Behavior of DNS' Top Talkers, a .com/.net View

Eric Osterweil - Verisign Labs
Danny McPherson - Verisign Labs
Steve DiBenedetto - Colorado State University (CSU)
Christos Papadopoulos - CSU
Dan Massey - CSU

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DNS, the Internet's Favorite Kitchen Sink…

- Some have long wanted to use DNS as a general distributed database
  - TLS certs, phone numbers, etc. (researchers, IETF, ops)

- But, DNS is a piece of Internet infrastructure that we would have trouble doing without
  - How much do we do today that *doesn't* use DNS?

- Yet, what do we really known about its *global* query patterns?

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Let's Look Before We Leap

- Posit: before overloading DNS, we must understand *how it is being used*
  - How are resolvers behaving?
  - How dynamic are resolvers?
  - What are the most common query-types (qtypes)?
  - Who are the busiest resolvers?

- But when measuring, how do we separate wheat from chaff?
  - There's a lot of strangeness in DNS measurements

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Understanding How it's Being Used

- We present a month-long study of traffic seen at one instance (of 13) of .com/.net
  - These are two of the largest TLDs in the world
- To our knowledge, this is the largest study of resolver traffic and query patterns to date
  - ~975 million queries/day and ~950 thousand unique sources/day

What we found:

- A lot of strangeness
  - "Nothing ever dies in the Internet"
  - Sources just keep growing
  - Wide range of query patterns
- But, we find some consistency in the *top-talkers*

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Outline

- Background
- Our dataset (i.e. who we are seeing)
- Who top-talkers are and what *they* look like
- Conclusions and future work

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Background

- DNS is best thought of as a two party system
  - Resolvers (the clients) and name servers (the data owners) have different challenges, behaviors, etc.
- Domain names are grouped into hierarchical *zones*
  - example.com is a child of .com, and .com is a child of the root
- Each zone is served by one or more name servers
  - Any name server can serve domain names for its zone(s)
  - .com has 13 name server instances
- But resolvers cache data, so who sees the most traffic?
  - Relatively few queries go to the root, *many* more go to TLDs
- Observations from large TLDs (*cough* .com/.net *cough*) see many more queries than even the root

