

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



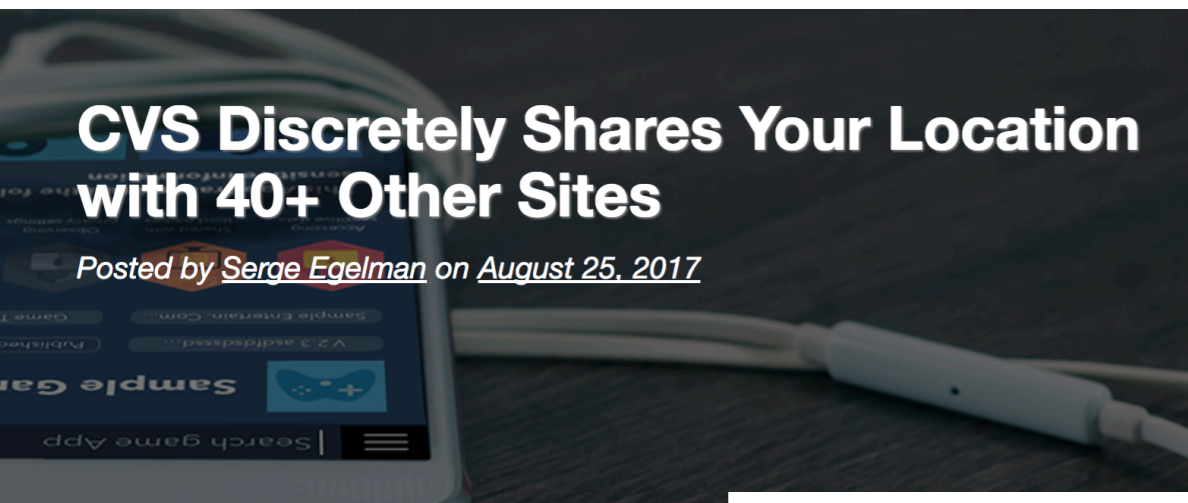
Mobile tracking



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



Recently, we decided to take a closer look at app sharing location data. This is a concern, because

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.





FIFA Soccer

Editors' Choice

ELECTRONIC ARTS Sports

★★★★★ 3,059,307

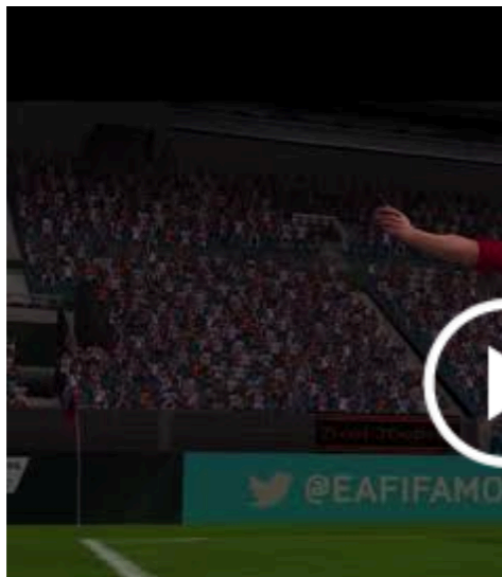
E Everyone

Offers in-app purchases

i This app is compatible with all of your devices.

Add to Wishlist

Install



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

Complete Star (HK) Limited designs, develops and publishes many social games for smartphones and mobile devices. Complete Star (HK) Limited, its subsidiaries, parent companies, affiliates, joint ventures and other corporate entities under common ownership (collectively, "we", "our", or "us") take our users' ("users" or "you") privacy rights seriously.

This Privacy Policy explains how we may collect, use, store, disclose and manage the personal information ("Personal Information") you provide to us when using, or about to using, any of our applications, games or software (collectively, the "Services"). Whenever you access or use our website and domain name, and any of the Services, you agree to allow us to collect, use, store, disclose and manage your Personal Information as explained in this Privacy Policy, and accept this Privacy Policy in registration or game installation.

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

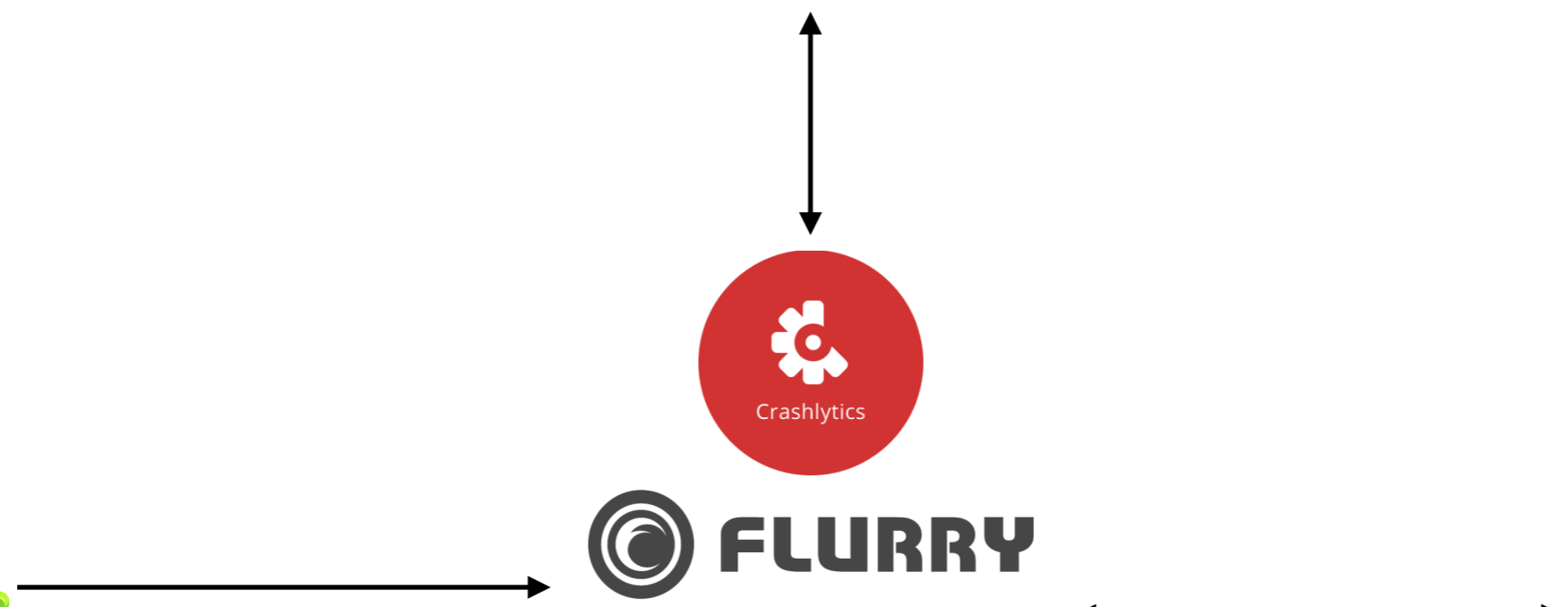
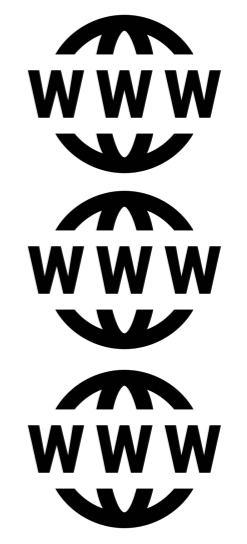
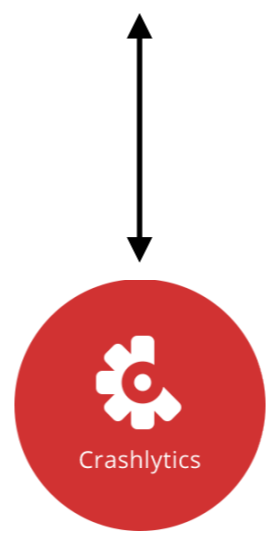
- 90% of mobile apps are free, many are monetized using ads
- Apps use 3rd-party services to collect tracking data and display ads
 - **Advertising and Tracking Services (ATS, for short)**
 - Not visible to the users
 - Data sharing policies are unknown to the users and researchers
- No complete study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

More than meets the eye

- 90% of mobile apps are free, many are monetized using ads
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 - **Advertising and Tracking Services (ATS, for short)**
 - Not visible to the users
 - Data sharing policies are unknown to the users and

We aim to bring transparency to this ecosystem.

