

# DNS "Openness"

Geoff Huston AM  
APNIC Labs

# Openness?

When speaking about *openness*, we do not mean *open* in a competitive sense, but rather:

“Can users access and distribute information and content, use and provide applications and services, and use terminal equipment of their choice, irrespective of the user’s or provider’s location or the location, origin or destination of the information, content, application or service?”

# But that was the entire POINT of the DNS!

The DNS was engineered to deliver the same answer to the same query, irrespective of the querier

- The answer did not depend on who was asking, where they were asking from, what platform they were using to generate the query, the resolvers they used to handle the query
- The answer did not depend on the origin of the information used to form the response, the platform used to serve this information, nor the location of information servers

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**The answer is “Yes!”**

# Really?

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- Really? Do we all see the same DNS?
- No!
- Why not?
  - Government regulatory requirements to block the “correct” resolution of certain DNS names
    - It happens in China, UK, America, Australia, India, Russia, Syria, Iran, Vietnam, France, Turkey,.....
    - Its VERY widespread, for all kinds of national motives
  - ISP desires to monetise the DNS
    - NXDOMAIN substitution to direct traffic from named destinations or services that do not exist to other destinations or services of their choosing
  - Threat mitigation where the DNS names associated with malware are blocked
    - Such as Quad9 threat intelligence informed DNS resolution

# Is this a "problem"?

Generally not:

- Nation states have a sovereign right to make such rules and bind their citizens to such rules
- Threat mitigation is typically regarded as a Good Thing rather than an incursion against the utility of a single DNS
- It's a problem when it gets used as a lever in a different fight
  - Such as the Australian rule to force Australian ISPs to block the DNS resolution of "thepiratebay.org"
    - It only pushes determined users to alternate name resolution strategies and ultimately is a comprehensive waste of everyone's time!
  - But even this is a relative sideshow to the larger DNS

# Another interpretation of "Openness"?

When speaking about *openness* we might not mean *open* in a competitive sense, but rather:

**"Is the DNS an "open" system?"**



# Is the DNS "Open"?

## Yes!

- The DNS name resolution protocol is openly specified without any IPR encumbrance
- Fully functional implementations of the DNS protocol are available as open source
- DNS name servers are configured as open “promiscuous” responders and will provide the same response to a query irrespective of the identity of the querier
- DNS information is openly available
  - There is some subtle qualification here in that the collection of a zone file may not be openly available, but the individual records in a zone can be queried
- DNS queries and responses are “open”

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- DNS queries and responses are "open"
  - **Which is a MASSIVE problem!**

# When "openness" is a weakness

The DNS is used by **everyone** and **everything**

- Because pretty much everything you do on the net starts with a call to the DNS
- If we could see your stream of DNS queries in real time we could easily assemble a detailed profile of you and your interests and activities - as it happens!
- If we could edit your DNS responses we could make services disappear from your Internet!

THE RUMORS ARE TRUE. GOOGLE  
WILL BE SHUTTING DOWN PLUS—  
ALONG WITH HANGOUTS, PHOTOS,  
VOICE, DOCS, DRIVE, MAPS, GMAIL,  
CHROME, ANDROID, AND SEARCH—  
TO FOCUS ON OUR CORE PROJECT:  
THE 8.8.8.8 DNS SERVER.

