Recursives in the Wild: Engineering Authoritative DNS Servers

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Before we start...

• How many DNS operators in the room?

• Role: point of view of a DNS operator that wants to reduce latency to its services

• Why? : **Time (latency) is money**

Many reports (google, amazon): report : high latency, less searches

• Paper presented at ACM IMC2017 in London
• Example of a DNS authoritative setup:
  8 authoritative name servers for the same zone (.nl)
  Could be the same for any second-level domain

• Redundancy for high availability
Introduction

Where is example.nl?
Introduction

Where is example.nl?
Introduction
area relative to the number of sites
Introduction

area relative to the number of sites

area relative to the number of queries
Introduction

Located in the Netherlands, the netnod is connected to multiple sites in the US. 23% of queries come from the US area relative to the number of sites. The diagram illustrates the connectivity and distribution of queries.
Why is that?

Recursive Resolver

who has example.nl?

Client

- unicast
- anycast

ns1 ns2 ns3 ns4 ns5

netno d nic.fr isc

d.nic.fr

unicast

amazon web services

facebook

Google Cloud Platform

at&t COMCAST

Deutsche Telekom kpn

USC Viterbi

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Research Questions

• How do recursive resolvers select authoritative name servers?

• [1] says, most *implementations* prefer faster responding authoritatives

• but what is the overall behaviour *in the wild?*

• To improve performance, how should DNS operators design their authoritatives?

Measurement Design

7 measurement setups:
- GRU+NRT
- DUB+FRA
- FRA+SYD
- GRU+NRT+SYD
- DUB+FRA+IAD
- DUB+GRU+NRT+SYD
- DUB+FRA+IAD+SFO

IPv4 only (for now)

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1 hour each measurement, ever 2 min

~9000 Ripe Atlas probes from ~2500 ASes
Do recursives query all authoritatives?

- Majority will quickly query ALL authoritatives
- Meaning “one bad apple may spoil the whole bunch”?
How do recursives distribute their queries over time?
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- Authoritatives with similar latency get similar number of queries
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- Authoritatives with similar latency get similar number of queries
- Larger difference leads to larger preference
- Authoritatives that respond faster are in general preferred
- Confirms previous work, but now in the wild
How do *individual* recursives distribute their queries?

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Up to 69% of resolvers have a weak preference (60% to 90% of their queries to one NS)
How do *individual* recursives distribute their queries?

Up to 37% of resolvers have a strong preference (more than 90% of their queries to one NS)
How do individual recursives distribute their queries?

Some resolvers always prefer the slower NS
Validation: Authoritatives in Production

- Root: +60% query at least 6 servers
- .nl: +90% query at least 4 servers
- Overall confirms the observations from our test bed

Root Servers (10 out of 13)
.nl Servers (4 out of 8)
Measurement Summary

• Resolvers will query ALL your authoritative servers
• Distribution is inversely proportional with the median RTT
  • Recursives prefer faster responding authoritatives
  • But they also query slower authoritatives from time to time
• Additional findings:
  • Lower RTT becomes more relevant if competing NSes are closer (<150 ms)
  • Stronger preference when querying more frequent (< 10min interval)
Recommendations for DNS Operators

• The slowest authoritative limits the response time of a DNS service

• Recommendation:
  • Use anycast on *all* your name servers
  • Anycast sites need to be well connected with good peering

→ Based on this work .nl is replacing unicast NSes with anycast
Data Sets

All data sets (but one) available:

https://ant.isi.edu/datasets/dns/index.html#recursives
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Yes, the majority of resolvers query every authoritatives


Questions?

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Additional Slides
Does preference change for distant recursives?

- VPs in EU reach Frankfurt 13 ms faster than Dublin
- Thus, they clearly prefer Frankfurt
- VPs in Asia reach Frankfurt 20 ms faster, but distribute their queries almost equally
  → Lower RTT becomes more relevant if competing authoritatives are closer to the recursive
How does query frequency affect the results?

- A higher query frequency leads to a stronger preference
- However, preference persists even after the default timeout of resolvers like Bind and Unbound