

DNS Wars: Episode IV

A New Bypass

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Abstract

- Due to pervasive unpreparedness of users, applications, operating systems, and protocols, DNS has become an essential control point for “cyber” security. Most networks have a mix of legacy, modern, safe, and unsafe devices attached to them, and this condition won’t change as quickly as the Beyondcorp initiative might suggest. However, DNS is also an important control point for authoritarian regimes, and so “bypass” innovation is continuous, rapid, and ambitious. Special attention is deserved by the “DNS over HTTP” or “DoH” protocol now being strongly pushed by Mozilla, CloudFlare, and others. A brief mention will be made of IRTF Resolverless DNS.

Now Under Construction: Resolverless DNS

- Web content providers and their CDN's want better performance
 - Which means, faster time-to-next-eyeball
- Most content includes many object references (images, scripts)
 - The time taken for a browser to look up these DNS names is measurable
 - (and may involve “ad blocking”)
- Therefore an IRTF WG is studying “Resolverless DNS”
 - Here, DNS data will be “pushed” as part of a normal web content fetch
 - DNSSEC signatures won't be included; TLS is considered “secure enough”
- This terrifically broadens the attack surface of web site defacement
 - Bit coin mining JS can now be downloaded without triggering EP protections

Peace of Westphalia, 1648 (from *Wikipedia*)

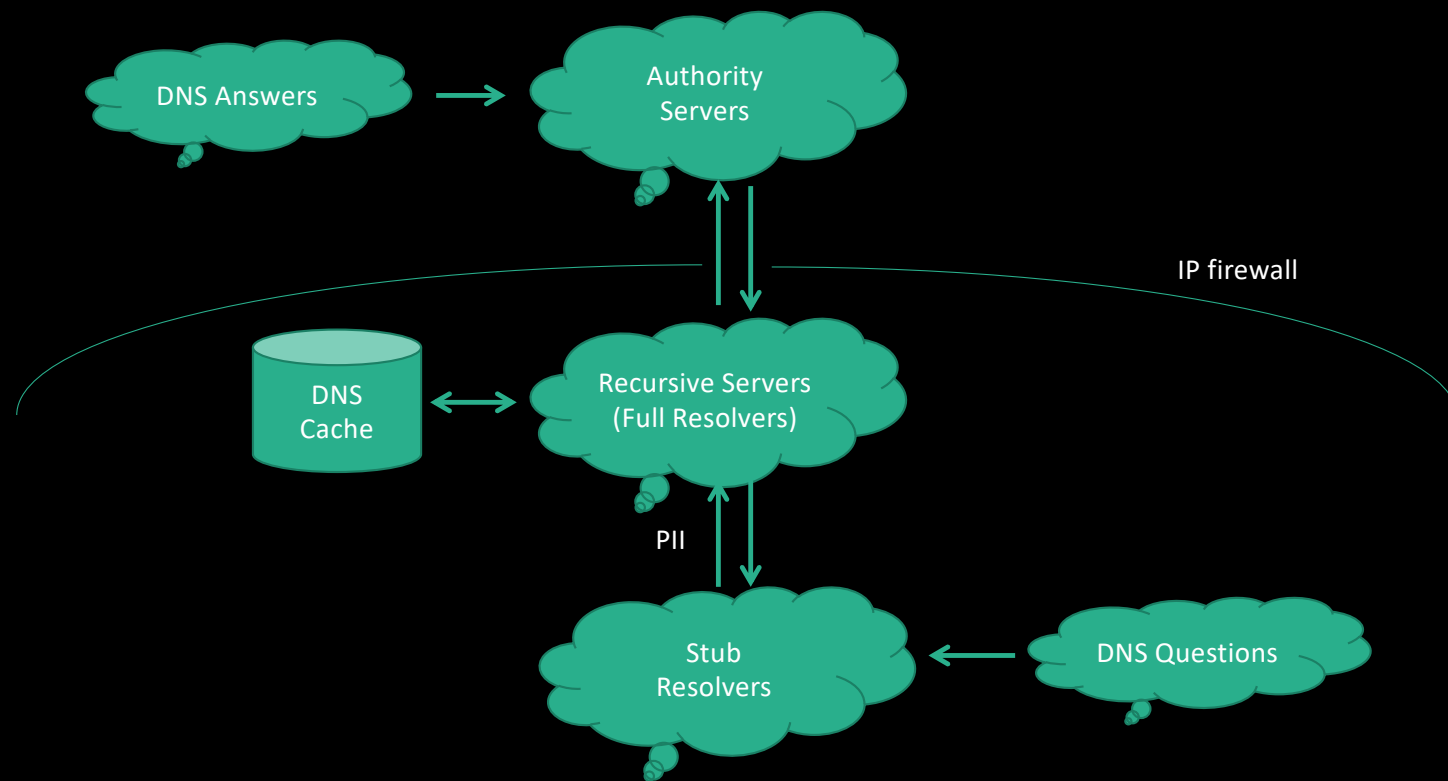
- “The Peace of Westphalia established the precedent of peace established by diplomatic congress. A new system of political order arose in central Europe, based upon peaceful coexistence among **sovereign** states.
- Inter-state aggression was to be held in check by a **balance of power**, and a norm was established against interference in another state's domestic affairs.
- As European influence spread across the globe, these Westphalian principles, especially the concept of sovereign states, became central to international law and to the **prevailing world order.**”

