DISSECTING DNS STAKEHOLDERS IN MOBILE NETWORKS

Mario Almeida, Alessandro Finamore, Diego Perino, Narseo Vallina-Rodriguez, Matteo Varvello
WHY TO STUDY DNS IN MOBILE NETWORKS?

- Complex scenario as domain owners, operators, app developers, and OSes operate autonomously

- DNS is prominent in mobile traffic, up to 50% of all flows [1]

- Performance wise, only query resolution time level has been considered [2,3]

[1] “Application Bandwidth and Flow Rates from 3 Trillion Flows Across 45 Carrier Networks” PAM’17
[3] “Behind the Curtain: Cellular DNS and Content Replica Selection” IMC’14
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QUESTIONS

- Who is responsible for all this traffic?
- Is it really needed?
- What is the role of DNS on users QoE?

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MOBILE NETWORKS DNS STAKEHOLDERS

STAKEHOLDERS

Domain owners & CDNs

- ADNS
  Authoritative DNS resolver

MNOs

- LDNS
  Local recursive DNS resolver

Developers & OSes

- cDNS
  On-device client DNS resolver

DNS COMPONENT

FUNCTION

Domain properties propagation

Control domain properties:
- domain-to-IPs mapping
- time to live (TTL)

Handle devices queries:
- Serves cached ADNS data
- Recursively query ADNS
- Can overwrite ADNS data (TTL violations)

Local cache:
- Controlled by the OS
- Developers can bypass it using raw sockets
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Mobile Network Operators

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Domain properties propagation

EACH STAKEHOLDER PLAYS AN IMPORTANT ROLE
DATASETS
**DATASETS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Dur</th>
<th>Apps</th>
<th>User Domains</th>
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<tbody>
<tr>
<td>MNO</td>
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<td>198M</td>
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Top-1M to compare popul.

20k apps for static analysis
ANALYSIS ROADMAP

Domains Footprint
- What are the relevant domains?
- What the role of the OS?
- What the role of Apps?

Domain Properties
- Original values at the ADNS
- How LDNS cache/mingle those properties
- On-device caching performance

Configs & Apps Design
- Are explicit proxies widely adopted?
- Are developers using OS configurations?

Impact on QoE
- DNS impact on webpage page load time (PLT)
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DOMAINS FOOTPRINT: FOCUS ON POPULAR DOMAINS

- 198M domains in MNO dataset, but top-10k most popular generate 87% flows
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POPULAR DOMAINS

DRIVE FLOWS COUNT
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POPULAR DOMAINS

DRIVE FLOWS COUNT

BECAUSE THEY ARE ALSO COMMON ACROSS APPS
DOMAINS FOOTPRINT: FOCUS ON UNPOPULAR DOMAINS

- Out of 198M, 162M (82%) domains are used only once in 1 month
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**UNPOPULAR DOMAINS ➔ EPHEMERAL**

Example: `d-2294771243204135673.ampproject.net`

**TRACKING/PERSOANLIZATION INTRODUCES OVERHEAD**

5 services handle 80% of ephemeral domains
TTL POLICIES ARE AGGRESSIVE

- 50% of domains have TTL < 60s
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Simulation based on domains requested more than once
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DNS IMPACT ON WEBPAGES PLT

- Consider top-1k Alexa pages, and measure DNS latency over the critical path (i.e., content downloaded entirely/partially in isolation)
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QUICK OVERVIEW OF OTHER RESULTS

- Alexa rank does not well intersect with the popular domains
- iOS and Android share popular domains, but iOS devices are more “chatty”
- Aggressive TTL values, but domains have <10 IPs over 1 month
- Almost no TTL violations found, but LDNS architecture can impact caching performance
- Explicit proxies are not widely adopted, nor developer bypass OS config
SO DNS HAS AN IMPACT
HOW DO WE REDUCE IT?
## Design Options

Ideally one would like not to have any DNS traffic.

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<th>Stakeholder</th>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>Explicit proxy</td>
<td>No</td>
<td>Operator</td>
<td>No DNS on radio access</td>
<td>From tests, reduces only 50% DNS latency on PLT</td>
</tr>
<tr>
<td>Domains pre-fetching</td>
<td>No</td>
<td>Developer</td>
<td>Lower latency</td>
<td>More DNS traffic</td>
</tr>
<tr>
<td>Domains pre-staging</td>
<td>-</td>
<td>OS/Operators</td>
<td>From tests, is the best performing</td>
<td>Complex to engineer</td>
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GOING BEYOND THIS PRELIMINARY WORK

What is the “PLT” of generic mobile apps traffic?

What is on the “critical path” beyond DNS?
THANK YOU!