Questions to answer

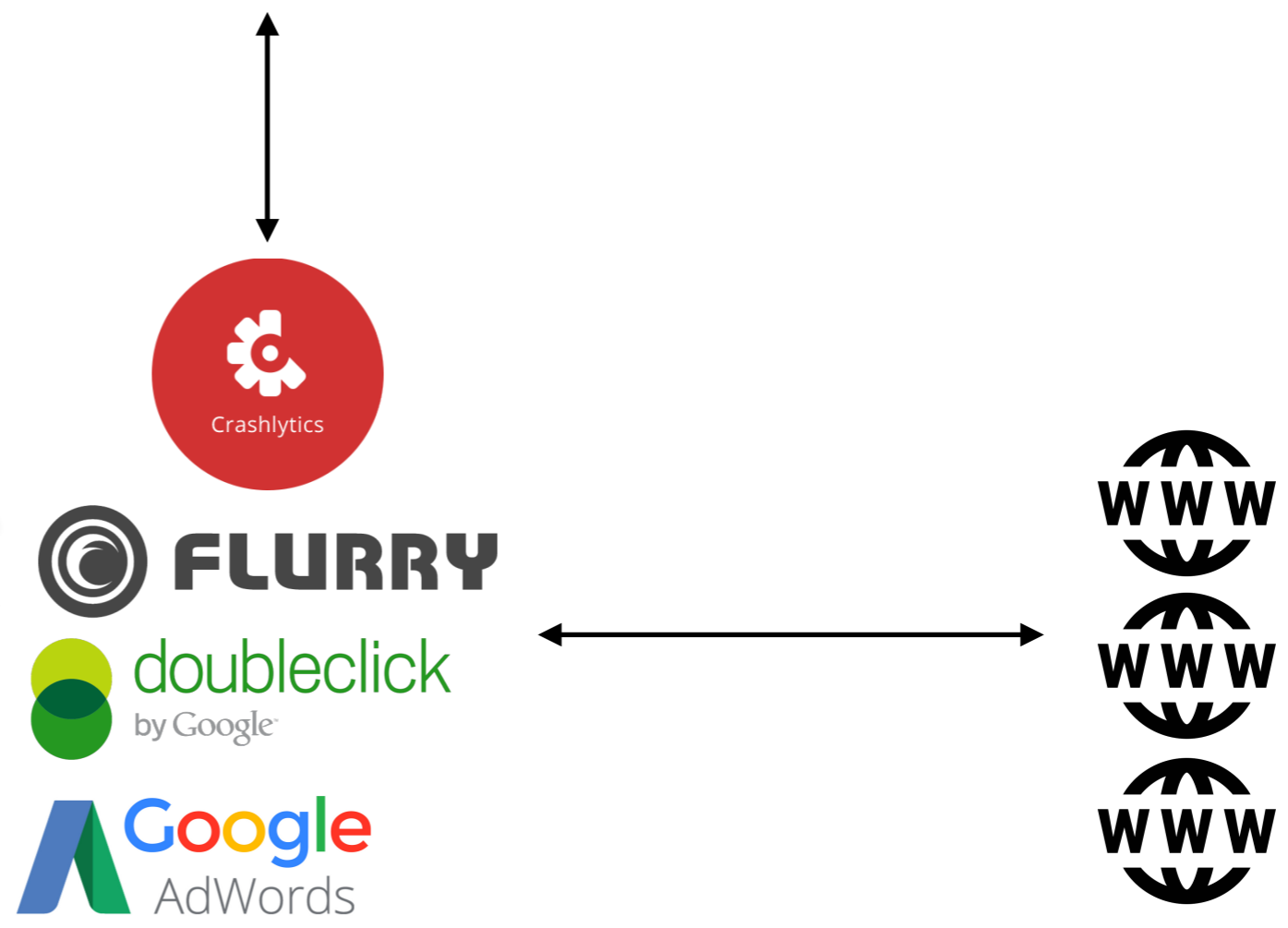


Questions to answer



1

What are the domains associated with 3rd-party ATSEs used by mobile apps?



Questions to answer

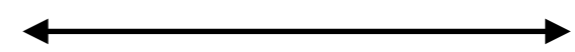
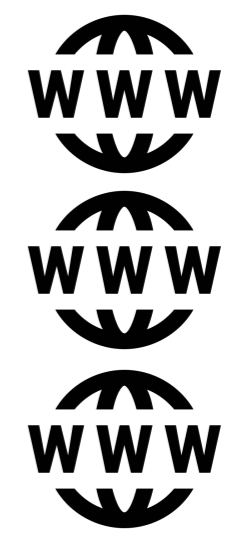
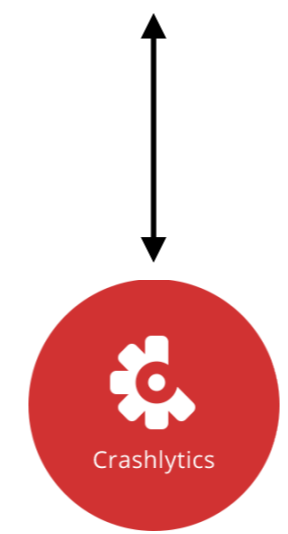
2

Who are the parent organizations of these mobile ATSeS?



1

What are the domains associated with 3rd-party ATSeS used by mobile apps?



Questions to answer

2

Who are the parent organizations of these mobile ATSeS?



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Which mobile ATSeS are capable of cross-device tracking?



Questions to answer

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Who are the parent organizations of these mobile ATSeS?



verizon^v Alphabet



4

What do their privacy policies look like?

1

What are the domains associated with 3rd-party ATSeS used by mobile apps?



3

Which mobile ATSeS are capable of cross-device tracking?



Existing datasets are incomplete and/or inaccurate

McAfee Trusted Source

URL	Category
http://flurry.com	Internet Services
http://cloudflare.com	Internet Services

AdBlock Plus (EasyList)

URL	Category
http://flurry.com	None
http://cloudflare.com	None

OpenDNS Domain Tagging

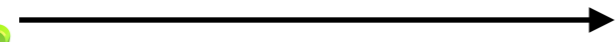
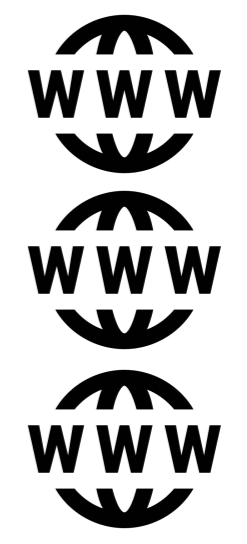
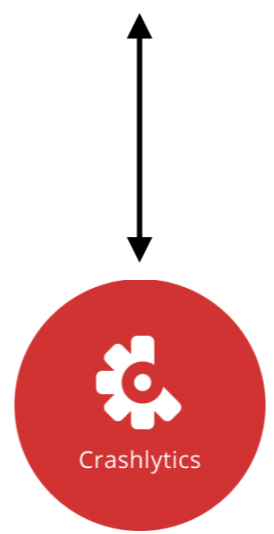
URL	Category
http://flurry.com	Software/Technology, Advertising, Business Services
http://cloudflare.com	Business Service