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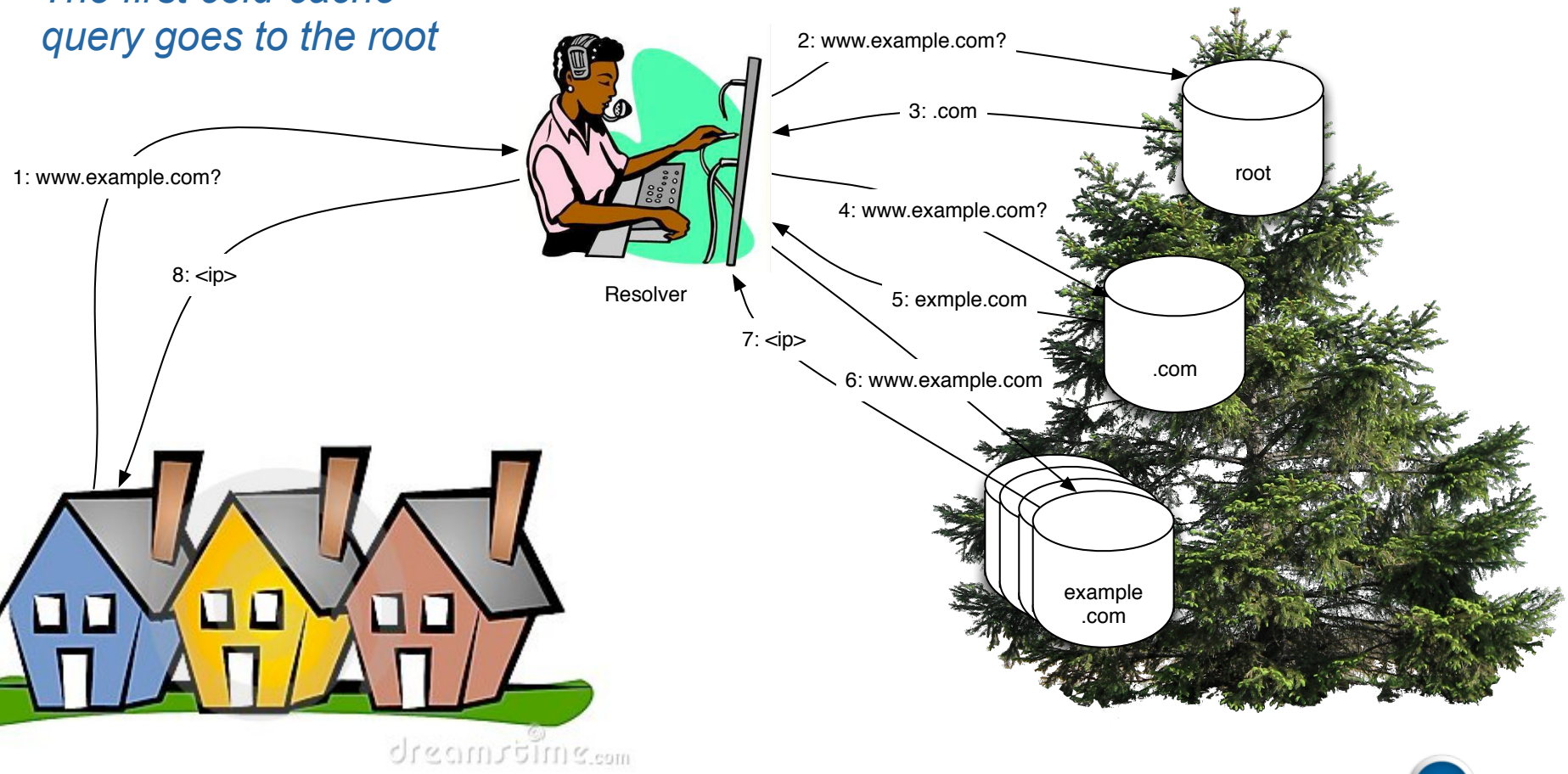
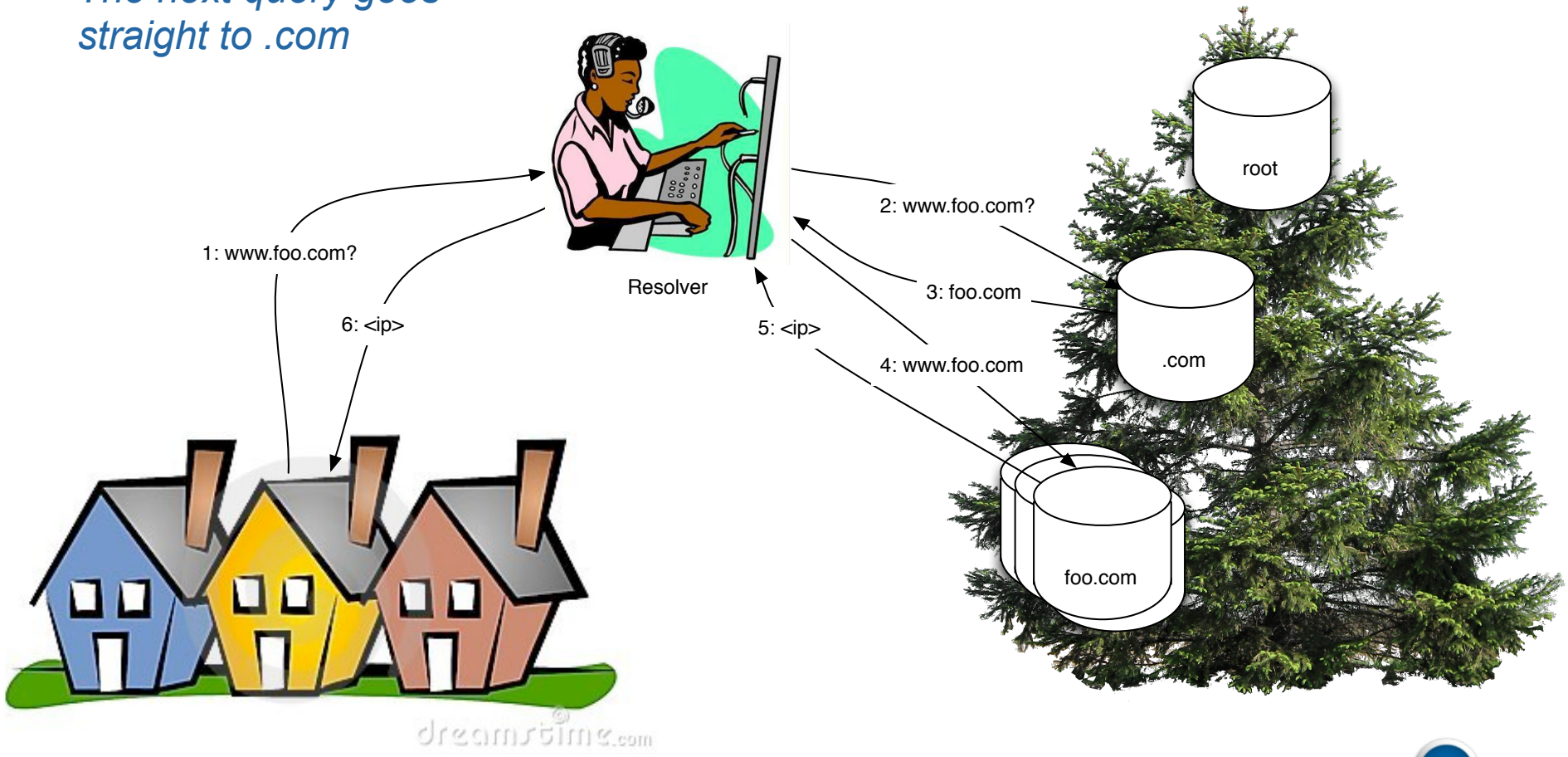
Example

The first cold-cache query goes to the root



Example (2)

