The Split Horizon DNS Problem

ADD/DPRIVE/DNSOP Interim, Jan 2022

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Based on work by Tiru Reddy, Dan Wing, and Kevin Smith

1. Definitions

What is “split horizon DNS”?

- The network-provided resolver gives answers that are **meaningfully different** from the answers you will get from an external resolver.
- Examples
  - **Intranet domains**: *foo.corp.example.com* is NXDOMAIN in the public DNS.
  - **Internal variations**: *example.com* resolves to a canary instance when using Example Inc’s resolver.
  - **Network proximity**: *downloads.example.edu* resolves to a local server at each campus when using the resolver provided by that campus’ network.
- Typical users
  - Enterprise
  - Education
  - Home (power users, home gateways)
  - ISP (subscriber configuration panel)

What is “DNS hijacking”?

- Answering queries for a domain name **without authorization by the zone**.
- DNS hijacking is not allowed within IETF standards:
  - RFC 2826: there must be “a single owner or maintainer to every domain … who is responsible for ensuring that each sub-domain of that domain has the proper records”.
  - DNSSEC regards hijacking of signed zones as Bogus.
- Examples
  - Answering for *www.example.com* without permission from the *example.com* zone.
  - Answering for *nonexistent.example.com* without permission (“**NXDOMAIN hijacking**”).
  - Inventing new Pseudo-TLDs without IANA/ICANN permission (i.e. NXDOMAIN hijacking at the root).

“Split-horizon DNS” **-** “DNS hijacking” **=** “**authorized split-horizon DNS**”.

2. Intractable Topics

Trust relationships

- If a device and network are not managed by the same entity, they might not have a high degree of mutual trust. In this, each party will choose its own DNS behavior (such as which resolvers to use) independently.
    - Likely driven by each party's security assumptions.
- ADD Charter: **"Making any recommendations about specific policies for clients or servers is out of scope."**

Unachievable goals for standards development

- Make clients and networks work together if they have incompatible security assumptions.
- Make people change their security assumptions.

Plea: Let’s focus on use cases where the only thing missing is a technical solution.

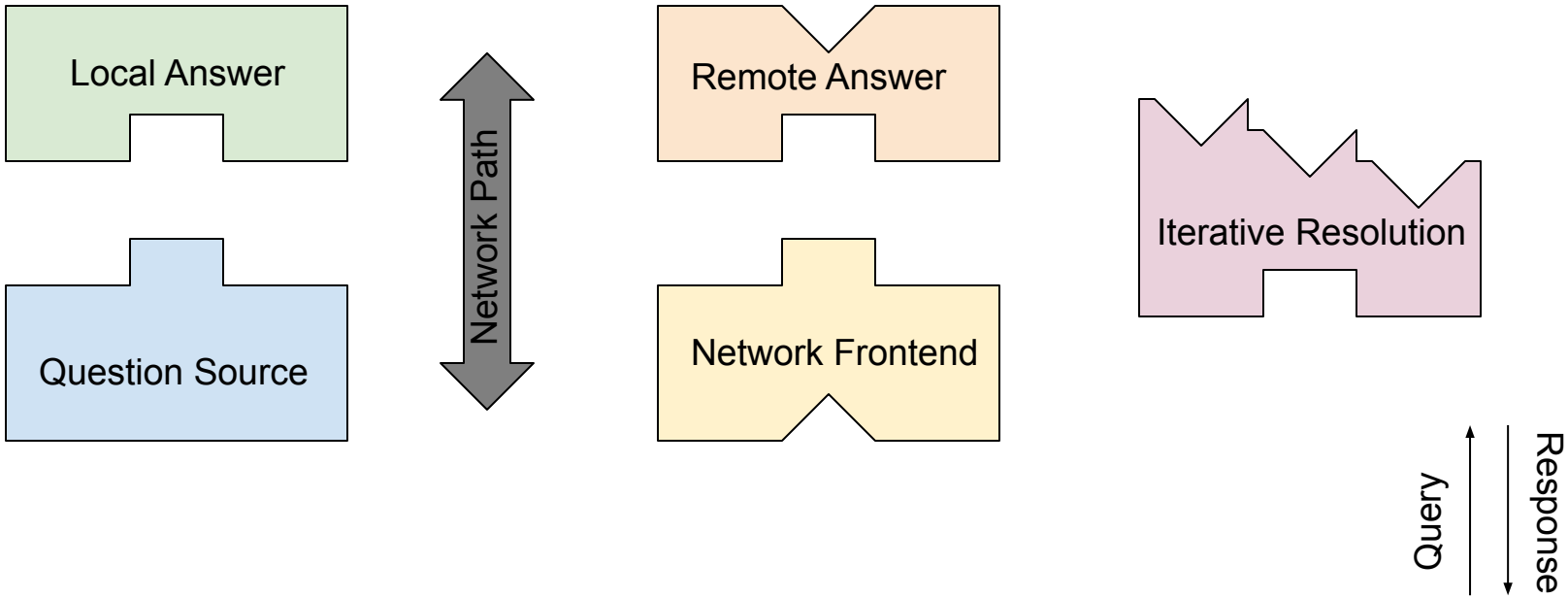
Looking for “interesting”

