Recursives in the Wild: Engineering Authoritative DNS Servers

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Introduction

Go to the tab Start. Here you will find two buttons as shown below. By means of these buttons you can easily switch between text levels.
Introduction

- **ns1**
- **ns2**
- **ns3**
- **ns4**
- **ns5**
- **netnod**
- **nic.fr**
- **isc**

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**Recursive Resolver**

Who has *example.nl*?

**Client**

- **unicast**
- **anycast**

.\nl setup
Introduction

[Diagram showing a recursive resolver with nodes ns1 to ns5, netnod, nic.fr, and isc. The diagram illustrates unicast and anycast routing with a question mark pointing to a client asking "who has example.nl?".]

- Start
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Title + Text (100%)
Introduction

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Introduction

area relative to the number of sites
Introduction

area relative to the number of sites

area relative to the number of queries
Introduction

area relative to the number of sites

23% of queries from the US

area relative to the number of queries

located in the Netherlands
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 operators design their authoritatives?

Authority Server Selection in DNS Caching Resolvers.
Measurement Design

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)
Measurement Design

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)
Do recursives query all authoritatives?

Yes, the majority of resolvers query every authoritative.
How do recursives distribute their queries over time?

![Graph showing RTT (ms) and queries share across locations]

**RTT (ms)**
- FRA: 0
- DUB: 30
- IAD: 100
- SFO: 200
- GRU: 300
- NRT: 400
- SYD: 500

**Queries Share**
- GRU NRT: 0.2
- DUB: 0.4
- FRA: 0.6
- SYD: 0.8
- IAD: 1.0

Locations: FRA, DUB, IAD, SFO, GRU, NRT, SYD

**Questions:**
1. How do recursives distribute their queries over time?
2. What is the RTT (ms) for each location?
3. What is the queries share for each location?
How do recursives distribute their queries over time?

- Authoritatives with similar latency get similar number of queries
How do recursives distribute their queries over time?

- Authoritatives with similar latency get similar number of queries
- Larger difference leads to larger preference
How do recursives distribute their queries over time?

- 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?

![Graph showing distribution of queries across different regions (EU, DUB, SYD)]
How do individual recursives distribute their queries?

![Graph showing distribution of queries across regions: EU, EUA, EUB, and EUC. The graph compares NRT, GRU, DUB, FRA, SYD, and FRA distributions across different recursive levels.]
How do individual recursives distribute their queries?
How do *individual* recursives distribute their queries?

![Graph showing the distribution of queries among different regions (NRT, GRU, DUB, FRA, SYD)]
How do *individual* recursives distribute their queries?

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
How does query frequency affect the results?

- A higher query frequency leads to a stronger preference
- Preference persists even after the default timeout
Measurement Summary

- 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:
  - Stronger preference when querying more frequent (< 10min interval)
  - Lower RTT becomes more relevant if competing NSes are closer (<150 ms)
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
All data sets (but one) available:

https://ant.isi.edu/datasets/dns/index.html#recursives
Data Sets

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https://ant.isi.edu/datasets/dns/index.html#recursives

Questions?

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Additional Slides
Does preference change for distant recursives?

• VPs in EU reach Frankfurt 13 ms faster than Dublin, they clearly prefer Frankfurt
• VPs in Asia reach Frankfurt 20 ms faster, query distribution almost equal
→ Lower RTT becomes more relevant if competing authoritatives are closer
How do individual recursives distribute their queries?

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