Questions to answer

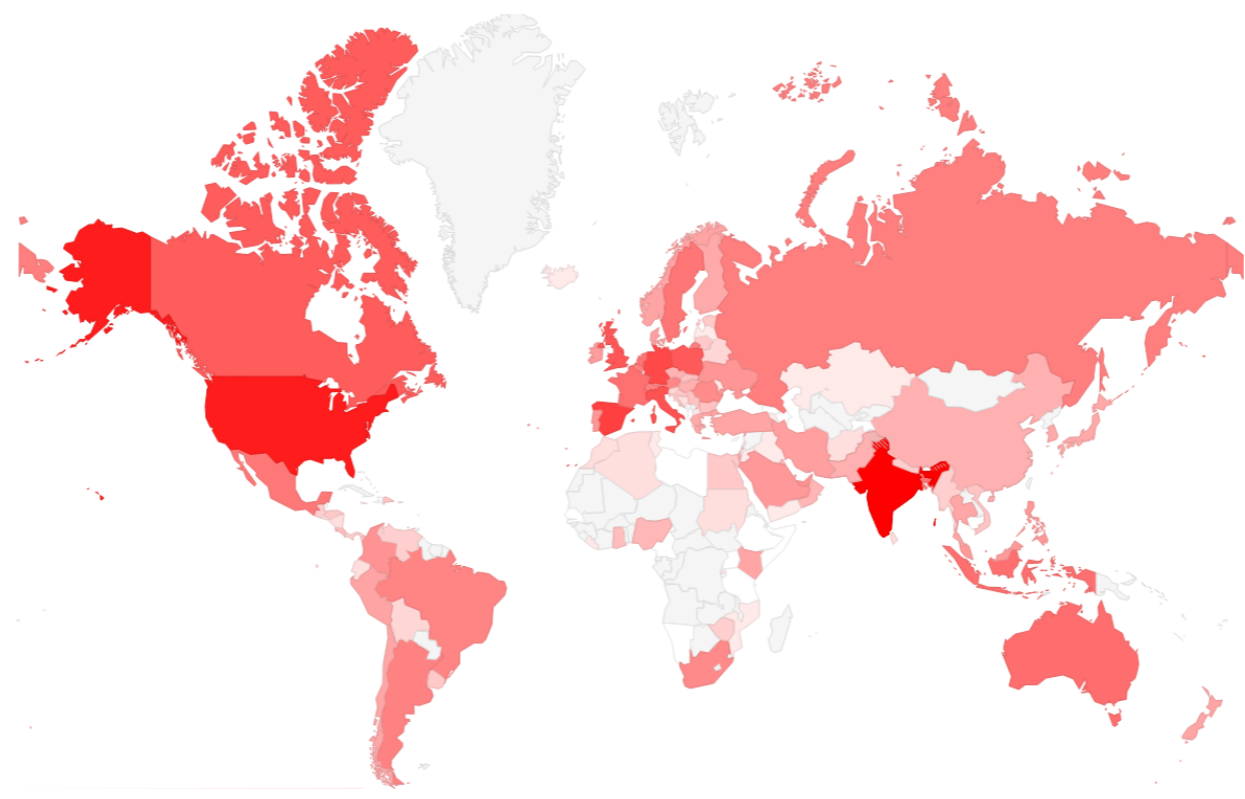


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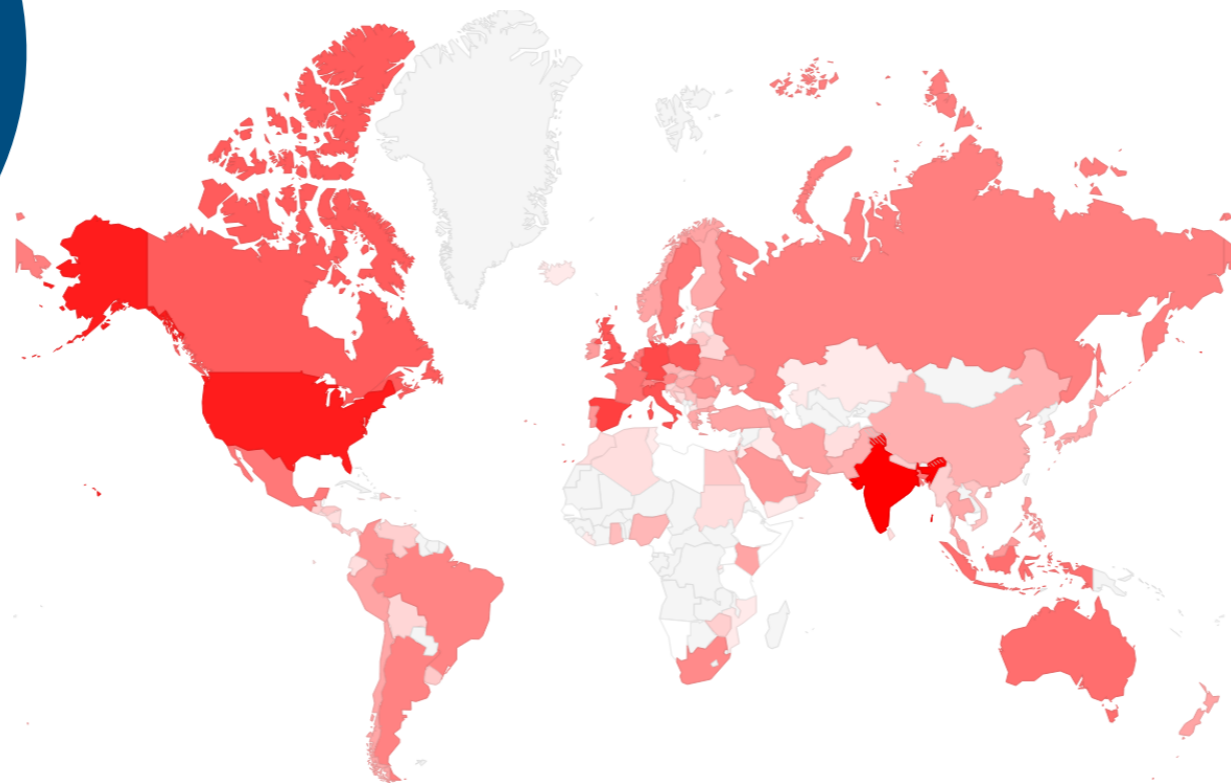


