Apps, Trackers, Privacy, and Regulators
A Global Study of the Mobile Tracking Ecosystem

Abbas Razaghpanah, Rishab Nithyanand, Narseo Vallina-Rodriguez, Srikanth Sundaresan, Mark Allman, Christian Kreibich, Phillipa Gill
Mobile tracking
Mobile tracking

OnePlus denies sending users' clipboard data to China

Jan 29, 2018  Eva Yoo

News
Mobile tracking

CVS Discretely Shares Your Location with 40+ Other Sites

Posted by Serge Egelman on August 25, 2017

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Recently, we decided to take a closer look at apps in our database that are sharing location data. This is a concern, because it could be used to track
Mobile tracking

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Why is this company tracking where you are on Thanksgiving?
A data collection service called SafeGraph collected 17 trillion location markers for 10 million smartphones during the holiday last year.
Privacy Policy

PLEASE NOTE THAT THIS PRIVACY POLICY APPLIES ONLY TO THOSE USERS OF THE SERVICES WHO ARE AGE 13 AND OLDER. SPECIAL PROCEDURES ARE USED WHEN COLLECTING INFORMATION FROM USERS UNDER THE AGE OF 13, WHICH ARE DISCUSSED IN THE “POLICIES REGARDING CHILDREN UNDER THE AGE OF 13” SECTION BELOW.

Privacy Policy

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We have the right to amend this Privacy Policy from time to time. Use of your information we collect now is subject to the Privacy Policy in effect at the time such information is used. Whenever you use our sites or the Services, please check this Privacy Policy to make sure that you are aware of any amendments in our privacy practices. The date our Privacy Policy was last updated will be displayed therein. We will post a revised policy on our sites and/or mobile products to inform you and other users if we make any material revisions to this Privacy Policy. You understand that you accept the amendments to our Privacy Policy by continuously using our sites or the Services.
More than meets the eye

- 90% of mobile apps are free, many are monetized using ads
- Apps use 3rd-party services to collect tracking data and display ads
  - **Advertising and Tracking Services (ATS, for short)**
  - Not visible to the users
  - Data sharing policies are unknown to the users and researchers
- No complete study of mobile tracking and advertising ecosystem
More than meets the eye

- 90% of mobile apps are free, many are monetized using ads
- Apps use 3rd-party services to collect tracking data and display ads
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We aim to bring transparency to this ecosystem.
Questions to answer
Questions to answer

1. What are the domains associated with 3rd-party ATSes used by mobile apps?
Questions to answer

1. What are the domains associated with 3rd-party ATSes used by mobile apps?

2. Who are the parent organizations of these mobile ATSes?

- verizon
- Alphabet
- Facebook
- Crashlytics
- Flurry
- doubleclick by Google
- Google AdWords
- WWW
Questions to answer

1. What are the domains associated with 3rd-party ATSes used by mobile apps?

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3. Which mobile ATSes are capable of cross-device tracking?
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1. What are the domains associated with 3rd-party ATSes used by mobile apps?
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3. Which mobile ATSes are capable of cross-device tracking?
4. What do their privacy policies look like?

Verizon
Alphabet
Facebook
Crashlytics
Flurry
doubleclick by Google
Google AdWords
Existing datasets are incomplete and/or inaccurate

<table>
<thead>
<tr>
<th>McAfee Trusted Source</th>
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</thead>
<tbody>
<tr>
<td><strong>URL</strong></td>
</tr>
<tr>
<td><a href="http://flurry.com">http://flurry.com</a></td>
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<tr>
<td><a href="http://cloudflare.com">http://cloudflare.com</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AdBlock Plus (EasyList)</th>
</tr>
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<tr>
<th>OpenDNS Domain Tagging</th>
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Questions to answer

1. What are the domains associated with 3rd-party ATSes used by mobile apps?
Lumen Dataset
Lumen Dataset

12,000 users
Lumen Dataset

12,000 users

14,000 apps\(^1\)

\(^1\) 48% of apps have at least 1M installs
Lumen Dataset

12,000 users

14,000 apps[1]

40,000 domains[2]

[1] 48% of apps have at least 1M installs
[2] Top-10K domains are found on iOS traffic and account for 65% of total monthly traffic on a EU MNO
Lumen Dataset

12,000 users

14,000 apps[1]

8.5M flows

40,000 domains[2]

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How we identified advertising and tracking services

App-domain flows → Third-party identifier → ATS domain classifier

APP
APP
APP
APP
Identifying 3rd-Party Services
Identifying 3rd-Party Services

Step 1: Distinguish between 1st-party domains and 3rd-party ones

- com.accuweather.android
- com.spotify.music
- com.facebook.katana
- com.htc.sense.hsp

**.accuweather.com**
- Issued by: DigiCert SHA2 Secure
- Expires: Sunday, August 25, 2019
- Daylight Time
- This certificate is valid