The next query goes straight to .com



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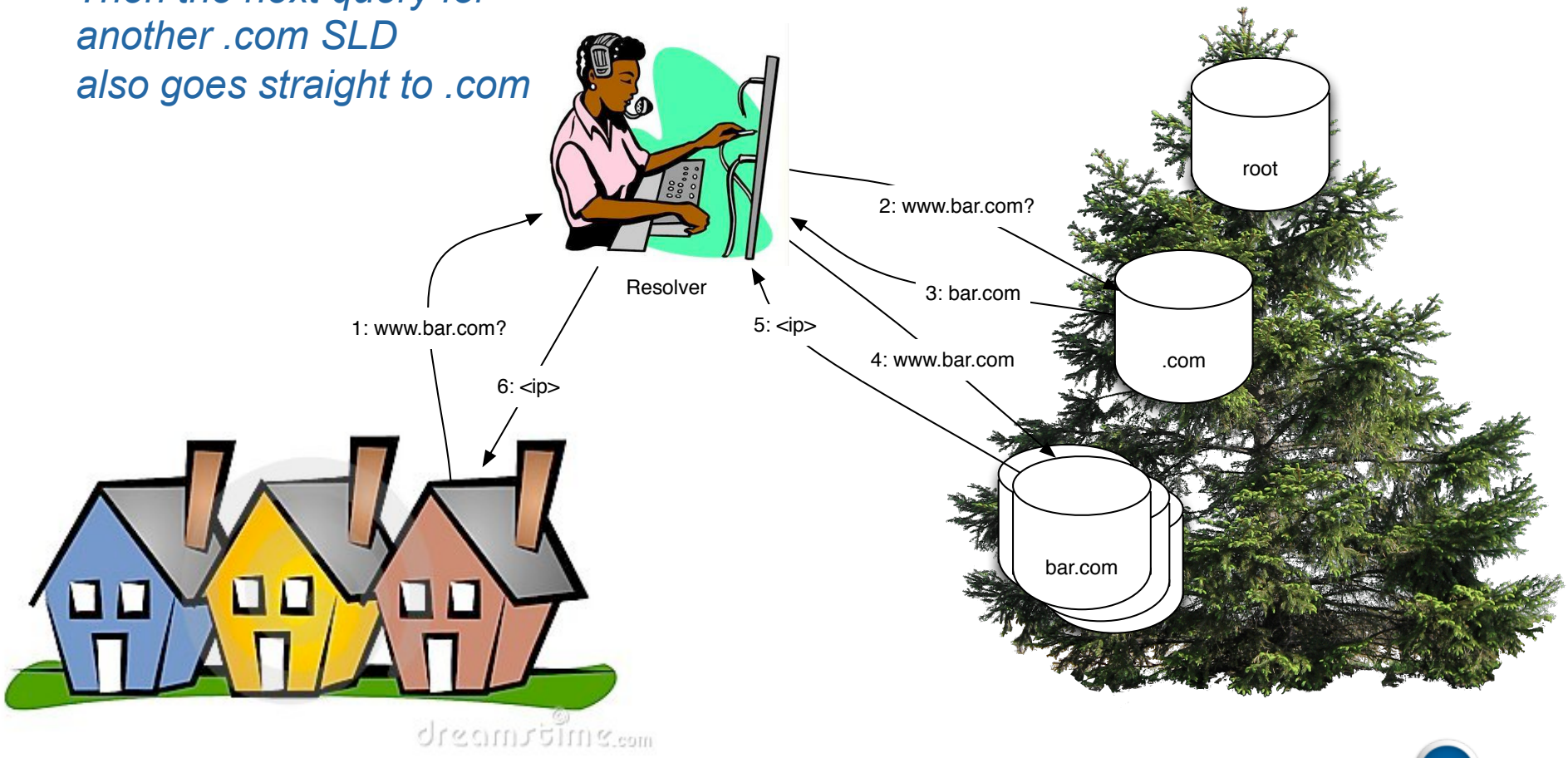
Example (3)

Then the next query for another .com SLD also goes straight to .com



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Our Dataset

- The .com/.net registry contains ~200 million delegations
- It is served by 13 name server instances
  - Each NS has a different domain name and a different IP address
  - Some of these are unicast, some are anycast
- These instances are served from over 70 sites, worldwide

- We limited our analysis to just *one* instance of .com/.net
  - g.gtld-servers.net (the G instance)
  - Unicast from a single site in California, USA
- This instance serves both .com and .net referrals
  - Verisign serves more TLDs, but this analysis was restricted

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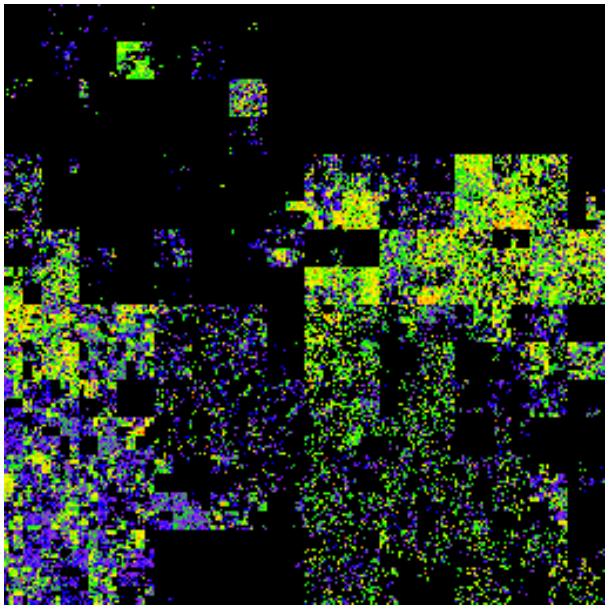
Who the G Instance Sees



- We saw clients from all over
- In just 10 minutes, large traffic volumes from all over the IP space
- We saw lots of strangeness
  - 7th most popular query type is for A6 records (a deprecated type)!
  - Number of unique source addrs didn't stop growing during measurements
  - We saw *pinning and polling* behavior
    - Resolvers probing different name servers and swinging traffic back and forth! (see the paper) ;)
- Strangeness makes it tough to discern signal from noise
  - How does one determine when outliers are skewing…