Lumen Dataset



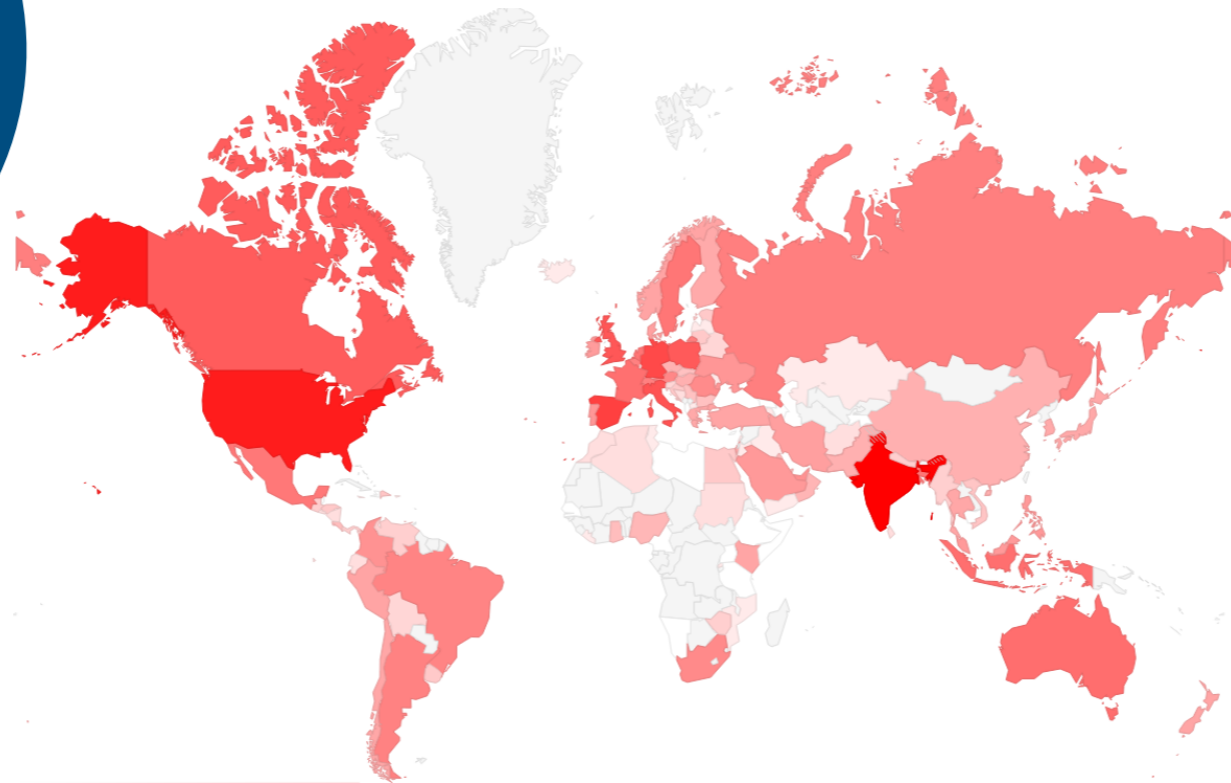
Lumen Dataset

12,000
users



Lumen Dataset

12,000
users

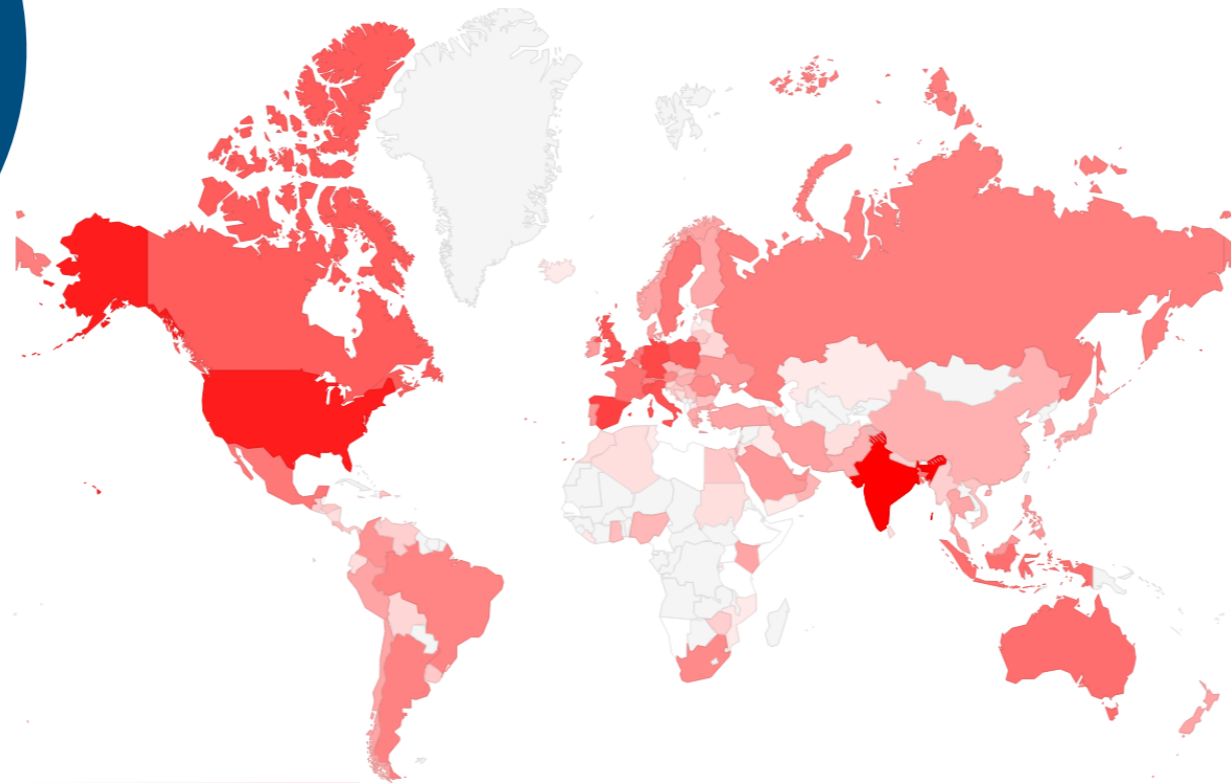


14,000
apps^[1]

[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

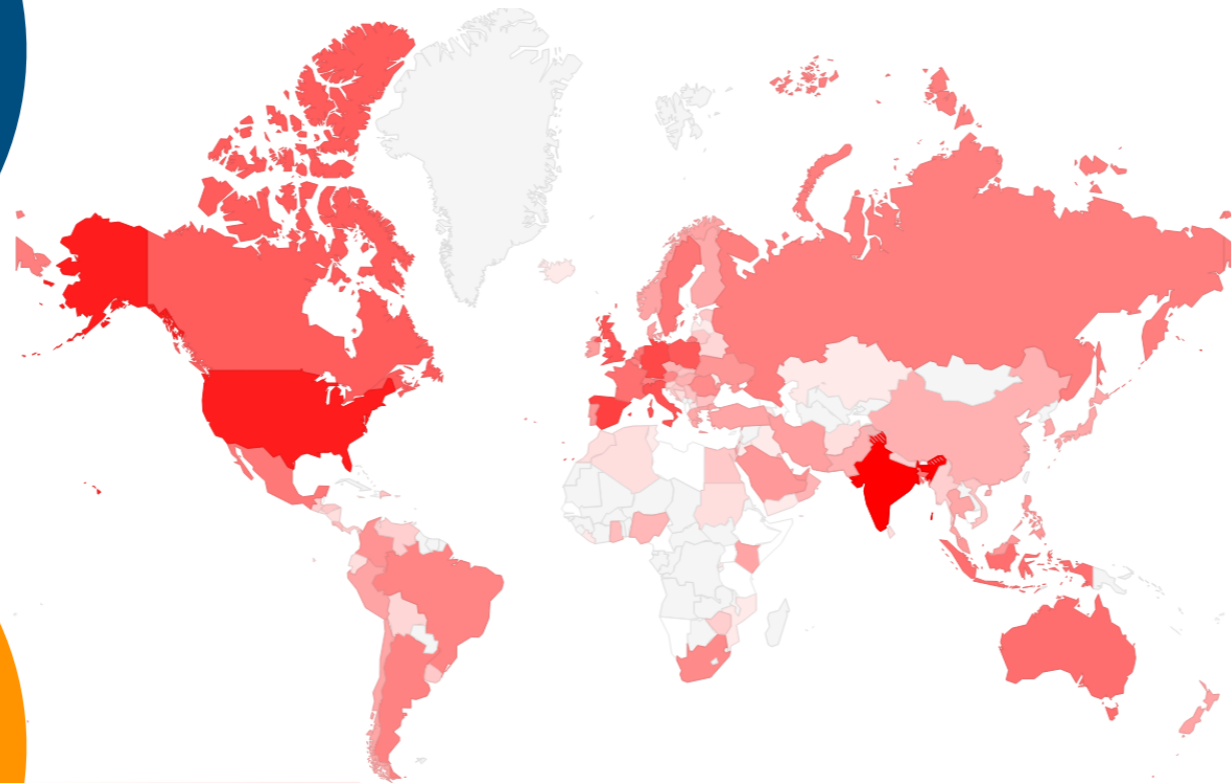
Lumen Dataset

12,000
users

14,000
apps^[1]

8.5M
flows

40,000
domains^[2]



[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 Privacy Monitor

Int. Computer Science Institute-UC Berkeley Tools

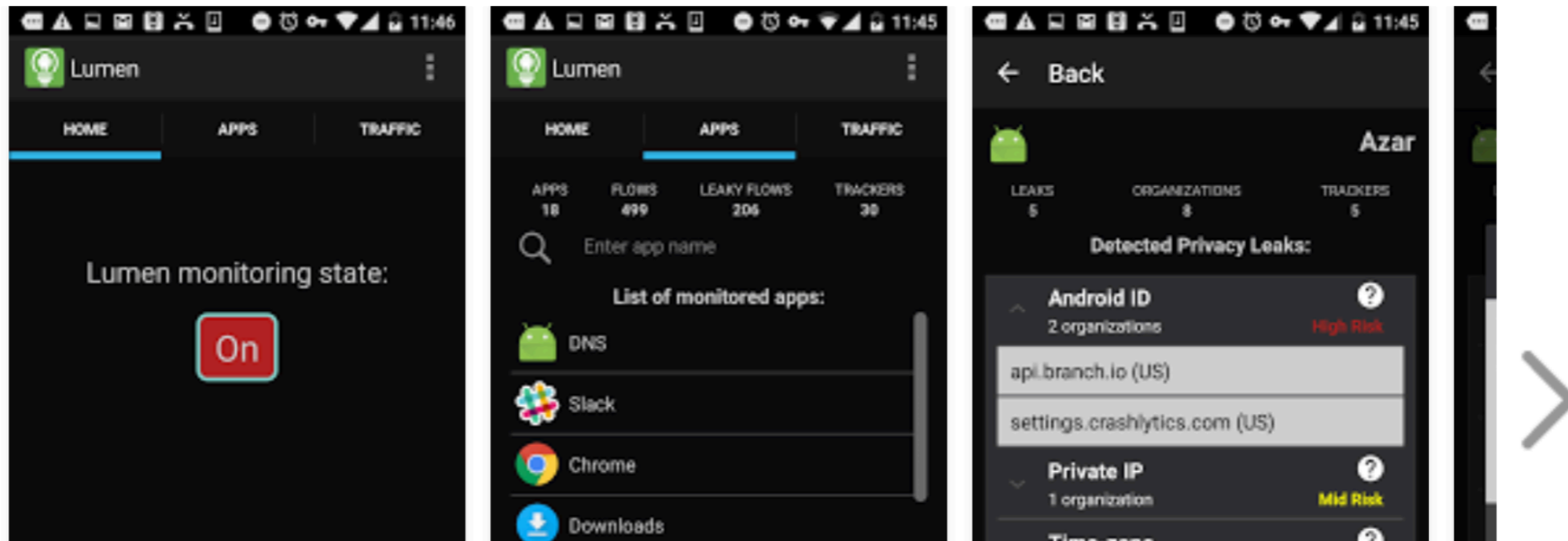
★★★★★ 85

E Everyone

i This app is compatible with all of your devices.