Domains of Operations (Public, Private)

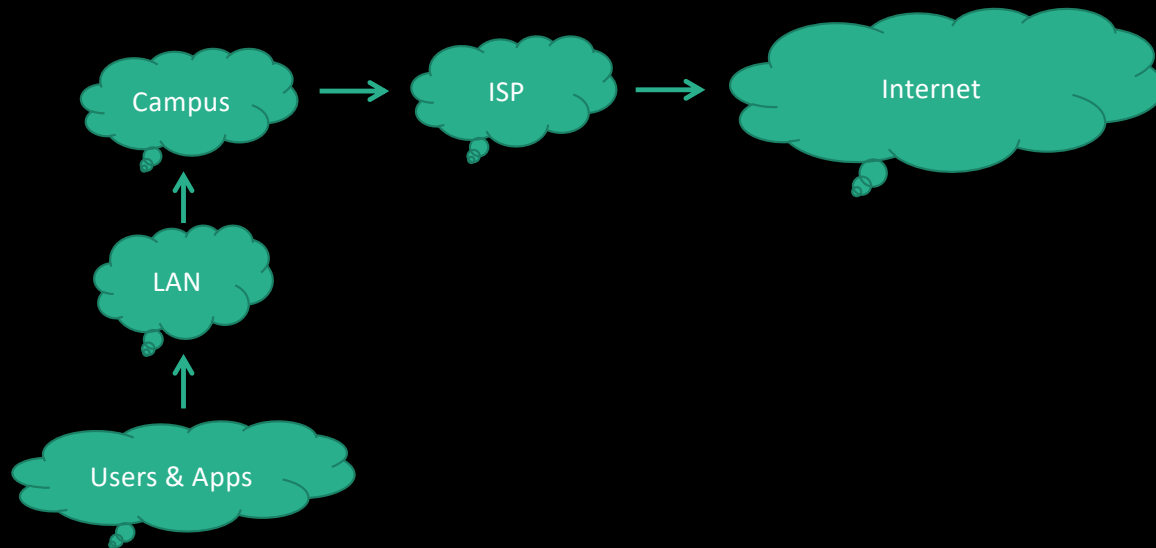
1. *Land*
2. *Sea*
3. Air
4. Space
5. I.T.

Hierarchy of values: supremacy, parity, awareness

DNS System Architecture (Traditional)