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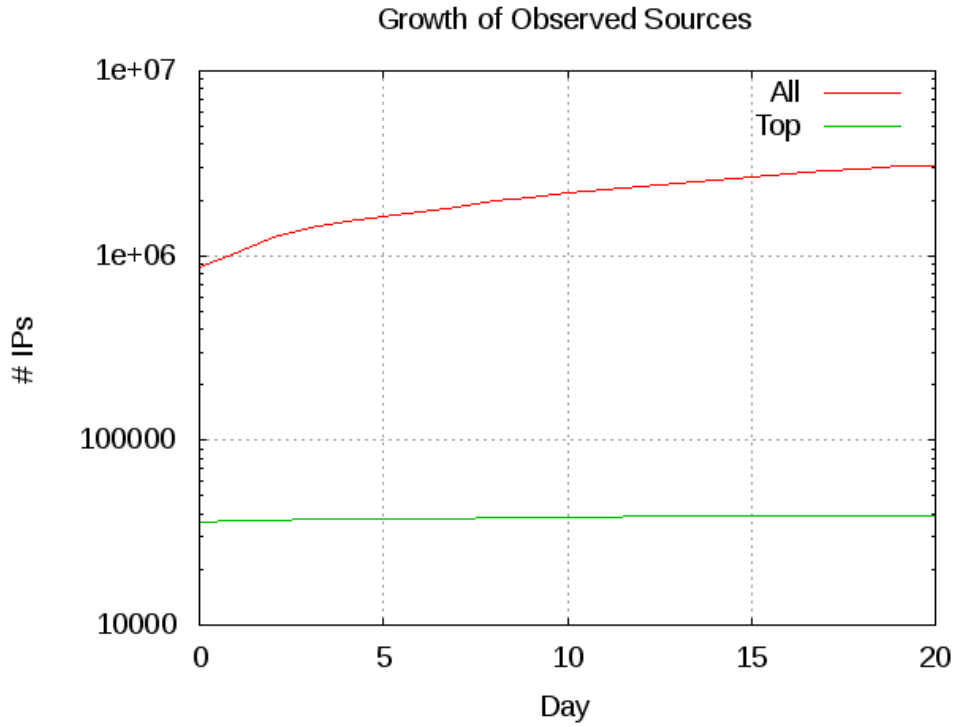
Top-Talkers

- Starting point: what are some of the key behaviors of the most active query sources?
- # of sources grows without ebbing, but those responsible for 90% stabilizes



- We, therefore, classify most of our query traffic as coming from these *top-talkers*
  - In 1 day, out of 958,558 sources, we saw 39,936 top-talkers
  - Roughly 4 million unique sources in 30 days

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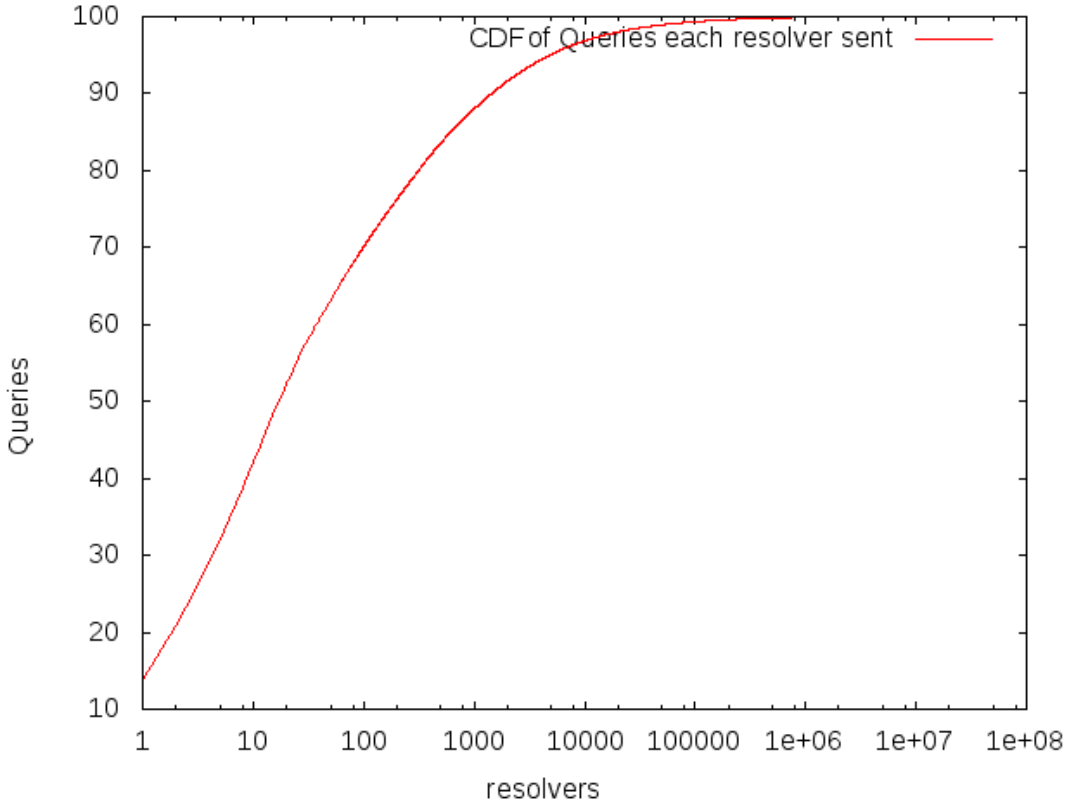
How Much Traffic Makes a Source a Top Talker

- From the log-scale plot, we see the diminishing returns after including source beyond 90%
- Though not hard and fast, is it a good starting point?