Add to Wishlist

Install

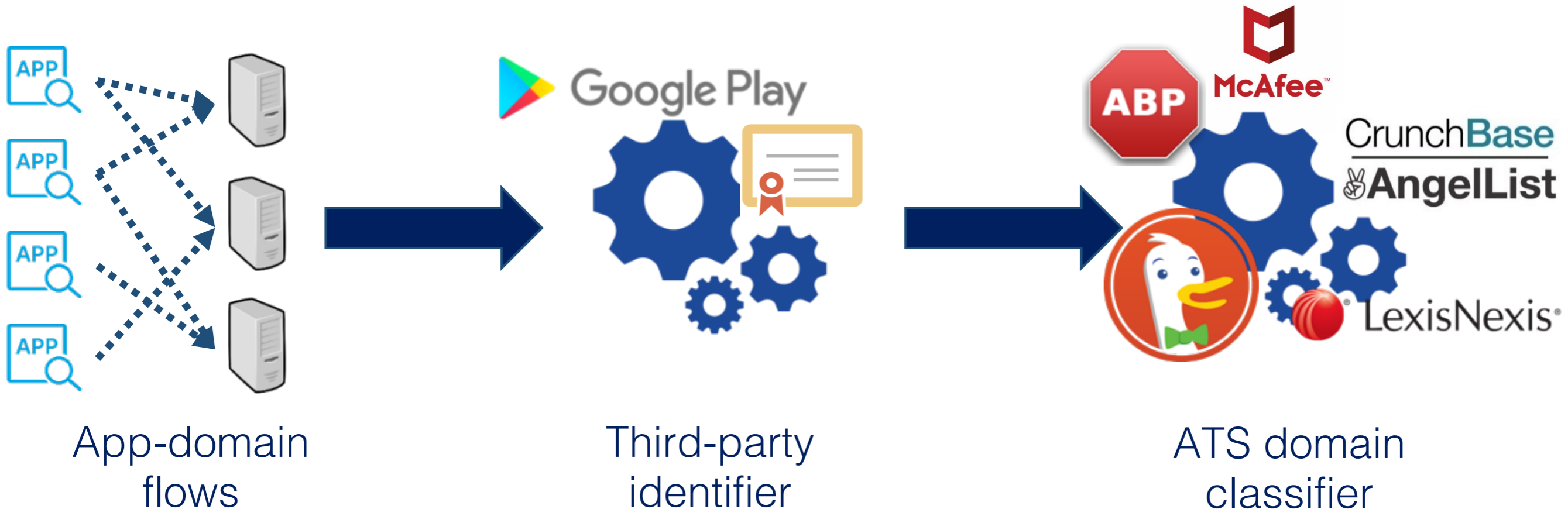


DATA
TRANSPARENCY
LAB

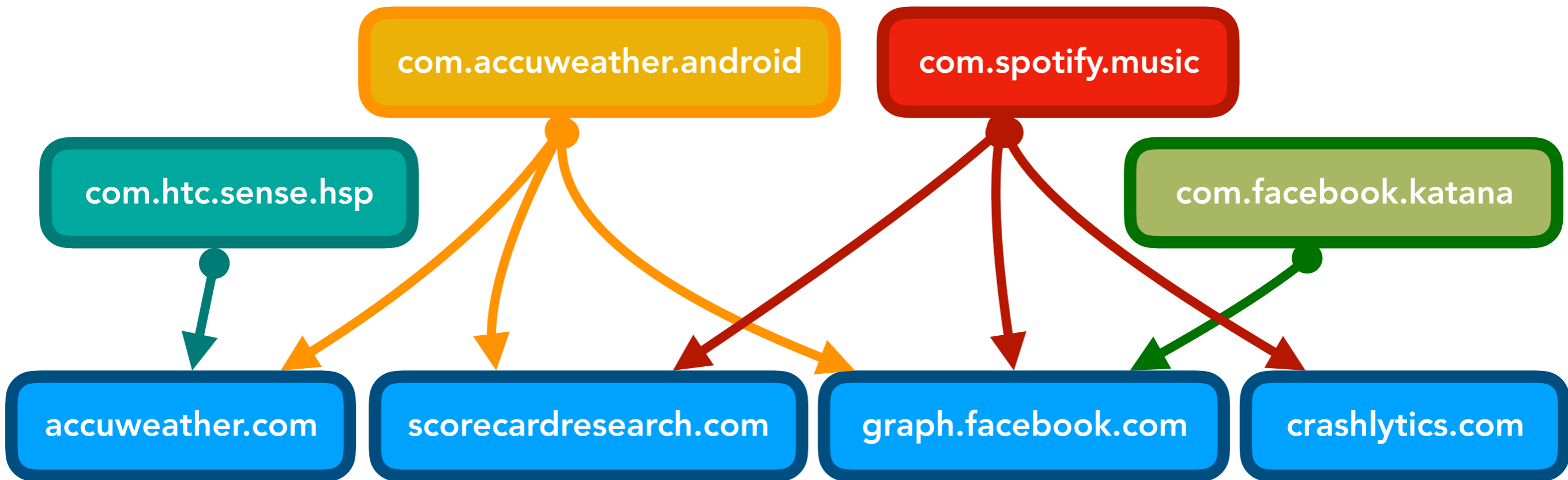


Funded by the Horizon 2020 Framework Programme of the European Union

How we identified advertising and tracking services

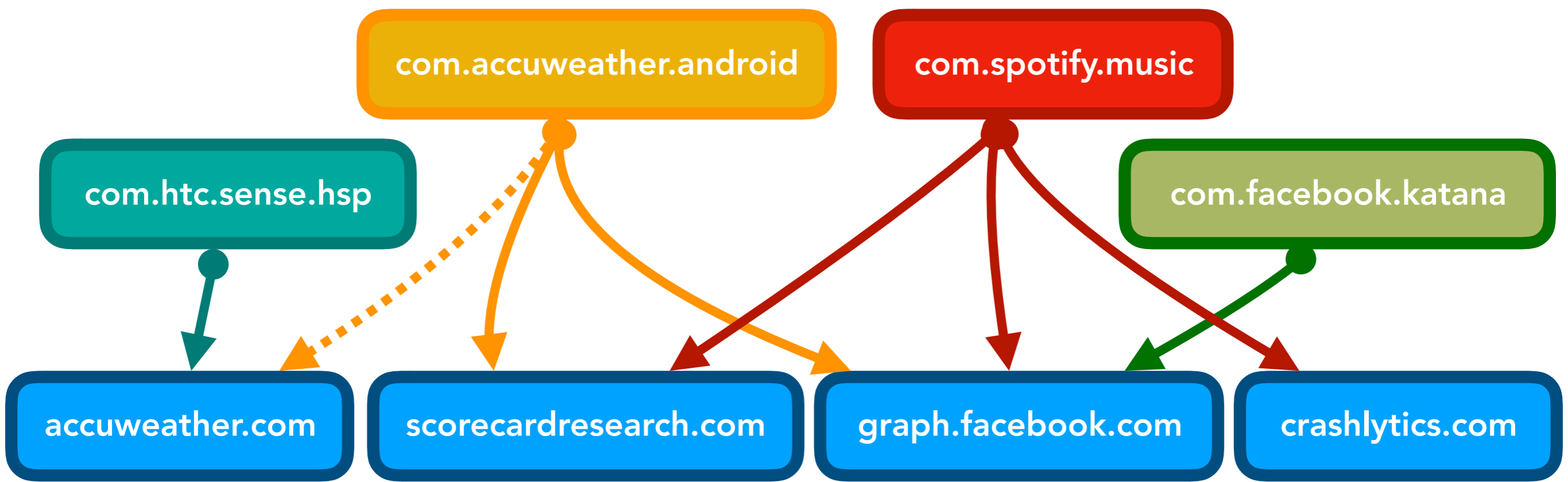


Identifying 3rd-Party Services



Identifying 3rd-Party Services

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



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

▼ Details

Subject Name	_____
Country	US
State/Province	Pennsylvania
Locality	State College
Organization	Accuweather, Inc.

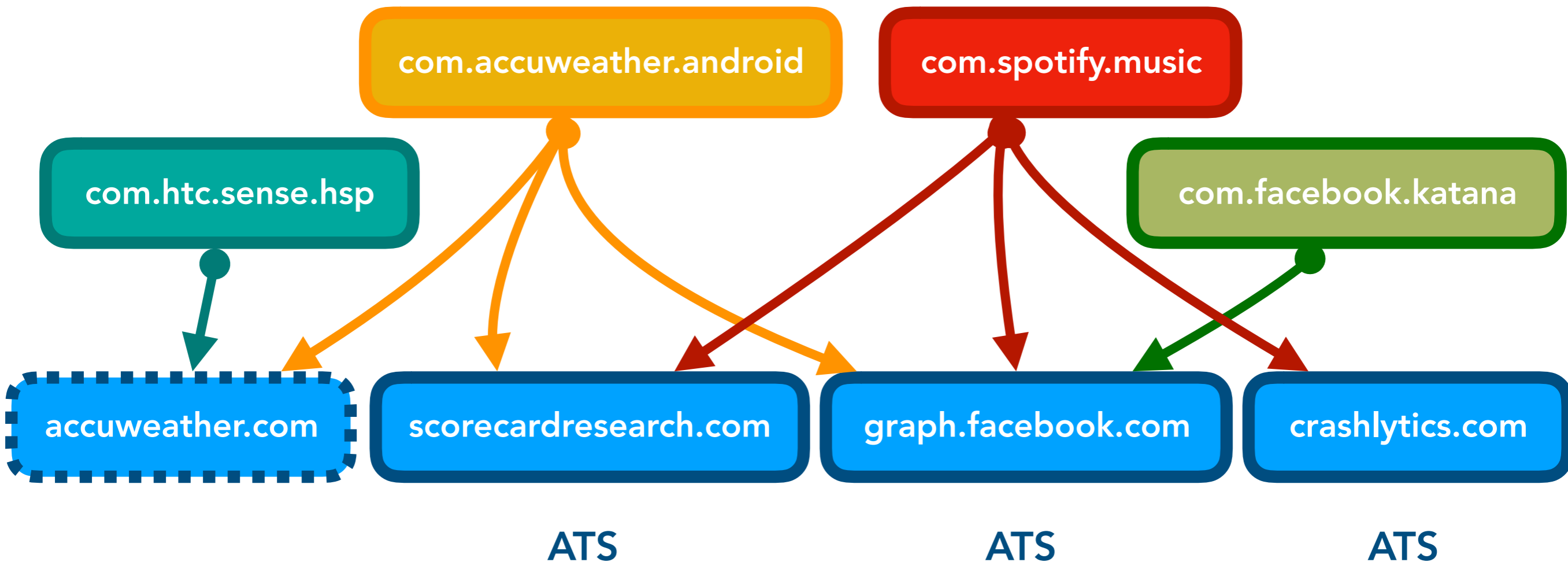
 ***.facebook.com**
Issued by: DigiCert SHA2 High
Expires: Friday, March 22, 201
✔ This certificate is valid