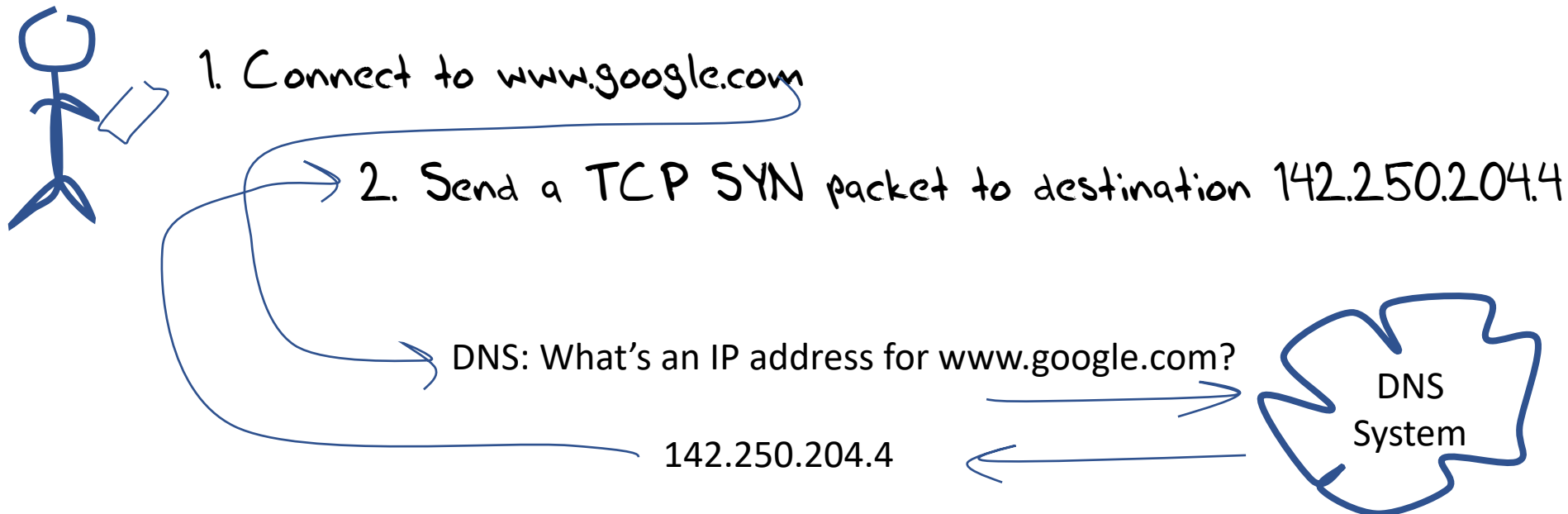


# Lets look into this further

The DNS is mapping system which takes human-use labels that name services and maps these labels to IP addresses

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# What's in that DNS "cloud"?

How the idealised model of the DNS works



# Clients, Resolvers and Servers

- Clients send their query to a resolver
  - The resolver's addresses was provided to the client by their ISP, or the user configured it directly into their device
- When it receives a query, the resolver first must work out whom to ask (discover the *authoritative server* for this domain name) and then it will direct a query to this server
- The resolver will use this response to answer the original query from the client
- And the resolver will also cache the answer to allow it to reuse this information if it is asked the same query in the future.



# Clients, Resolvers and Servers

- Clients send their query to a resolver
  - The resolver's addresses was provided by their ISP, or the user configured it directly into their OS
- When it receives a query, the resolver first must work out whom to ask (discover authoritative server for this domain name) and then it will forward the query to this server

*But you knew this already!*

- And the resolver will also cache the answer to allow it to reuse this information if it is asked the same query in the future.

# Scaling DNS infrastructure

- Large scale DNS resolvers are generally implemented as a DNS server “farm”, where incoming queries are farmed across multiple resolver engines
- Very large DNS resolvers use a common front end service IP address farms, and use anycast to perform query load balancing over multiple distributed resolver farms
- Authoritative servers have also taken to anycast, both as a scaling option and a DOS defence



But all that is still not all of  
"the DNS"

- The DNS is more than its mapping role, and more than its infrastructure elements of resolvers and servers
- So what is the DNS?