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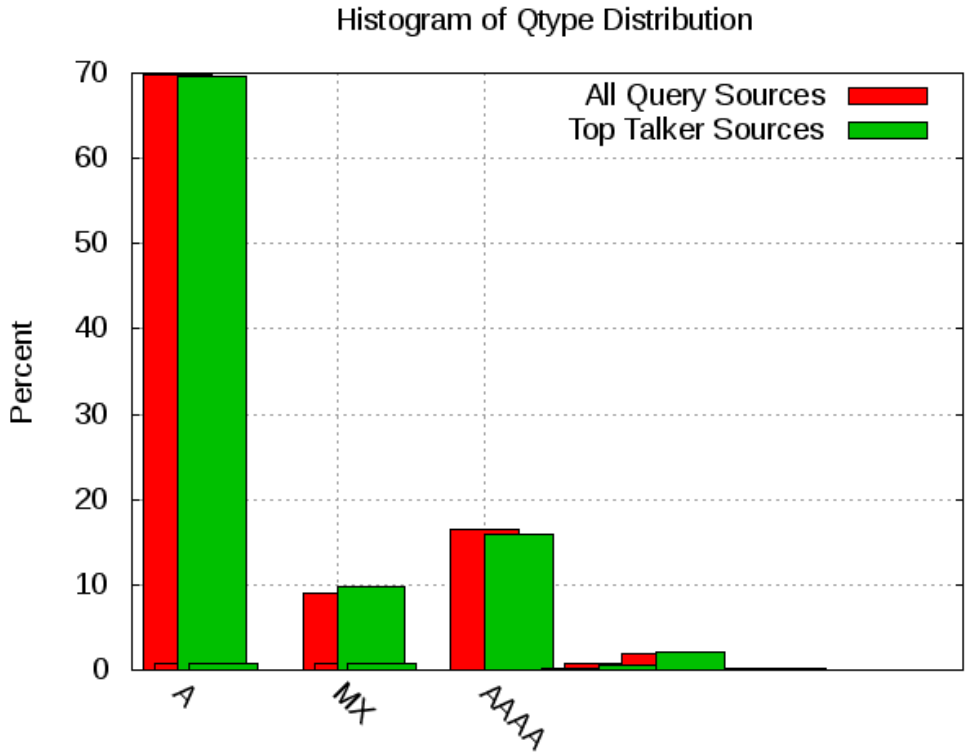
What Resolvers are Querying For

- Resolvers seem to mostly just query for A/AAAA/MX RRs
  - There are other popular types, but not in comparison
- By looking at this sort of distribution, we cannot tell IPv6 adoption, but likely can gauge things like “happy eyeballs”
  - If concurrent IPv4/IPv6 queries are issued, our data should see both



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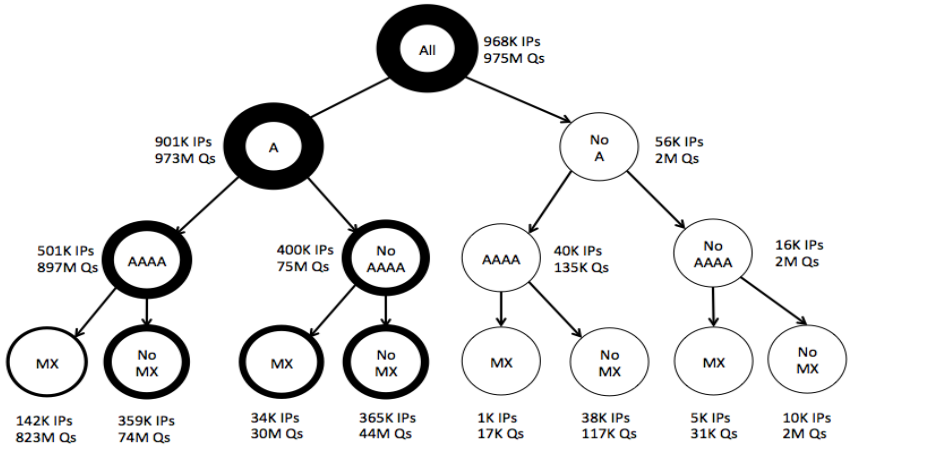
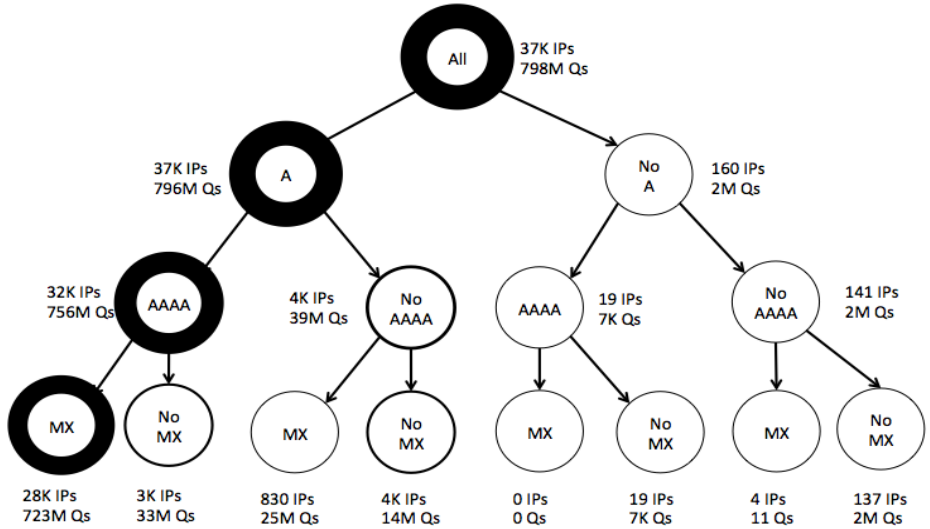
Top Talkers: a Low Pass Filter