▼ Details

Subject Name	_____
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



ATSeS discovered

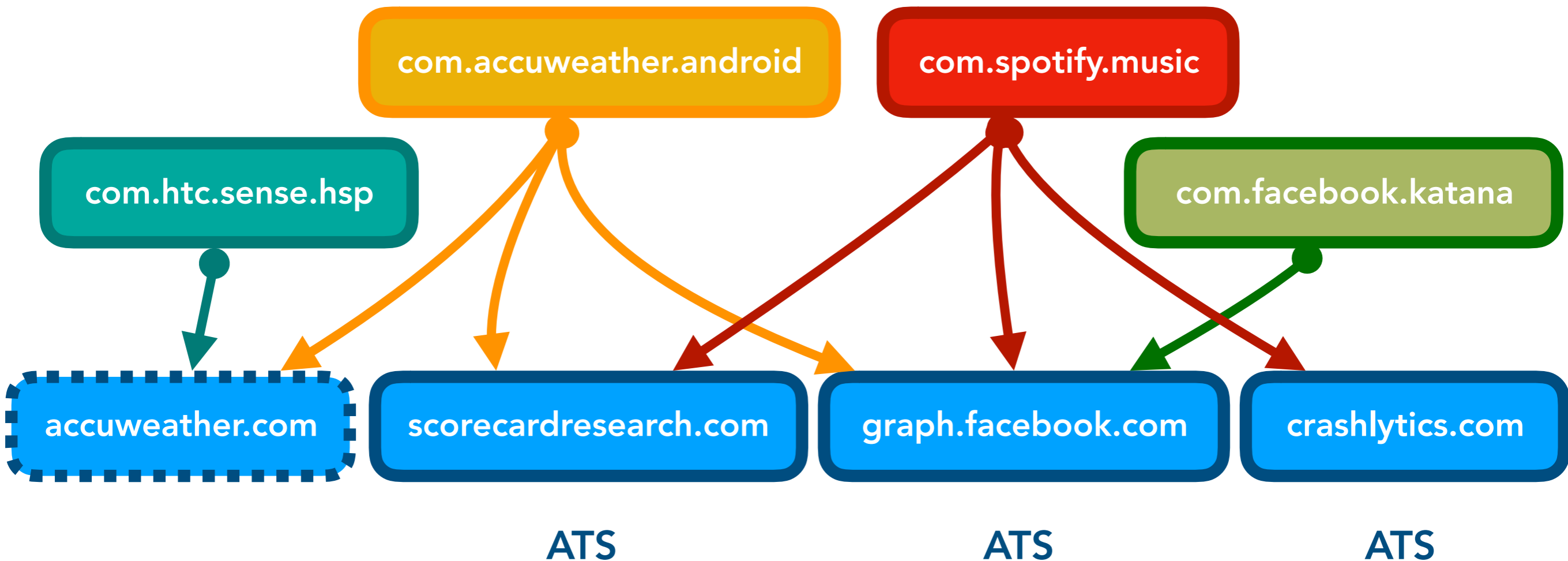
Domains	3rd-party domains	ATS second-level domains	ATS-Capable second-level domains
40,553	8,099	2,121	730

ATSeS discovered

Domains	3rd-party domains	ATS second-level domains	ATS-Capable second-level domains
40,553	8,099	2,121	730
Coverage	EasyList	38%	24%
	hpHosts	77%	35%

Identifying 3rd-Party Services

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



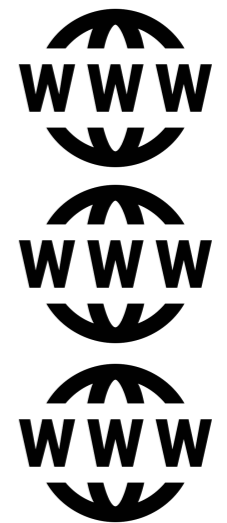
Questions to answer

2

Who are the parent organizations of these mobile ATSeS?

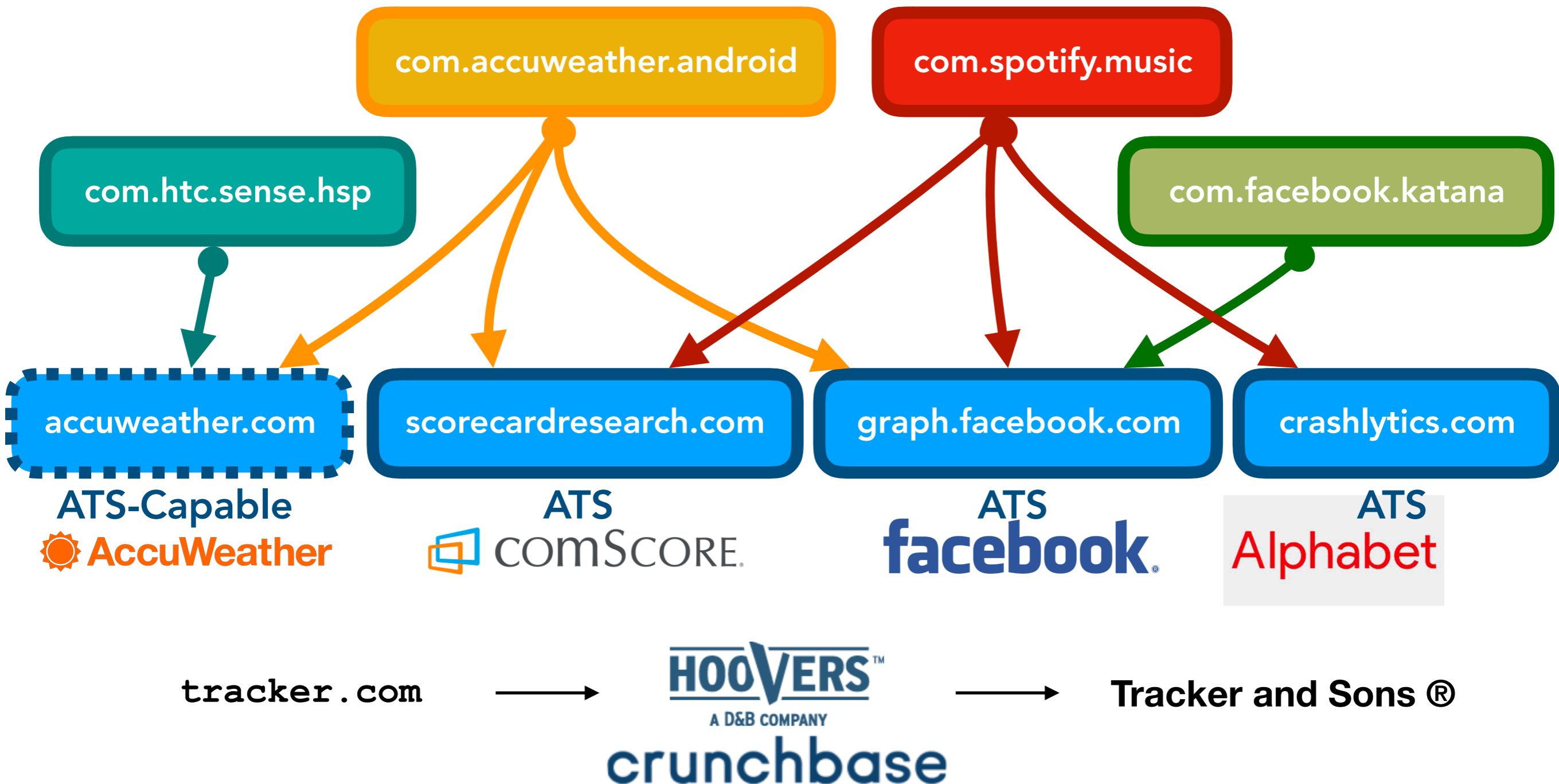


verizon^v Alphabet



Identifying Parent Companies

Identify parent company



ATS parent companies

- **292 parent orgs. own nearly 2,000 ATSes**
- As expected, big companies dominate, but...