# What is "the DNS"?

- ❑ **A name space:** A collection of word-strings that are organised into a hierarchy of labels
- ❑ A distributed **name registration** framework that assigns a unique "license to use" to human-centric word-strings to entities (for money)
- ❑ A **distributed database** that maps human-centric word-strings into IP addresses
- ❑ A **protocol** used by DNS protocol speakers to "resolve" a word-string into a defined attribute (usually an IP address)
- ❑ A **signalling medium** that is universally supported across all of the Internet

# What are DNS "Markets"?

The DNS is not a single market – it is a highly devolved framework and there are a number of discrete markets that are at best loosely coupled .

Some of these are:

- The market for new “top level” labels (gTLDs) operated by ICANN. This market is open to ICANN-qualified registry operators. A registry has an exclusive license to operate a TLD.
- The market for “registrars”, who act as retailers of DNS names and deal with clients (registrants) and register the client’s DNS names into the appropriate registry
- The market for clients to register a DNS name with a registry
- The market for DNS name certification, which is a third party that attests that an entity has control of a domain name
- The market for DNS name resolution where users direct their queries to a resolver and the resolver provides DNS “answers”
- The market for hosting authoritative name services, where “bigger is better” has driven a highly aggregated market
- The market for DNS query logs

# Maybe it's more than markets

- Perhaps this is best viewed as a collection of requirements
  - Some are well established
  - Some are emergent requirements
- Perhaps the question could be rephrased as one that asks to what extent are conventional open markets a good fit for these various DNS requirements
- And to what extent these market-based mechanisms are failing!

# So, what should we talk about?

If we want to talk about the DNS as “a market”

- The DNS is not a single market place, or even a collection of inter-dependent and tightly coupled market place
- The DNS is constructed of many elements, some of which appear to behave as tightly regulated markets, some of which are openly competitive markets, some of which are comprehensive market failures!
- Maybe we should think of the DNS using a number of themes to give some focus to this discussion



# Current DNS Themes

- DNS as a control element
- DNS and privacy
- DNS and trust
- DNS and name space fragmentation
- DNS as a rendezvous tool
- DNS as a collection of markets
- DNS and market aggregation
- DNS and abuse and cyber attacks
- DNS as an economic failure
- DNS as the last remaining definition of a coherent Internet

# This is now a very big agenda

- Far bigger than we have time for here!
- So I'll just take a couple of themes and develop them further

# I. The Open Market for Trust

# DNS and Trust

Can you trust what you learn from the DNS?

**NO!**

DNS responses can be altered in various ways that are challenging to detect

We know how to improve this situation by using digital cryptography to protect the integrity, accuracy and currency of DNS responses

But does this improvement in the trust of the DNS correlate to a visible consumer preference?

Is security in the DNS a market failure?

# DNSSEC

- A framework to attach digital signatures to DNS responses that attest to the accuracy and currency of the DNS response
  - The method of attachment does not alter the behaviour of the DNS protocol, nor does it require any changes to DNS servers
- A procedure for clients to follow to validate the DNS response through processing this digital signature

## Changes:

- Zone management – add DNSSEC digital signature records through “zone signing”
- Registry management – add DS records alongside NS records for delegated zones
- Client behaviour – perform additional DNS queries to perform digital signature validation

# Is DNSSEC being used?

You might think that a change to the DNS that improved the trust in the DNS would prove to be highly popular in the DNS space

- DNS name “owners” would like their name to be trustworthy
- DNS users would like the names they use to be “genuine” and trustable

So everyone wants to use DNSSEC?