- This simple metric helps to separate some strange behaviors from what we might expect
- Whereas many sources asked for heterogeneous combinations of qtypes, top-talkers mostly asked for As, AAAAs, and MXs
  - Not all, but we wouldn't expect all





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Conclusions and Future Work

- The top-talkers approach helped us identify meaningful trends in our data, while systematically removing less active sources
  - We have not quantified the relative benefit of using different cut-offs 85%, 95%, etc.
- The *pinning and polling* behavior has given us a chance to begin classifying variations of resolvers
- We have begun to use the top-talkers filter to classify typical traffic vs. large-scale attack traffic
  - We have begun building automated attack defenses
  - He are investigating correlations between abnormal top-talkers and external events (MX spam campaigns)
  - Etc.

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Thank You

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Backup

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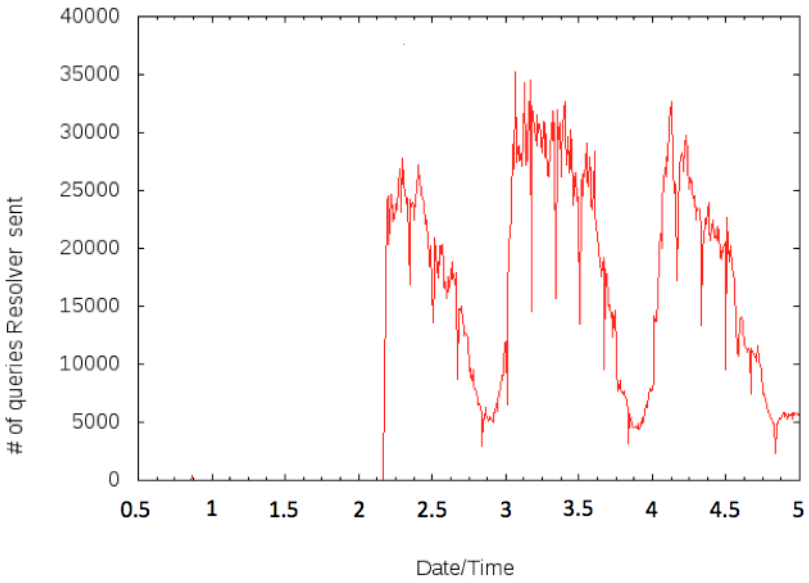
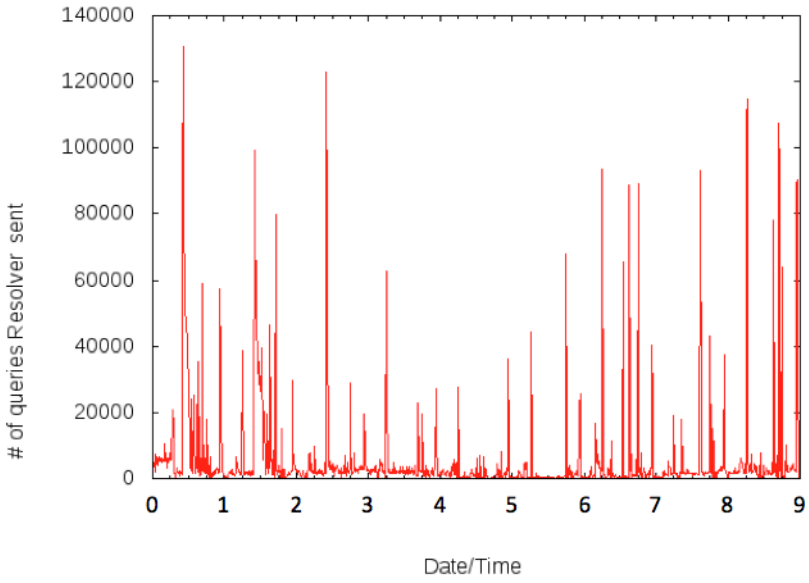
Pinning and Polling