#1



#4

ATS parent companies

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#1 Alphabet

#4 verizon^v



ATS parent companies

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#1 Alphabet

#4 verizon^v



Aol.

ATS parent companies

- 292 parent orgs. own nearly 2,000 ATSES
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#1 Alphabet

#4 verizon[✓]



Aol.

YAHOO!

ATS parent companies

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#4 verizon^v

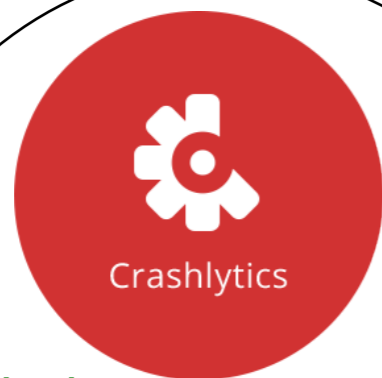


ATS parent companies

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#1 Alphabet

#4 verizon^v



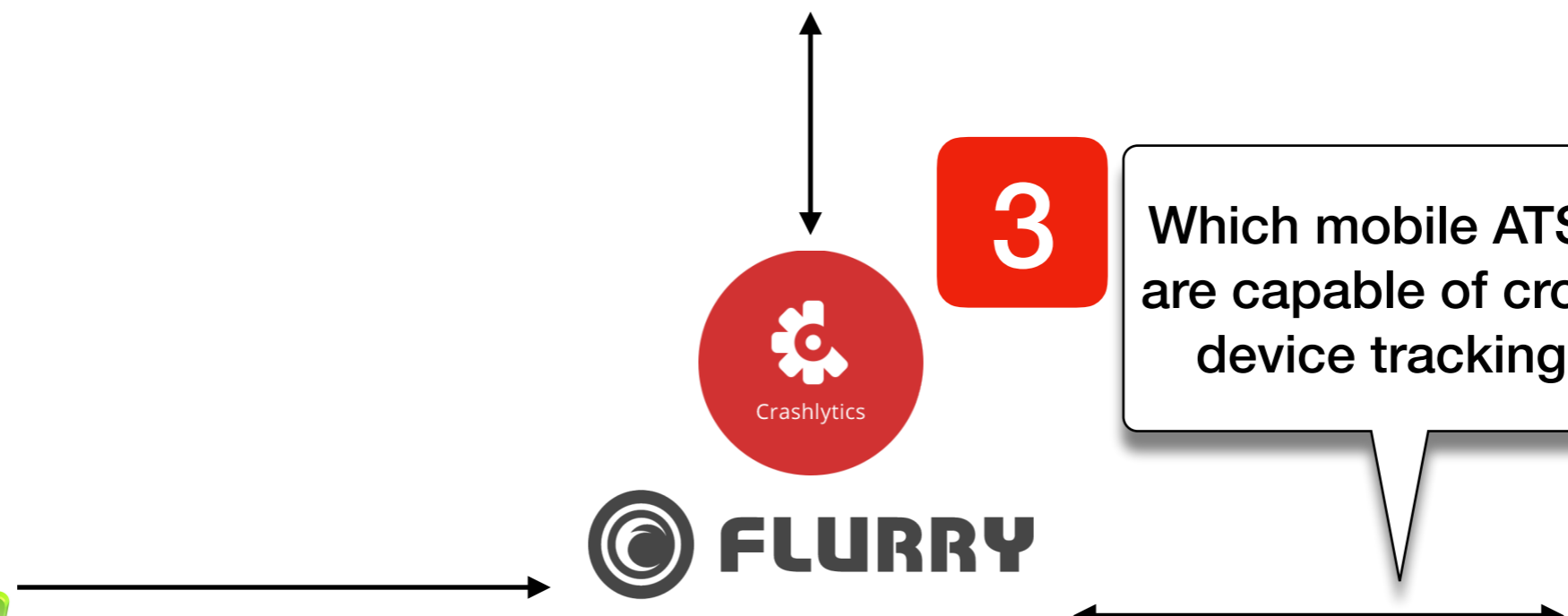
Aol.

YAHOO!

Questions to answer



Which mobile ATSeS are capable of cross-device tracking?



Cross-device Tracking

```

    return -1 !== k.indexOf("Google Web Preview") || 1E-4 > Math.random()
  )),
  ra = function() {
    try {
      a: {
        var a = e.document.querySelector("script[nonce]");
        if (a) {
          var b = a.nonce || a.getAttribute("nonce");
          if (b && oa.test(b)) {
            var c = b;
            break a;
          }
        }
        c = void 0;
      }
      return c;
    } catch (d) {}
  };
  var r = function() {
    return e.googletag || (e.googletag = {});
  };

```

```

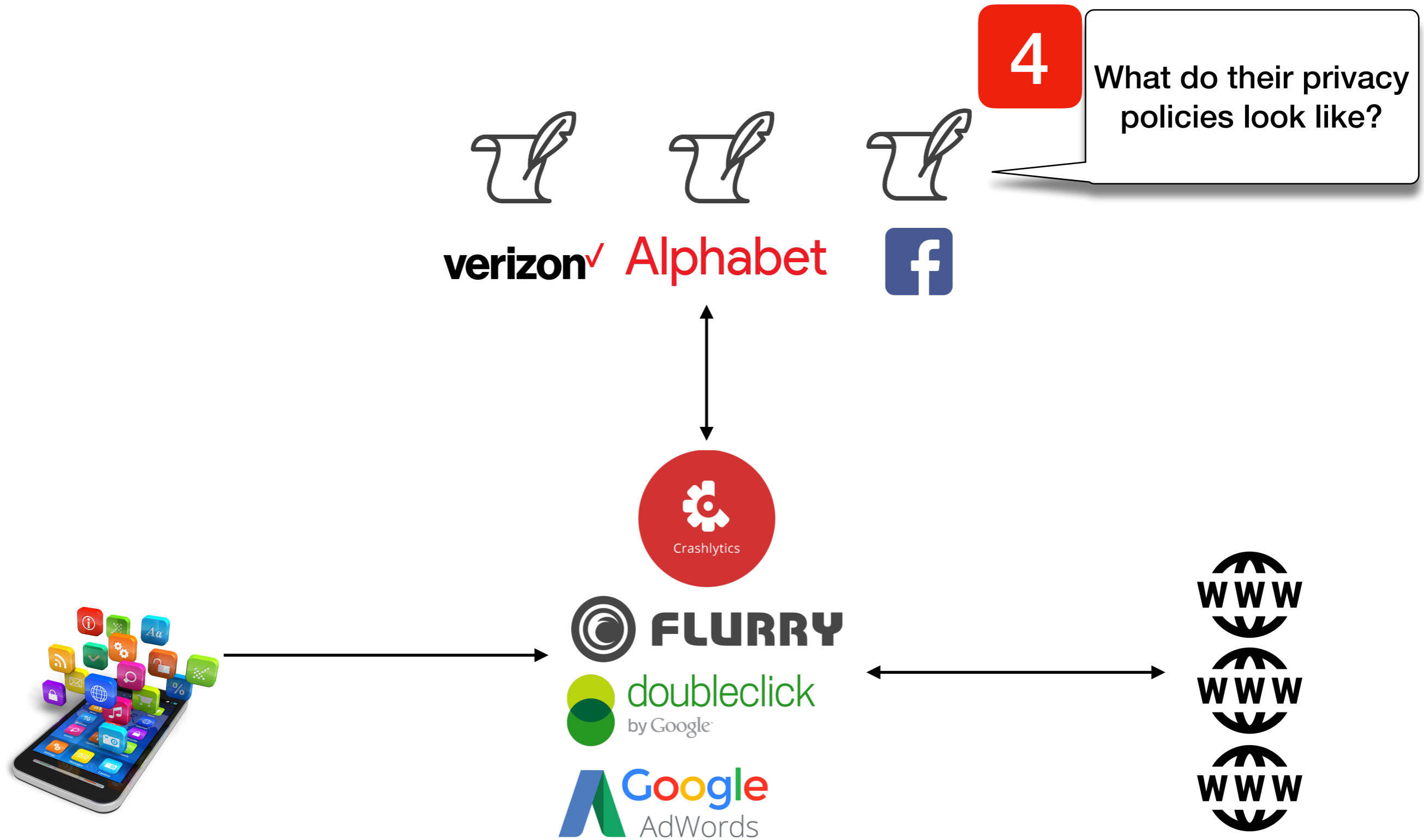
var u = {
  1: "pagead2.googlesyndication.com",
  2: "pubads.g.doubleclick.net",
  3: "securepubads.g.doubleclick.net",
  173: "pubads.g.doubleclick.net",
  174: "securepubads.g.doubleclick.net",
  7: .02,
  13: 1500,
  23: .001,
  24: 200,
  27: .01,
  29: .01,
  33: "pagead2.googlesyndication.com",
  37: .01,
  38: .01,