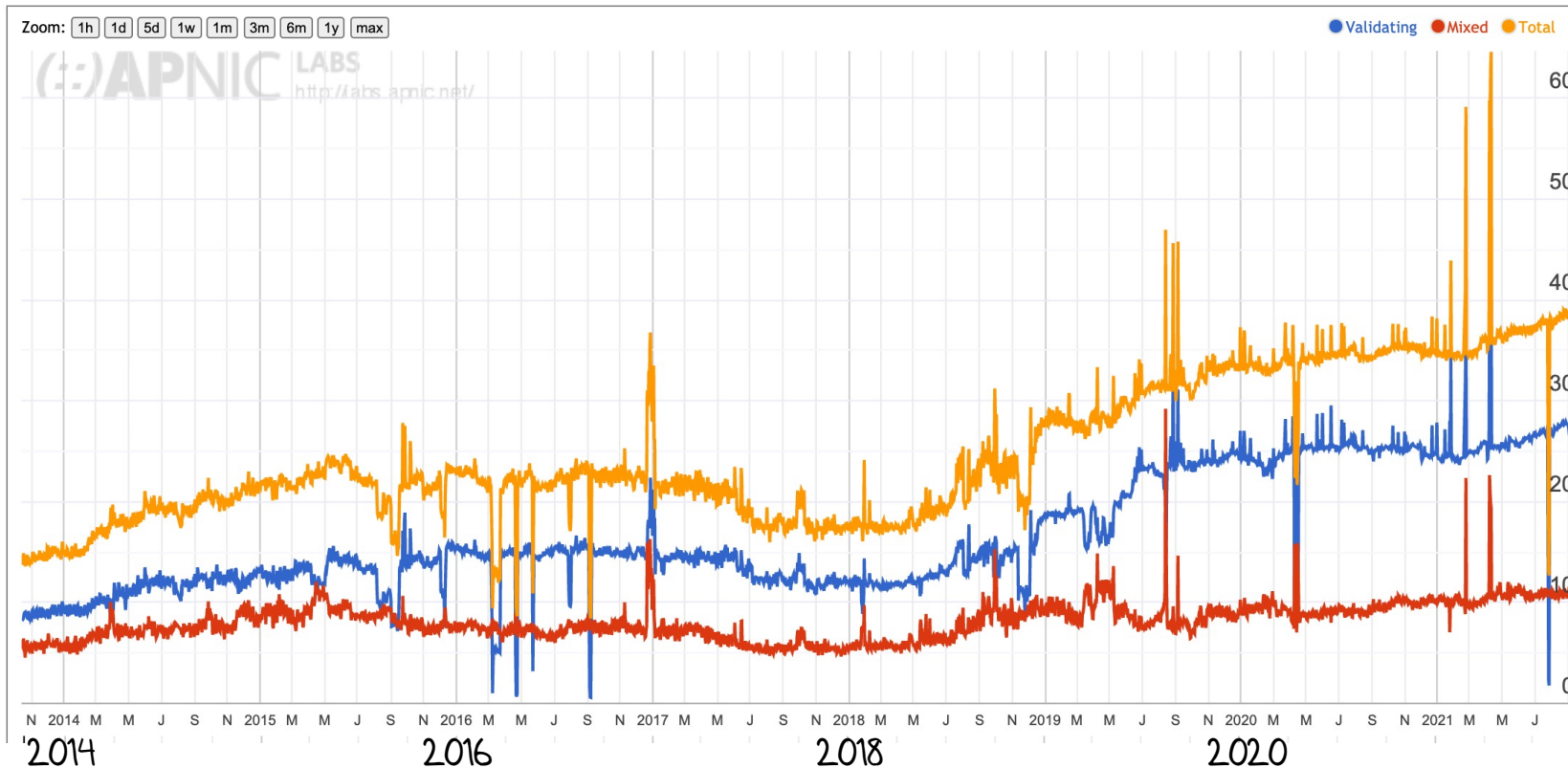
Right?