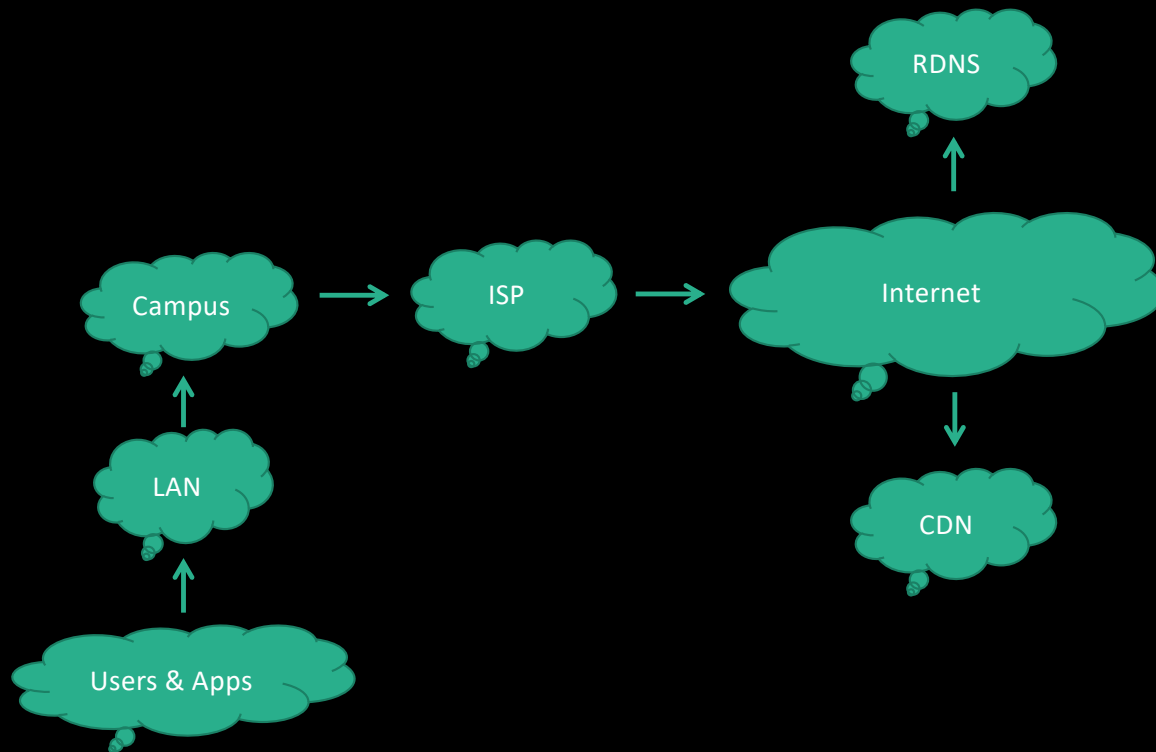
Internet System Topology, ~1999



DNS Wars – Earlier Episodes

- Ep. I: VeriSign™ and SiteFinder™ put a wildcard address at *.COM
 - Ending: delegation-only, delegation-only-except, lawsuit
- Ep. II: Anycast RDNS, OpenDNS, NXD redirection, Google redirection
 - Ending: creation of 8.8.8.8, with many others to follow
- Ep. III: Creation of EDNS Client Subnet (ECS)
 - Ending: less privacy+authenticity due to larger attack surface

