Internet Protocols
Laboratory

Another Man's Treasure:
Security and Privacy Risks of Junk DNS Queries

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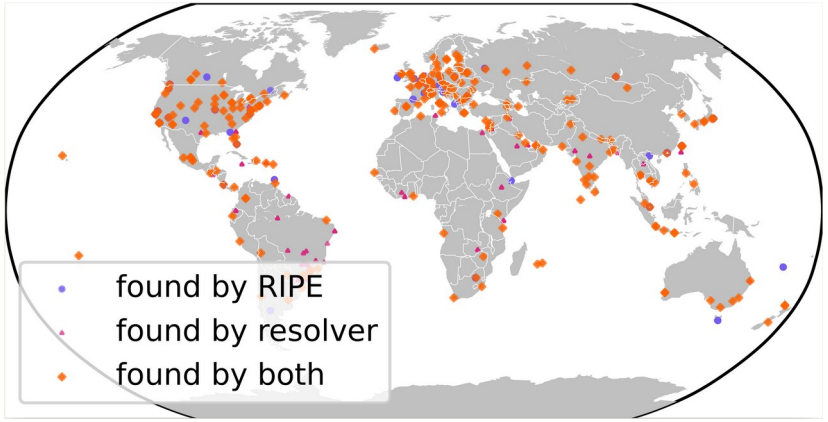
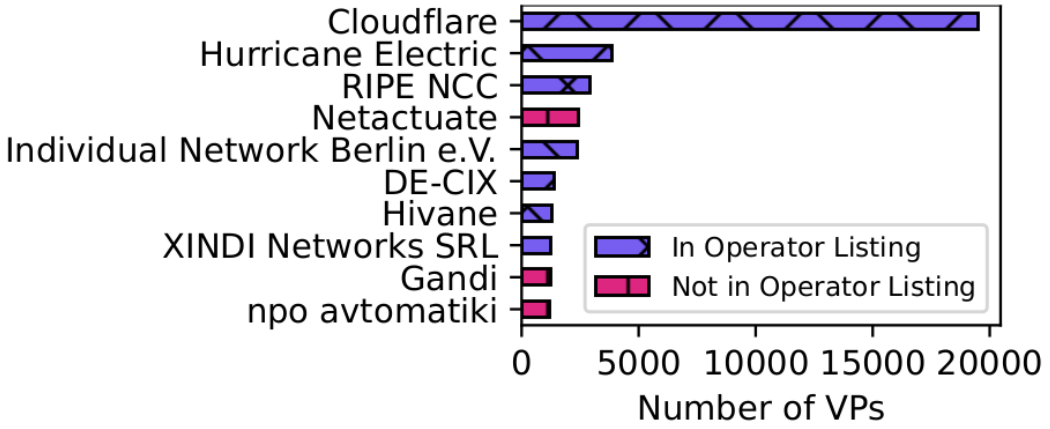
What is AS112?

- **Junk queries:** queries with no meaningful response, e.g. reverse DNS queries for private addresses
- **AS112:** anycast DNS deployment that captures junk queries
  - Diverts them from `.arpa/in-addr.arpa` nameservers
  - Responds with NXDOMAIN
  - Nameserver for reverse mappings of RFC1918 private addresses and link-local IPv4 addresses, `home.arpa` and `service.arpa`
    - Reverse mapping: 203.0.113.23 → 23.113.0.203.in-addr.arpa
    - Reverse DNS (rDNS) query: PTR query for the reverse mapping

Who runs AS112?

- Volunteer-run network
  - **Anyone** can add a site! Loosely coordinated by DNS-OARC
- We found **469 AS112 sites**, run by **97 operators**
  - **Cloudflare:** 216 sites
- More on this work at RIPE DNS-WG





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What queries go to AS112?

- AS112 is volunteer-run and uncoordinated
- Relies on **assumption** that AS112 traffic is harmless
- Our questions:
  - **What queries** are sent to AS112?
  - What could a **malicious operator** do with these queries?
- **Work in progress**, these are preliminary results

Our Dataset

- DNS-OARC Day in The Life 2025 data (8-10 April 2025)
  - **RIPE NCC site (Amsterdam): ~**542M requests, ~246K clients
  - **WIDE site (Osaka):** 2,252M requests, ~145K clients
  - **TIX site (Dar es Salaam): ~**4M requests, ~2K clients
  - In total: **2,799,058,875 requests, 393,183 clients**
- We found:
  - Reverse DNS queries
  - DNS Dynamic updates
  - Service Discovery queries
  - Lame-delegated queries