So lets look at the metrics of deployment of DNSSEC validation



# Is DNSSEC being used?

Validation Rate of Signed DNS responses



← 25÷ of users are behind DNSSEC - validating resolvers who will not resolve a badly signed DNS name



# Problems with DNSSEC

- Large DNS responses cause robustness issues for DNS
  - Getting large responses through the network has reliability issues with UDP packet fragmentation and timing issues with signalled cut-over to TCP
  - The validator has to perform a full backtrace query sequence to assemble the full DNSSEC signature chain
  - So the problem is that DNSSEC validation may entail a sequence of queries where each of the responses may require encounter UDP fragmentation packet loss

**All this takes time**

**And nobody is tolerant of delays in today's Internet**

# Some More Problems with DNSSEC

- Cryptographically “stronger” keys tend to be bigger keys over time, so the issue of cramming more data into DNS transactions is not going away!
- The stub-to-recursive hop is generally not using validation, so the user ends up trusting the validating recursive resolver in any case

**The current DNSSEC framework represents a lot of effort for only a marginal gain**

# DNSSEC is a Market Failure!

- Users don't pay for queries
  - Users have no leverage with recursive resolvers in terms of expressing a preference for authenticity
- Users don't have a choice in what they query for
  - Users have no ability to express a preference for using domain names that are signed
- The benefits of a signed DNS zone and validating resolvers are indirect
  - Cost and benefit are totally mis-aligned in this space!

# II. The Open Market for Resolution

# The DNS Name Resolution Economy

- In the public Internet, end clients don't normally pay directly for DNS name resolution services
- Which implies that outside of the domain of the local ISP, DNS resolvers are essentially unfunded by the resolver's clients
- And efforts to monetise the DNS with various forms of funded misdirection (such as NXDOMAIN substitution) are generally viewed with extreme disfavour
- Open Resolver efforts run the risk of success-disaster
  - The more they are used, the greater the funding problem to run them at scale
  - The greater the funding problem the greater the temptation to monetise the DNS resolver function in more subtle ways

# The DNS Name Resolution Economy

- The default option is that the ISP funds and operate the recursive DNS service, funded by the ISP's client base
  - 70% of all end clients use their ISPs' DNS resolvers
- However the fact that it works today does not mean that you can double the input costs and expect it to just keep on working tomorrow
- For ISPs the DNS is a cost department, not a revenue source
  - We should expect strong resistance from ISPs to increase their costs in DNS service provision

# The resistance to change in the DNS

- The quality of an ISP's DNS service does not appear to be a significant competitive discriminatory factor in the consumer market
- So the ISP does not generally devote many resources to tuning their DNS infrastructure for high performance, resiliency and innovation
- Most users don't change their platform settings from the defaults and CPE based service provisioning in the wired networks and direct provisioning in mobile networks will persist
- So current innovations such as improved DNS privacy (DNS over TLS, DNS over HTTPS) are looking like being another mainstream market failure in the DNS space
- But maybe that's not the full story ...

# Fragmenting the DNS

- It appears more likely that **applications** who want to tailor their DNS use to adopt a more private profile will hive off to use DNS over HTTPS to an application-selected DNS service, while the platform itself will continue to use libraries that will default to DNS over UDP to the ISP-provided recursive DNS resolver
- That way the application ecosystem can fund its own DNS privacy infrastructure and avoid waiting for everyone else to make the necessary infrastructure and service investments before they can adopt DNS privacy themselves
- The prospect of **application-specific naming services** is a very real prospect in such a scenario



# Fragmenting the DNS

- It appears more likely that **applications** will use to adopt a more private or their DNS application-select or their DNS cont: or their DNS prov: f will to the ISP-
- That *Those parts of the environment with sufficient motivation and resources will simply stop waiting for everyone else to move. They will just do what they feel they need to do!* privacy else to make the service investments before they can themselves
- The prospect of **application-specific naming services** is a very real prospect in such a scenario

# It's life Jim, but not as we know it!\*

- The overall progression here is an evolution from network-centric services to platform-centric services to today's world of application-centric services
- It's clear that the DNS is being swept up in this shift, and the DNS is changing in almost every respect
- The future prospects of a single unified coherent name space as embodied in the DNS, as we currently know it, for the entire internet service domain are looking pretty poor right now!

# Is the DNS "Open"?

- Yes, today.

# Will it continue to be "open"?

- Probably not!

It's just getting too hard to keep it together and keep it open.

Thanks!