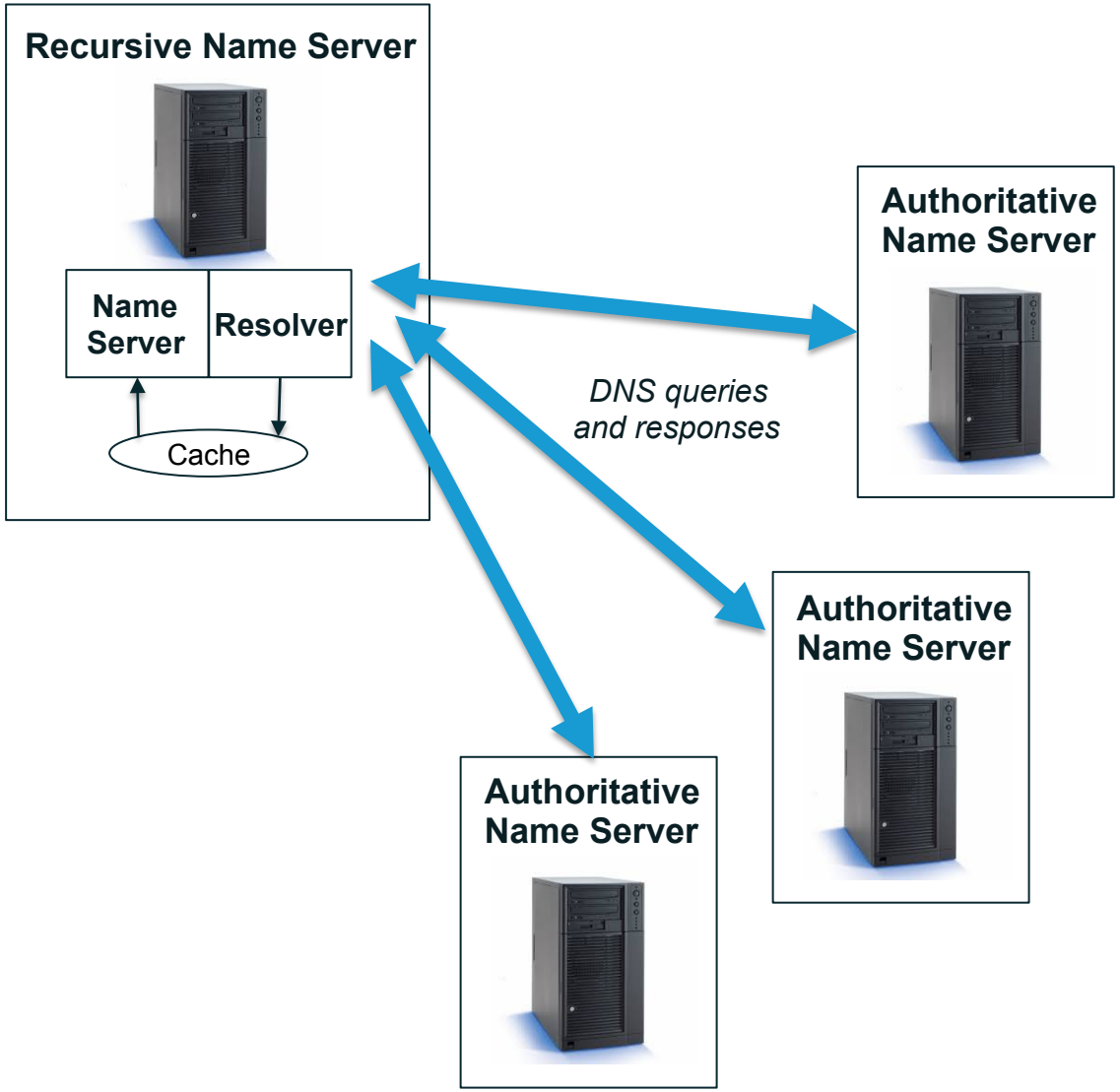
Parting Thoughts on Applications Doing DNS

- Applications doing their own DNS with DoH is new, but ADD in general is already being implemented in web browsers and mobile applications
- DNS privacy – especially end user DNS data privacy – is a major regulatory and societal concern
- Encrypting DNS data with TLS or HTTPS is good for addressing privacy concerns
- But implementation details matter, and there are a lot of public policy concerns for how ADD could be implemented in a way that has negative effects for end users, for service providers, and for regulators

From the Recursive to the Authorative

DNS Private Exchange (DPRIVE)

DNS Resolution Components at a Glance



Data Minimization.

- Only send the part of the query that the authoritative server needs to answer
- Query the Root Servers for the TLD only
  - Instead of querying for www.icann.org ask for .org
- Query .org name servers for second level only
  - Instead of querying for www.icann.org ask for icann.org
- And so forth…..

Encryption

- Solutions focus around DoT
- 853/TCP
  - But how to discover the keys to use for encryption?

One proposed solution is to use DNS-based Authentication of Named Entities (DANE) to place public keys in the DNS

Where are we now

ADD or DoT and DoH

- DoT is deployed and works over 853/TCP
- RFC 7858 – Specification for DNS over Transport Layer Security (TLS)
- RFC 8310 – Usage Profiles for DNS over TLS and DNS over DTLS

- DoH is being deployed and works over 443/TCP
- RFC 8484 - DNS Queries over HTTPS (DoH)

DPRIVE

- Not yet standardized but it is coming

  Most likely 853/TCP

Follow the DPRIVE wg at IETF

https://datatracker.ietf.org/wg/dprive/about/

Other good resources

- The DNS Privacy Project
- https://dnsprivacy.org

Very Recent

- The Encypted DNS Deployment Initiative
- https://encrypted-dns.org

Engage with ICANN – Thank You and Questions

One World, One Internet

Visit us at **icann.org**

@icann

facebook.com/icannorg

youtube.com/icannnews

flickr.com/icann

linkedin/company/icann

slideshare/icannpresentations

soundcloud/icann