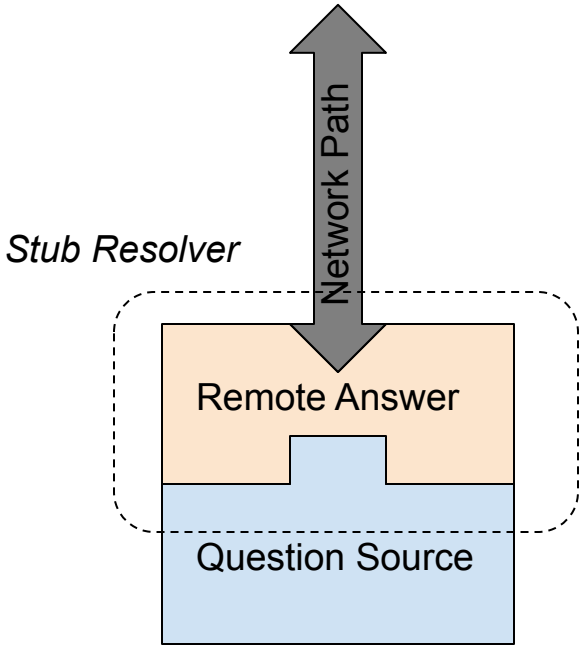
- We can still consider the effects of different policies, and define solutions that only work under certain policies.
- Clients that have a policy to **always** use the network-provided resolver will **always** see the split horizon names.
- Clients that have a policy to **never** use the network-provided resolver will **never** see the split horizon names.
- These cases are both **boring**.
- **What about clients that *sometimes* use the network-provided resolver?**