Pinned Resolver



Polling Resolver



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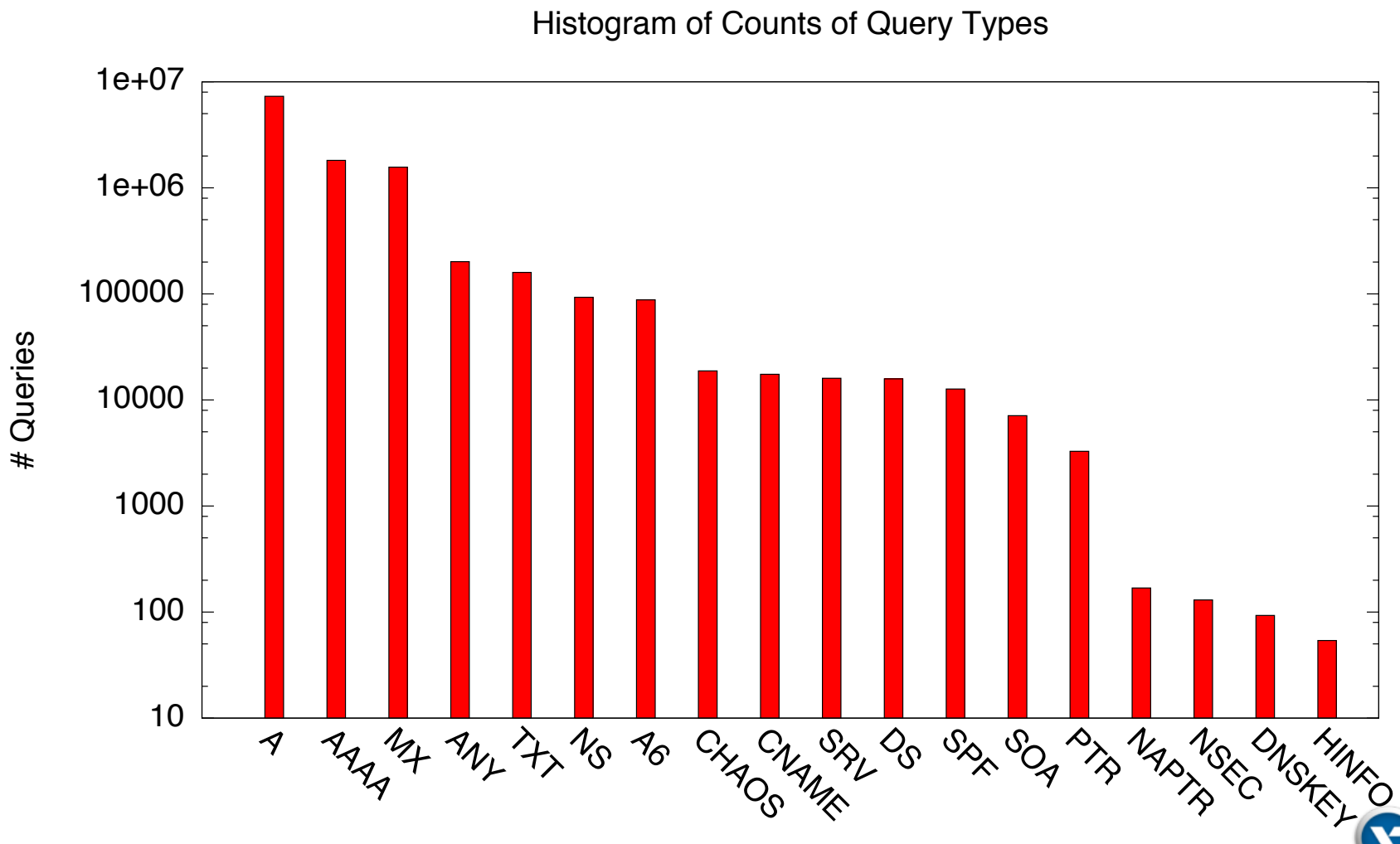
Full qtype distribution



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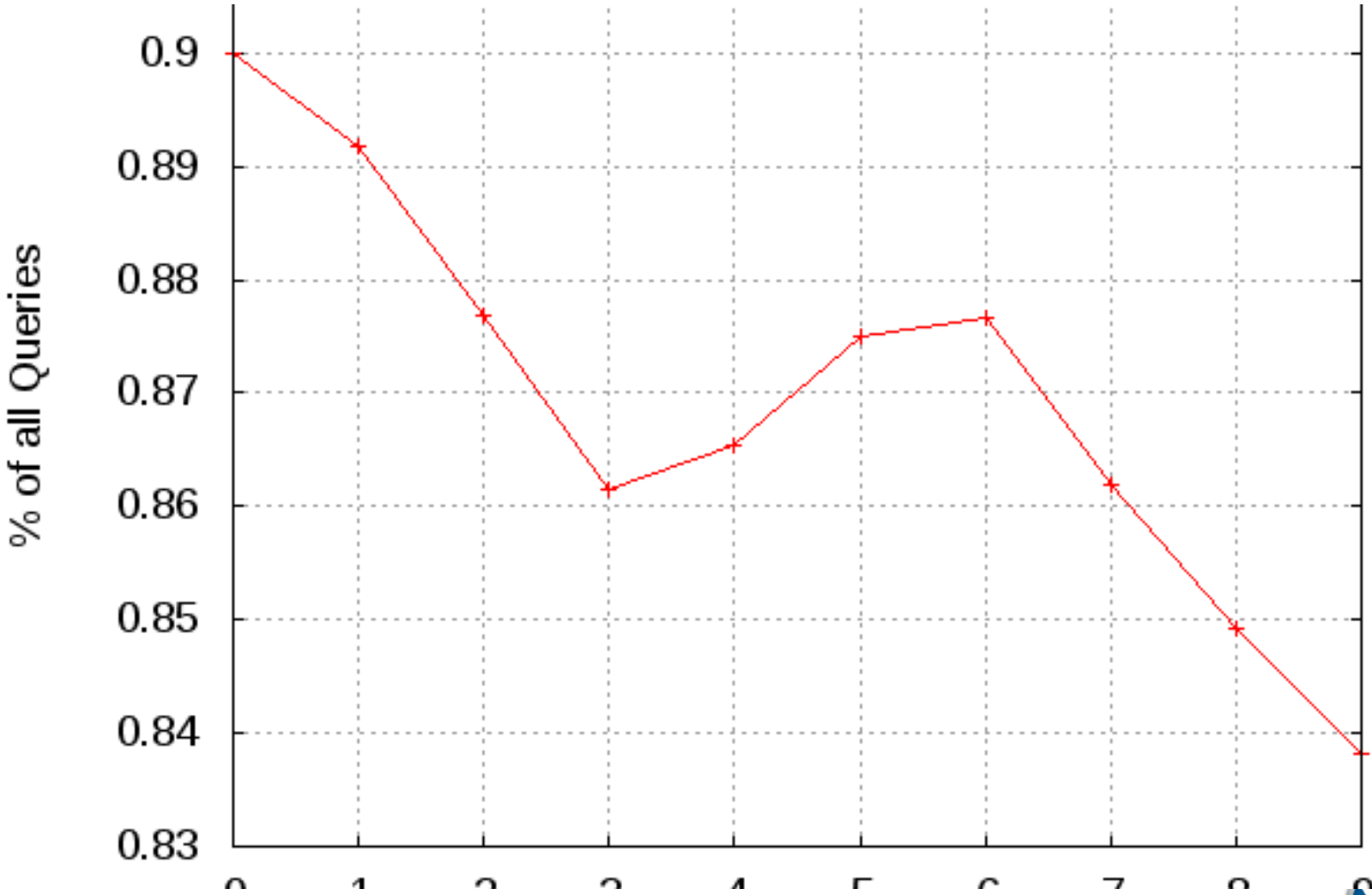
Rolling top talkers