RFC1918 Reverse Mapping Queries

- Most requests are for **reverse mappings of RFC1918 private addresses**
  - **37.62%** PTR (rDNS) queries for RFC1918 addresses
  - **27.09%** are other queries for RFC1918 reverse mappings (excluding service queries)
    - **33.8%** other query types (e.g. A, SOA, NS)
    - **50.04%** of form _.1.0.168.192.in-addr.arpa (malformed service query?)
    - Queries for personal devices, **9.69%** contain substring “iphone”

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DNS Dynamic Updates

- DNS Dynamic updates change contents of zone, e.g. used by DHCP
- Sent to AS112 if:
  - Host uses private IP address, updates its reverse mapping
  - Local DNS doesn’t serve the reverse mapping zone
- Studied in 2003 and 2006 [1,2]
- **5.80%** of requests are dynamic updates
  - Plus 0.57% TKEY queries to secure updates
- Malicious AS112 operator could learn local network configuration, and track individual users

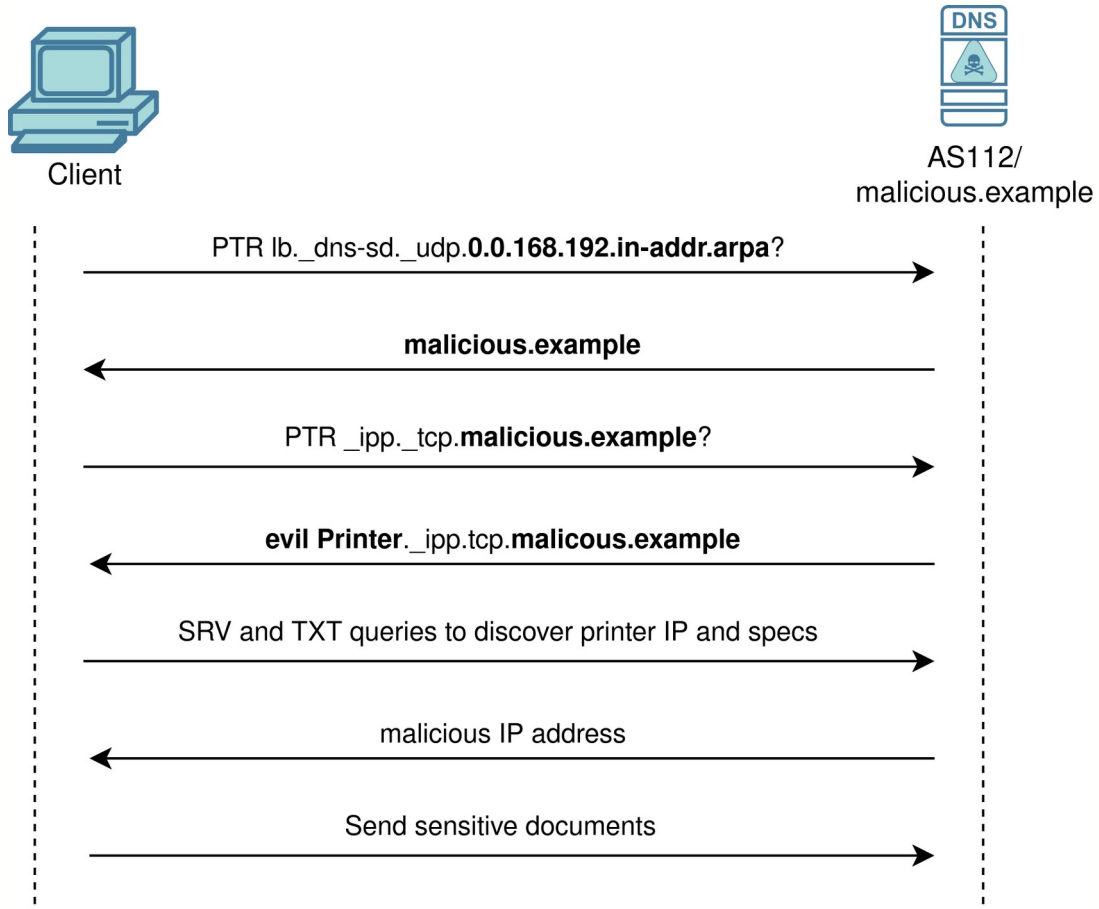
[1] [1] Broido, A., Nemeth, E. and claffy, kc 2003. Spectroscopy of private DNS update sources. Proceedings the Third IEEE Workshop on Internet Applications. WIAPP 2003 (Jun. 2003), 19–29.
[2] [1] Broido, A., Shang, H., Fomenkov, M., Hyun, Y. and Claffy, K.C. 2006. The Windows of Private DNS Updates. ACM SIGCOMM Computer Communication Review. 36, 3 (2006).