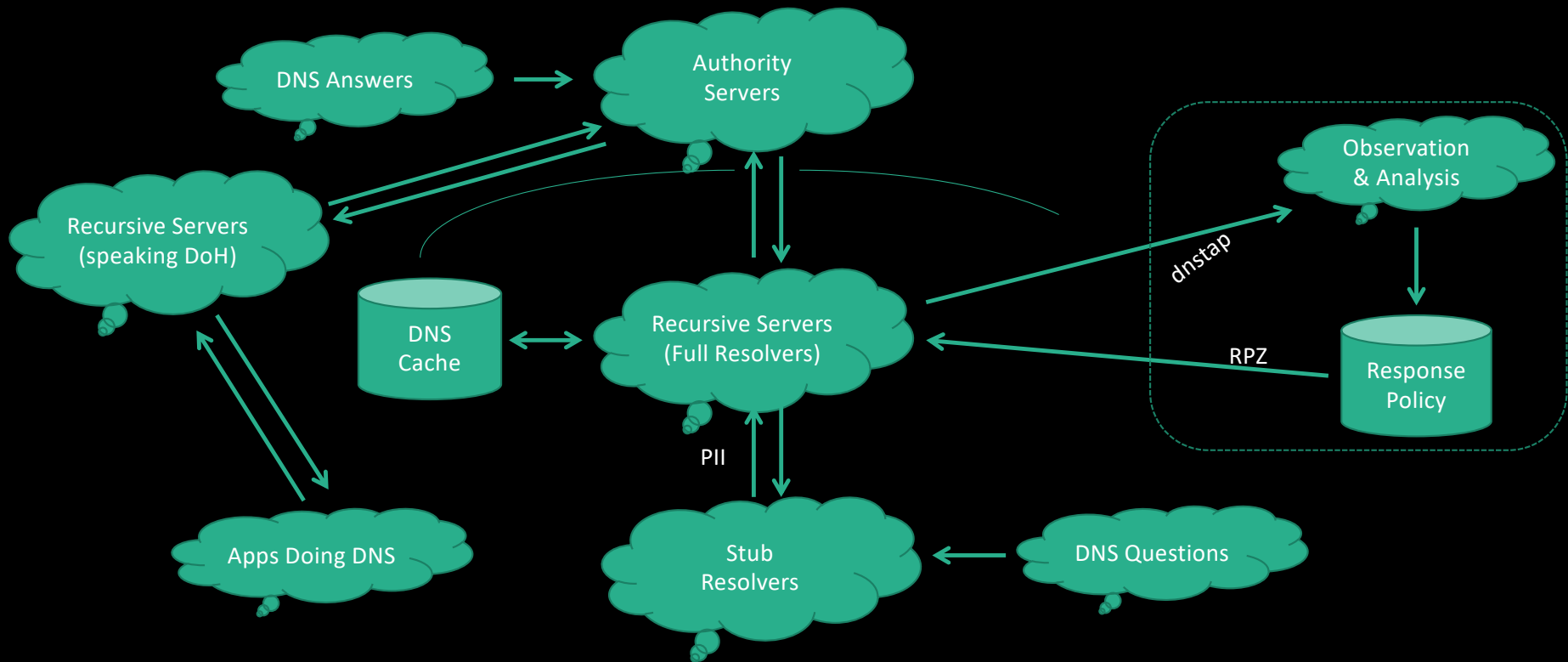
Internet System Topology, ~2019



Action and Reaction: encrypted DNS

- Ability to surveil and perturb DNS transactions was widely abused
 - By ISP's, by OpenDNS, and by governments (see also *Edward Snowden.*)
- So, IETF created DNS Over TLS (DoT), which is being deployed now
 - This is a new transport for any/all DNS transactions, above or below RDNS
 - This is TCP/853, better than TCP/53, and w/ TCPFO often better than UDP/53
 - Network operators can forbid, but cannot surveil or intercept, DoT
- Then, IETF created DNS Over HTTPS (DoH), also being deployed now
 - This is a new transport for stub-to-RDNS, but, meant to be firewall-proof
 - Since it uses TCP/443 a network operator may “think twice before blocking it”
 - DoH disintermediates parental controls at home, and company policy at work

DNS System Architecture, As Amended



Problems with DoH, part 1

- It's a political project, not a technical one
 - Encrypting stub-to-RDNS but not subsequent flows adds no actual privacy
 - An eavesdropper can guess DNS answers based on what happens afterward
 - Guessing the questions once you know the answers is trivial data science
- To stay out of jail in an authoritarian regime, you need a VPN
 - And once you have a VPN, what value would DoH add?
- Also note, many names are resolvable locally but not remotely
 - Most companies have their own internal-only TLD's like .CORP or .FORD
- The web is not the whole Internet; browsers can launch helper apps
 - Helper apps will use the normal stub resolver, getting different DNS answers

Problems with DoH, part 2

- DoH cannot differentiate between these network operators:
 - Parents, who use RDNS filtering as part of their family Internet controls
 - Sysadmins, who use RDNS filtering to block spam and malware
 - Security teams, who use RDNS monitoring to detect new malware infections
 - Authoritarian government, who uses RDNS for “thought control”
 - ISPs who wish to surveil their customers to aid in targeted advertising
- DoH’s costs would be tolerable if there was an accompanying benefit
 - However, DoH is a political act, adding no actual or effective privacy
- Some people think CCP has practical resource limits for GFW
 - Some people don’t

Selected quotation – July 2014 –
<https://medium.com/message/81e5f33a24e1>

- “The NSA is doing so well because software is bullshit.”
- “Next time you think your grandma is uncool, give her credit for her time helping dangerous Russian criminals extort money from offshore casinos with DDoS attacks.”
- “C is good for two things: being beautiful and creating catastrophic 0days in memory management.”
- “When we tell you to apply updates we are not telling you to mend your ship. We are telling you to keep bailing before the water gets to your neck.”