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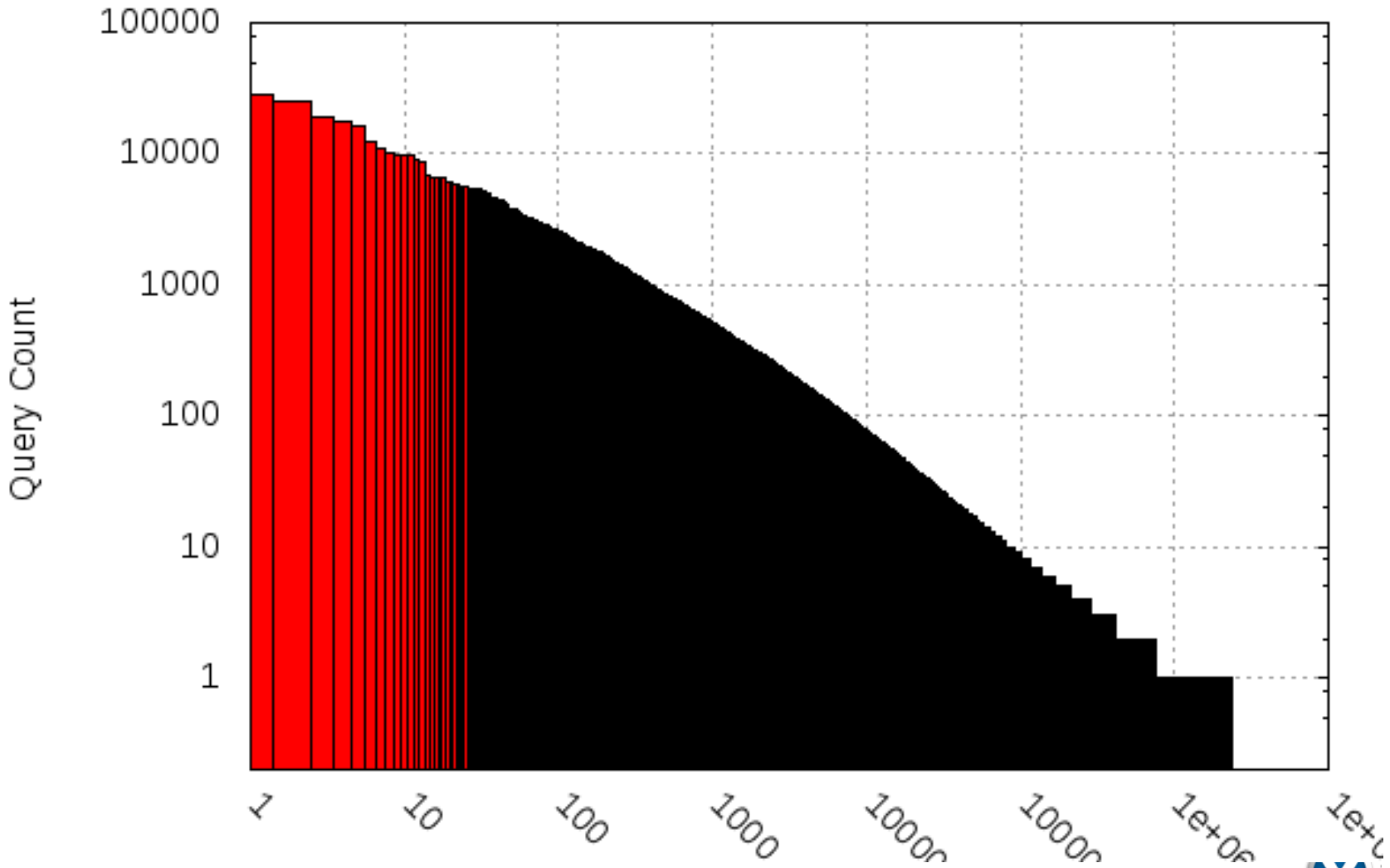
Qname distribution



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