Service Discovery Queries and Service Queries (1/3)

- Interaction between AS112 and DNS-Based Service Discovery
  - Client discovers services by sending SRV/TXT queries of the form `_<service name>._<protocol>.`**`<local domain>`** to the local DNS
    - e.g. `_ipp._udp.example.com`
  - Client has to first discover the **`<local domain>`**, through PTR queries of the form `lb._dns-sd._udp.`**`<bootstrap domain>`**
  - This bootstrap domain can be the reverse mapping of the local address
    - Queries go to AS112 if local address is RFC1918 private address, and local DNS does not serve this zone!

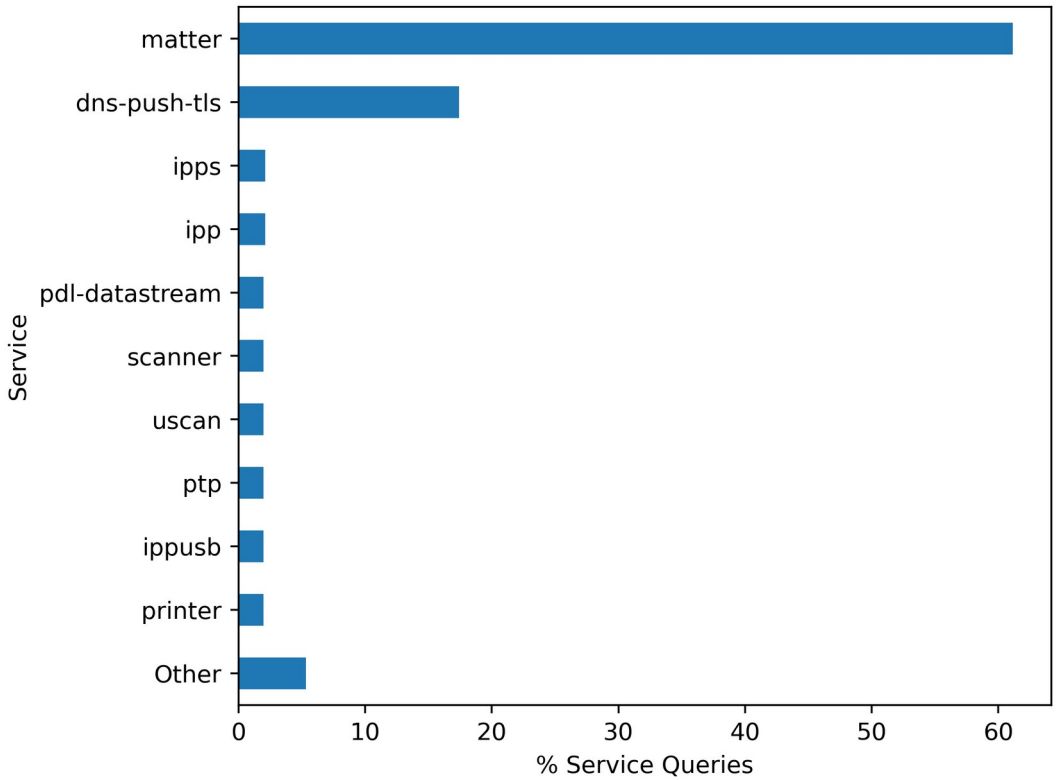
Service Discovery Queries and Service Queries (2/3)

- **18.17%** of requests are Service Discovery Queries
- Malicious attacker could misuse these queries to spoof the service
  - Return a bogus local domain, then return bogus IP address for the service
  - Fails if service is authenticated



Service Discovery Queries and Service Queries (3/3)

- **6.71%** of requests contain a service name
  - 320 services
  - “matter” was the most common (61.13%)
- Can be used to spoof local services if service is not authenticated



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Lame-delegated Queries

- 0.35% of requests are for domains not delegated to AS112, with public TLDs
- Malicious operator could respond and **spoof the site**
  - 38,447 domains; 43% of queries are for strepsils[.]top (malware/phishing domain!)
- Why are these queries going to AS112?
  - Analysed historical zone files and WHOIS for ~20k domains (from VirusTotal and DNS Coffee)
    - ~95% were **delegated to AS112** in the zone files (lame delegation)
    - Of these, ~75% use the same registrar (Hosting Concepts B.V.), 24.90% contain “bet|poker|gambl|win|slot|casino|kasino”
- Has anyone heard of this?

Conclusions

- ~2.8B queries from three AS112 sites
  - Found dynamic updates, service queries and lame delegated queries
- AS112 does not only receive “harmless” reverse DNS queries

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