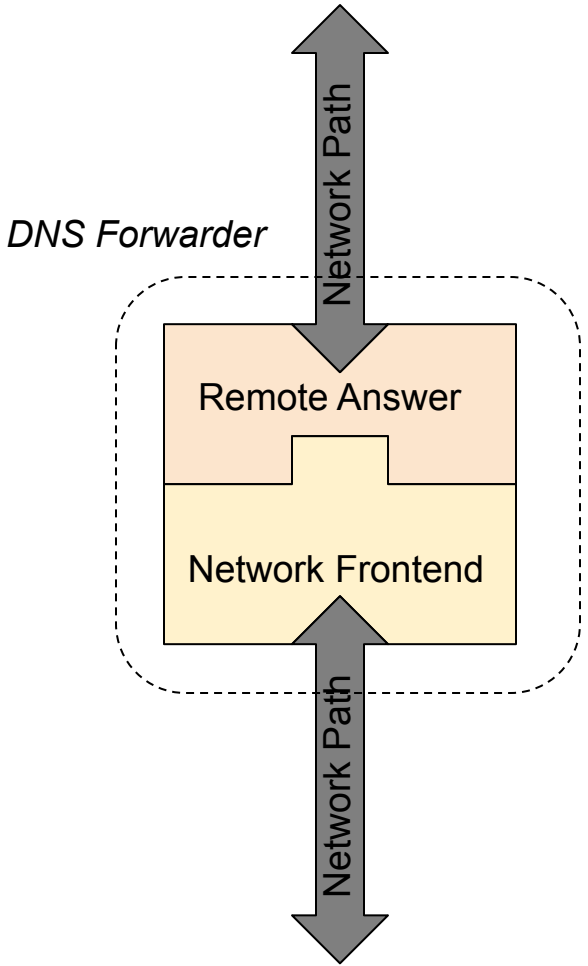
3. Hybrid Resolvers

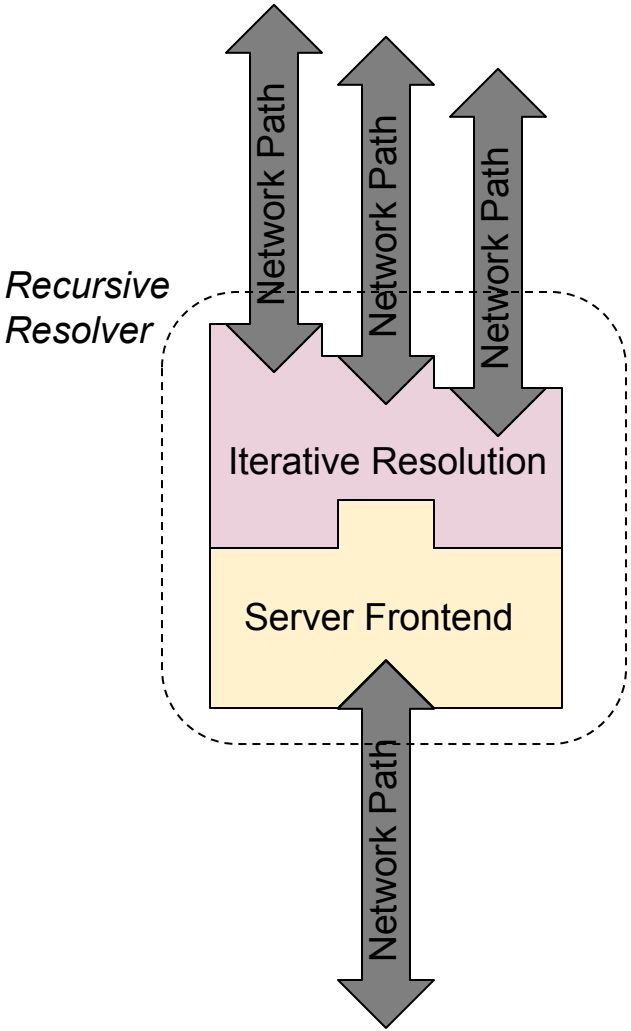
A brief digression with puzzle pieces

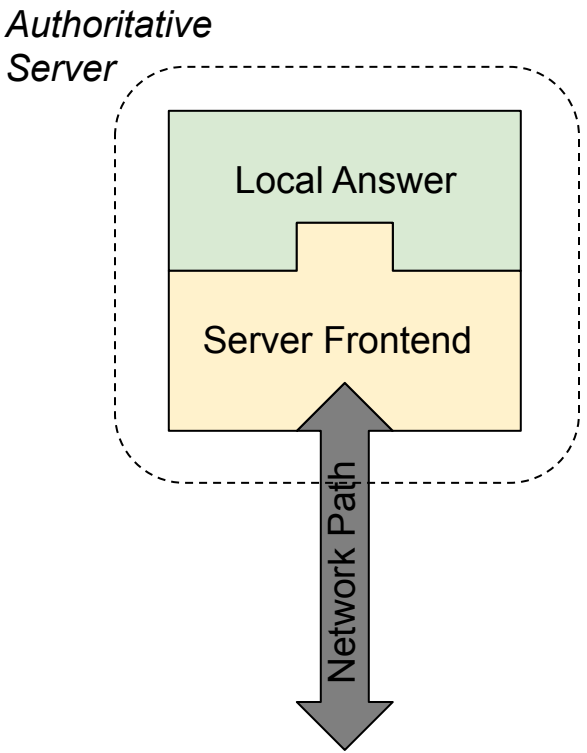
Building Blocks for a Resolver




Stub Resolver
Network Path
Remote Answer
Question Source

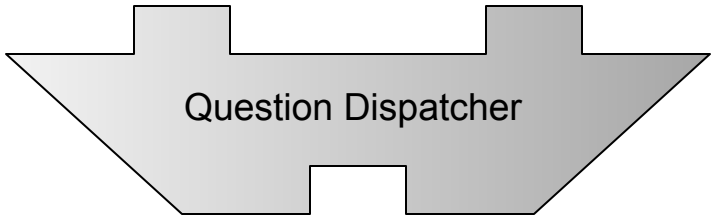

DNS Forwarder
Network Path
Remote Answer
Network Frontend
Network Path


Recursive
Resolver
Network Path
Network Path
Network Path
Iterative Resolution
Server Frontend
Network Path