Managed Private Networks

- Endpoints are fundamentally unsecurable
 - IoT; abandonware; supply chain poisoning; 0-days; intruders
- Allowing some kinds of traffic, disallowing others
 - Firewalls: IP, web, DNS
- Economics of scale force an anomaly detection posture
 - Bad actors must therefore try to “blend in”
- Nation-state and ISP networks are not private
 - But they want some of the powers of MPN’s (observation; filtering)
- DoH is not targeted against any of this
 - Most IP growth is mobile; most revenue is from tracking and advertising

Internet vs. Web

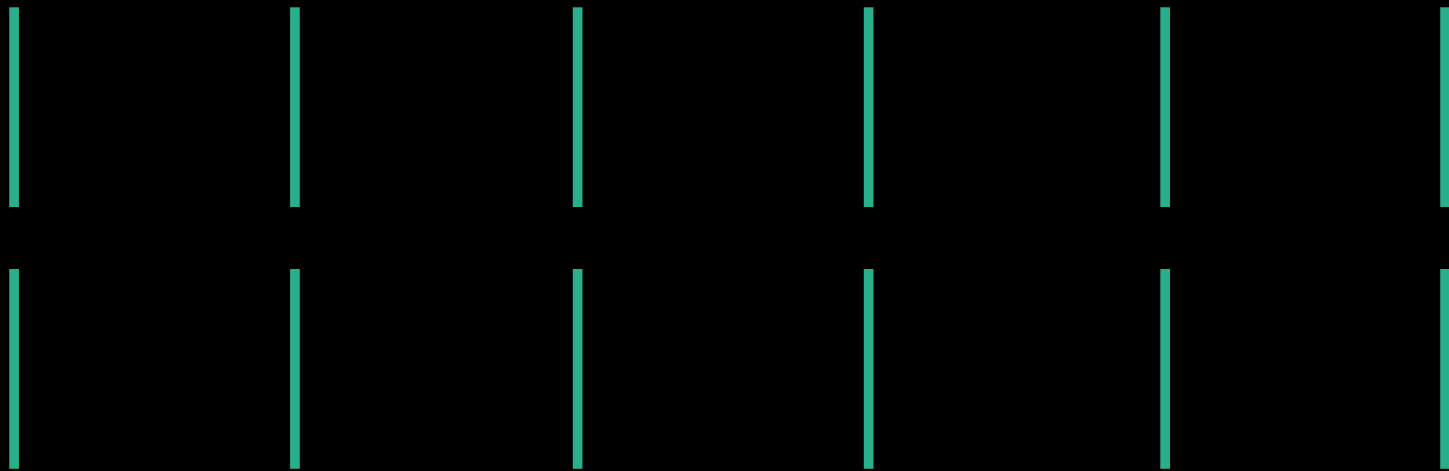
- It's going to become broadly necessary to control TCP/443 (HTTPS):
 - TLS 1.3 + ESNI means no more HTTPS MITM – requires proxy for all outbound
 - Every IP offering DoH will be widely blackholed, because of malware DoH use
- Possession is said to be 90% of the law
 - On the Internet (network of networks) that meant: “my network; my rules”
 - On the Web (network of eyeballs) that means: “my network; DoH's rules”
- As a form of Internet governance, DoH shows the worst of all worlds
 - Which is: *code is law* (or: *the rule of the strongest*)
- Whoever can get the most gold, makes the rules
 - Eventually this will mean LTE/5G for free in all IoT devices

Rise of the Corporate State

4. The user will be informed that we have enabled use of a TRR and have the opportunity to turn it off at that time, but will not be required to opt-in to get DoH with a TRR.

- Mozilla Corporation (of Firefox) is deploying DoH on an opt-out basis
 - Their first Trusted Recursive Resolver (TRR) is Cloudflare™
 - Both the opt-out policy, and the choice of a US company, are controversial
- The UK objected, and demanded a “summit meeting” in London
 - Mozilla agreed to leave the UK out of their DoH roll-out for now
- This leaves open the question: how many other countries will object?
 - And: how many other browser/app vendors will implement similar policies?