**.facebook.com**
- Issued by: DigiCert SHA2 High
- Expires: Friday, March 22, 2021
  - Subject Name: Facebook, Inc.
  - Country: US
  - State/Province: California
  - Locality: Menlo Park
  - Organization: Facebook, Inc.
Identifying 3rd-Party Services

Step 2: Separate ATS and ATS-Capable domains from other 3rd-party services using ML

- accuweather.com
- com.accuweather.android
- com.facebook.katana
- com.spotify.music
- com.htc.sense.hsp
- scorecardresearch.com
- graph.facebook.com
- crashlytics.com

ATS
ATS
ATS
## ATses discovered

<table>
<thead>
<tr>
<th>Domains</th>
<th>3rd-party domains</th>
<th>ATS second-level domains</th>
<th>ATS-Capable second-level domains</th>
</tr>
</thead>
<tbody>
<tr>
<td>40,553</td>
<td>8,099</td>
<td>2,121</td>
<td>730</td>
</tr>
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</table>
# ATSes discovered

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</table>

## Coverage

<table>
<thead>
<tr>
<th>Coverage</th>
<th>EasyList</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>38%</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>hpHosts</td>
<td>77%</td>
<td>35%</td>
<td></td>
</tr>
</tbody>
</table>
Identifying 3rd-Party Services

Step 2: Separate ATS domains from other 3rd-party services using ML

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- com.accuweather.android
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- crashlytics.com

ATS
ATS
ATS
Questions to answer

2. Who are the parent organizations of these mobile ATSes?
Identifying Parent Companies

tracker.com → HOOVERS → Tracker and Sons ®
ATS parent companies

• 292 parent orgs. own nearly 2,000 ATSes

• As expected, big companies dominate, but…
ATS parent companies

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#1 Alphabet  #4 verizon

doubleclick by Google  AdWords
ATS parent companies

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Aol.
ATS parent companies

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#1 Alphabet
#4 Verizon

doubleclick by Google
Google AdWords
Aol.
Yahoo!
ATS parent companies

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#1 **Alphabet**

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**doubleclick**

**Aol.**  **YAHOO!**
ATS parent companies

• 292 parent orgs. own nearly 2,000 ATses

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Crashlytics

doubleclick
by Google

Google AdWords

Aol.

Flurry

YAHOO!
Questions to answer

1. Which mobile ATSes are capable of cross-device tracking?
Cross-device Tracking

```javascript
function() {
  try {
    var a = e.document.querySelector("script[nonce]"),
        b = a_nonce || a.getAttribute("nonce"),
        c = b && oa.test(b),
        d = void 0;
    return c;
  } catch (d) {};
}

var r = function() {
  return e.googletag || (e.googletag = {});
}

var u = {
  1: "pagead2.google syndication.com",
  2: "pubads.g.doubleclick.net",
  3: "securepubads.g.doubleclick.net",
  173: "pubads.g.doubleclick.net",
  174: "securepubads.g.doubleclick.net",
  7: .02,
  13: 1500,
  23: .001,
  24: 200,
  27: .01,
  29: .01,
  33: "pagead2.google syndication.com",
  37: .01,
  38: .04,
```
Cross-device Tracking

• 15 out of top 20 parent organizations are also present in popular websites

• Cross-device tracking is already the norm!

• Users don’t know their activities can be tracked across devices
Questions to answer

4 What do their privacy policies look like?
# ATS Privacy Policies

<table>
<thead>
<tr>
<th>Company</th>
<th>Has ad subsidiaries?</th>
<th>Data sharing with subsidiaries?</th>
<th>Data sharing with 3rd-parties?</th>
<th>Opt-out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphabet</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Account settings</td>
</tr>
<tr>
<td>Facebook</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Account settings</td>
</tr>
<tr>
<td>Twitter</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Account settings / DAA</td>
</tr>
<tr>
<td>Verizon</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Account settings</td>
</tr>
<tr>
<td>AppsFlyer</td>
<td></td>
<td>✓</td>
<td></td>
<td>Email</td>
</tr>
<tr>
<td>ChartBoost</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>NAI/DAA webforms</td>
</tr>
<tr>
<td>Vungle</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Google ID Reset</td>
</tr>
<tr>
<td>AppLovin</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>TRUSTe/EU YOC</td>
</tr>
<tr>
<td>Adjust</td>
<td></td>
<td></td>
<td>✓</td>
<td>NAI webform</td>
</tr>
<tr>
<td>Alibaba</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Webform</td>
</tr>
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NAI: Network Advertising Initiative  
DAA: Digital Advertising Alliance
Trackers without borders
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Summary

- Identified 2,123 mobile ATSes using an automated mechanism to identify ATS domains, 233 of which were unreported by Web-based lists.

- Found mobile ATS presence in the Web to be pervasive.

- Identified 292 parent organizations running mobile ATSes.

- Top 10 parent companies allow either inter- or intra-organizational data sharing.

- Most mobile ATSes may be affected by proposed regulations in the EU.

arazaghpanah@cs.stonybrook.edu

haystack.mobi