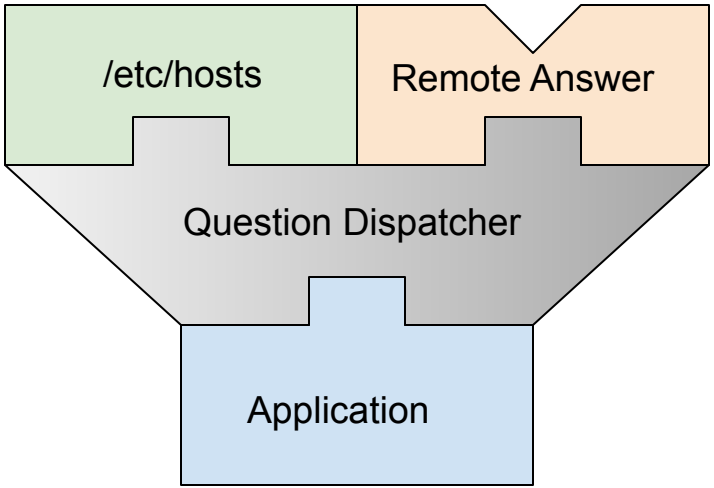

Authoritative
Server
Local Answer
Server Frontend
Network Path

Hybrid Resolvers

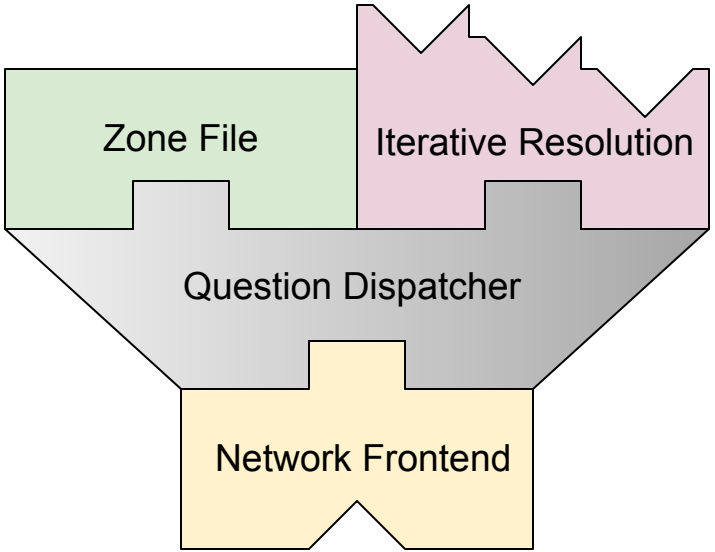
A *hybrid resolver* implements multiple resolution behaviors, and dispatches each question to an appropriate behavior according to a local policy.