Cooperation Is Alignment



Users, Apps

Clients, Servers

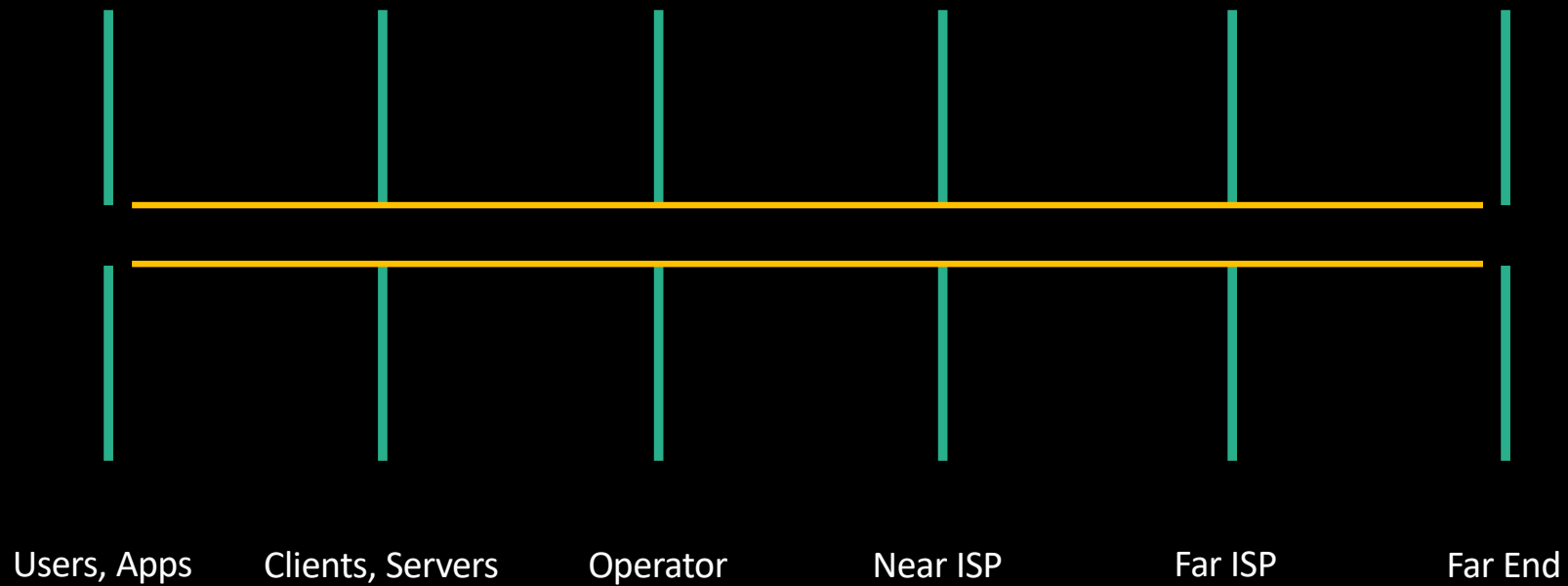
Operator

Near ISP

Far ISP

Far End

Cooperation \neq Was Alignment



Expensive (Imposed) Choices

- Faced with Internet Standards for RDNS bypass, a NetOp can either:
 - Allow malware, intruders, supply chain poison, BYOD to bypass DNS controls
 - Stop thinking any network can ever be secure, move beyond “perimeters”
 - Create smaller networks having explicit whitelists for must-be-reached
 - Allow Chromecast, Chrome, IoT unlimited access to their motherships
- ...Or:
 - Follow the tradition: *possession is 9/10th of the law*
 - Establish an AUP and enforce it for all outbound communications
 - Get creative about what (few) requires a proxy and what (many) does not
 - Firewall every app and every IoT device

Complexity

$$\left(\frac{n}{m + q} \right) < \frac{n}{m}$$

n is #/devices or #/technologies you use that you understand

m is #/devices or #/technologies you already have

q is #/devices or #/technologies you want to add

This fraction inversely predicts your complexity-related risk

“...unless, that is, he prefers DNS over HTTPS”

- “The poorest man may in his cottage bid defiance to all the forces of the crown. It may be frail – its roof may shake – the wind may blow through it – the storm may enter – the rain may enter - but the King of England cannot enter.”
 - William Pitt, the first Earl of Chatham, 1763

End Notes

- Every innovator solves the problems their/they customers have
 - Not every innovator knows or cares about systemic costs
- DNS is the first and only system of its kind that has scaled by 10^9
 - Distributed, coherent, reliable, autonomous, and hierarchical – unique!
- As in politics, economics, and climate change, this future is brutal
 - Our consent is no longer sought, and can only be withheld at notable cost
- Westphalian era is not strictly, completely, over
 - However, Space and I.T. operational domains ignore boundaries
 - “You can keep what you can defend” means something different vs. 1846
 - Some corporations now mostly have I.T. supremacy over most countries