Example: POSIX stub resolver with `/etc/hosts`

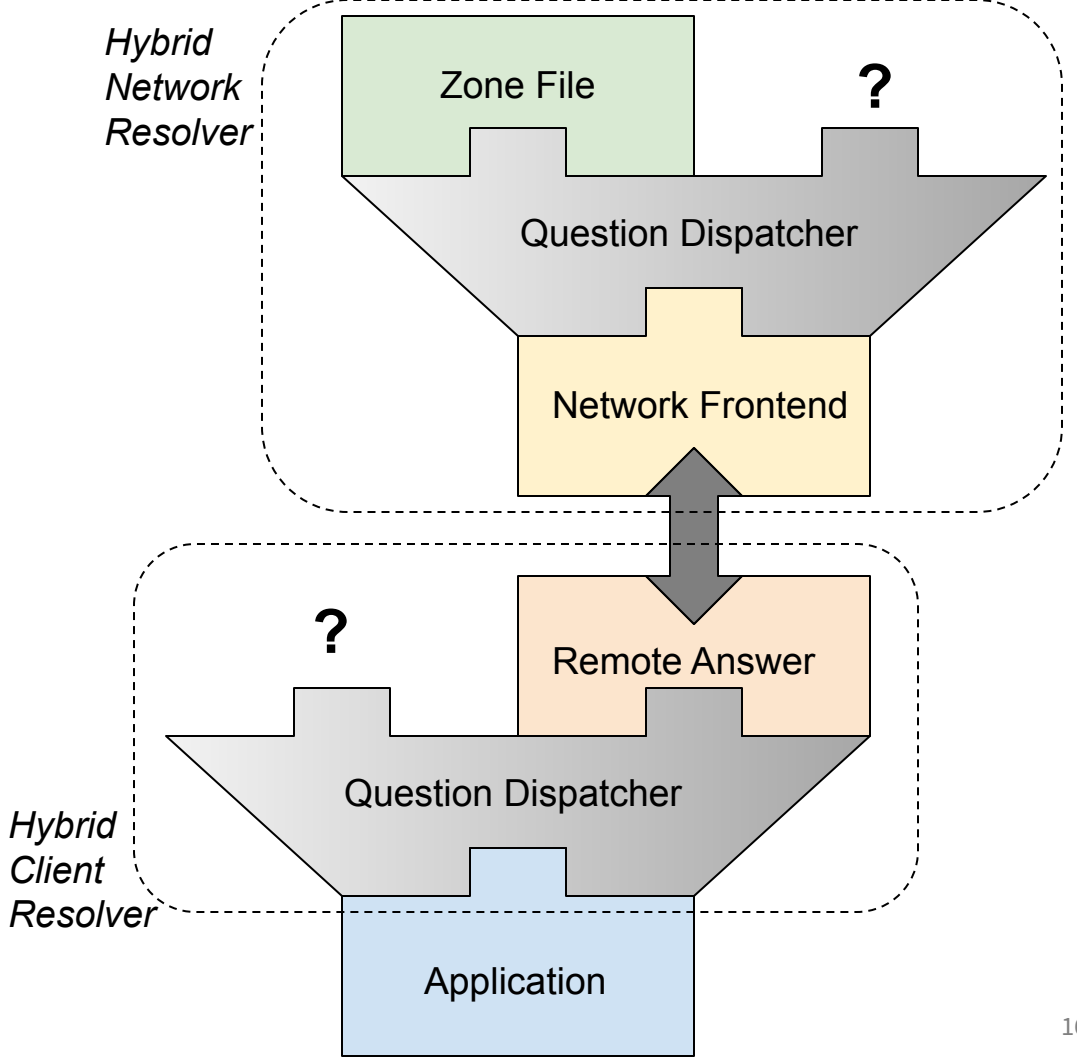


Example: “Authoritative Resolver”



The Interesting Case

- **Both resolvers are hybrids**,
- the network resolver has some local answers, **and**
- the client wants access to this resolver's local zones.
- The other branches might be "Remote Answer", "Iterative Resolution", etc.



4. Scoping and Mechanisms

Achievable goals for standards development

Easy: Enable clients to learn about split-horizon names available on this network.

Hard: Enable clients to distinguish *DNS hijacking* from *authorized split horizon DNS*.

Announcing split-horizon names (the easy part)

- Provisioning Domains (PvD)'s "dnsZones" extension (RFC 8801, Section 4.3)
  - No authentication. The network operator can put anything they want in this extension!
  - PvD source is identified but not necessarily trusted.
- Split DNS Configuration for IKEv2 (RFC 8598)
  - No authentication, but the client usually has a close relationship with the tunnel operator.
  - Supports overriding DNSSEC trust anchors! (but recommends a user confirmation step)
- DHCP Search Option (RFC 3397)?
  - Not exactly the right semantics but really very similar to the PvD support.

Confirming authorization (the hard part)

- To confirm that a local resolver (**R**) is authorized to serve a given DNS zone, the client would need
  - (1) an identity for **R** (presumably an Authentication Domain Name (**ADN**))
  - (2) an **assertion** by the zone owner that it authorizes **ADN** to serve this zone
  - (3) a way to ensure that the assertion was **not forged** by **R**
  - (4) a **secure transport** to **R**, authenticated to this **ADN**
- Example solutions (from draft-reddy-enterprise-dns-08)
  - DNR (draft-ietf-add-dnr) provides the ADN (1) and bootstraps the secure transport (4)
  - An NS record asserts that this ADN is authorized to serve the zone (2)
  - To prevent forgery (3), the client resolves the NS record
    - through an independent resolver over a secure transport, or
    - using local DNSSEC validation (if the claimed zone is signed and the client does local DNSSEC)

END

New DNS security standards have created new opportunities to make Split-Horizon DNS more secure and compatible.

We can make progress, but only if we focus on the use cases where a solution is possible.

Even a limited or inconvenient solution would be better than the status quo.