```

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



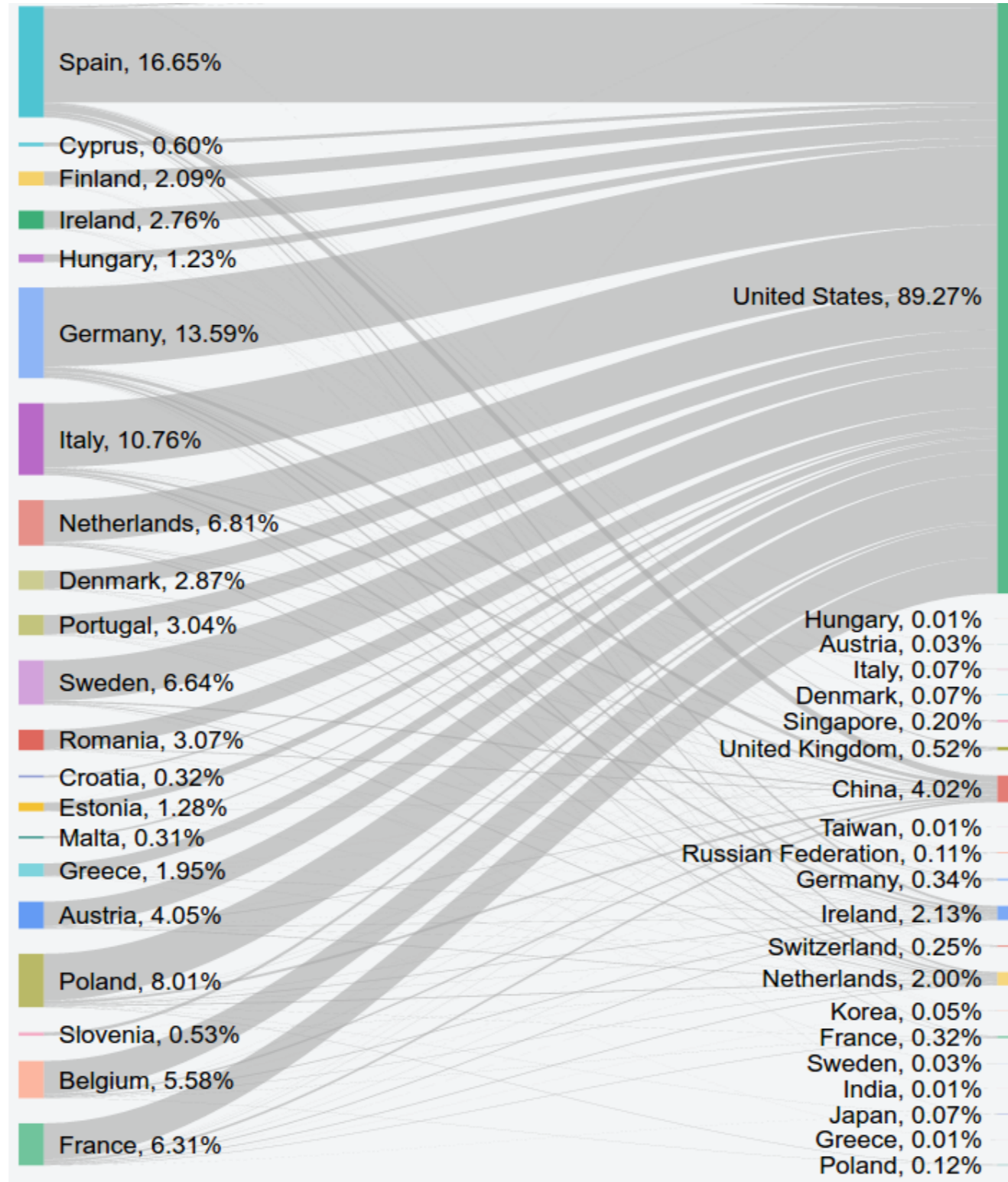
ATS Privacy Policies

Company	Has ad subsidiaries?	Data sharing with subsidiaries?	Data sharing with 3rd-parties?	Opt-out
Alphabet	✓	✓		Account settings
Facebook	✓	✓		Account settings
Twitter	✓	✓	✓	Account settings / DAA
Verizon	✓	✓	✓	Account settings
AppsFlyer			✓	Email
ChartBoost	✓	✓	✓	NAI/DAA webforms
Vungle	✓	✓	✓	Google ID Reset
AppLovin	✓	✓	✓	TRUSTe/EU YOC
Adjust			✓	NAI webform
Alibaba	✓	✓	✓	Webform

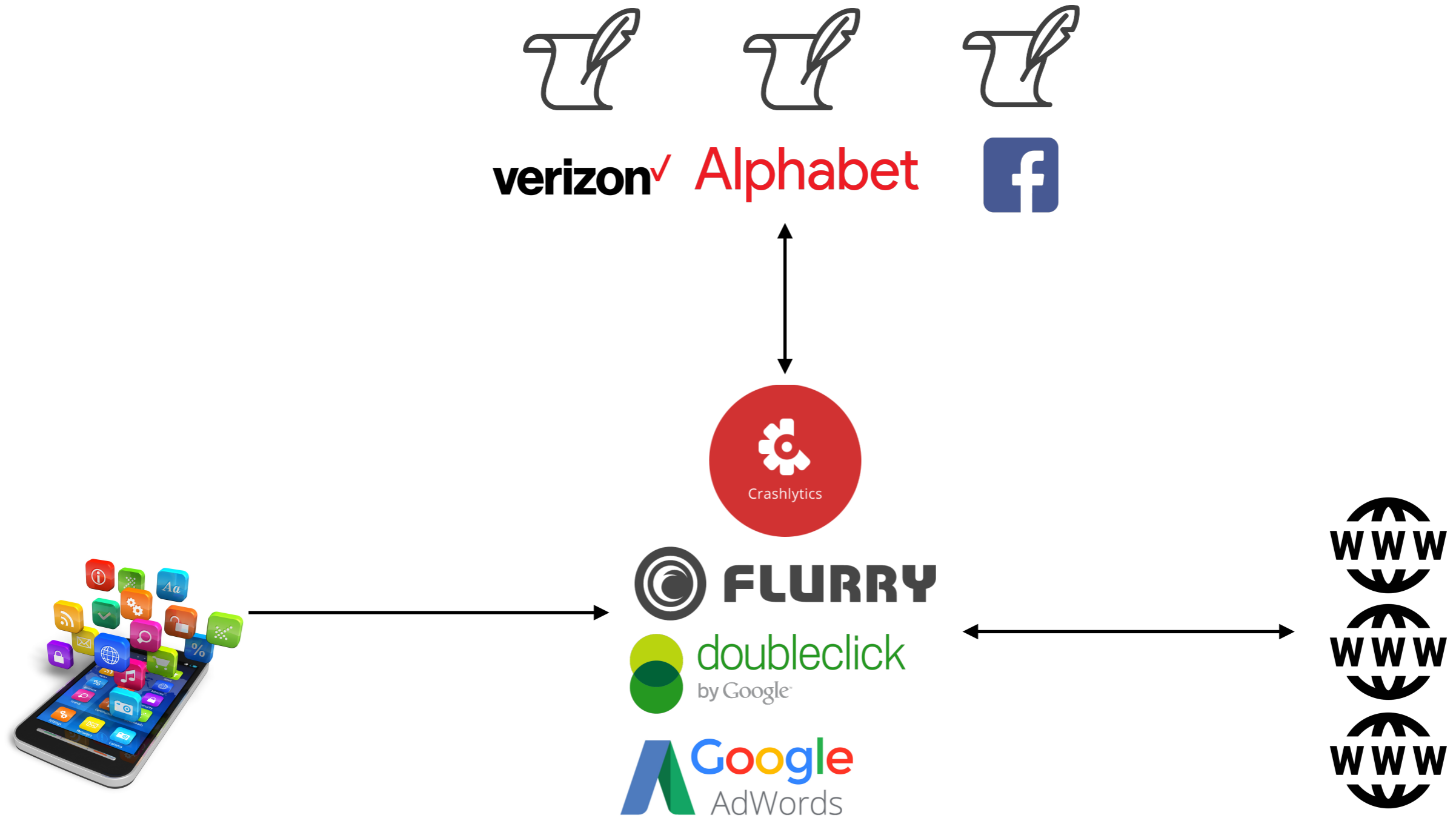
NAI: Network Advertising Initiative

DAA: Digital Advertising Alliance

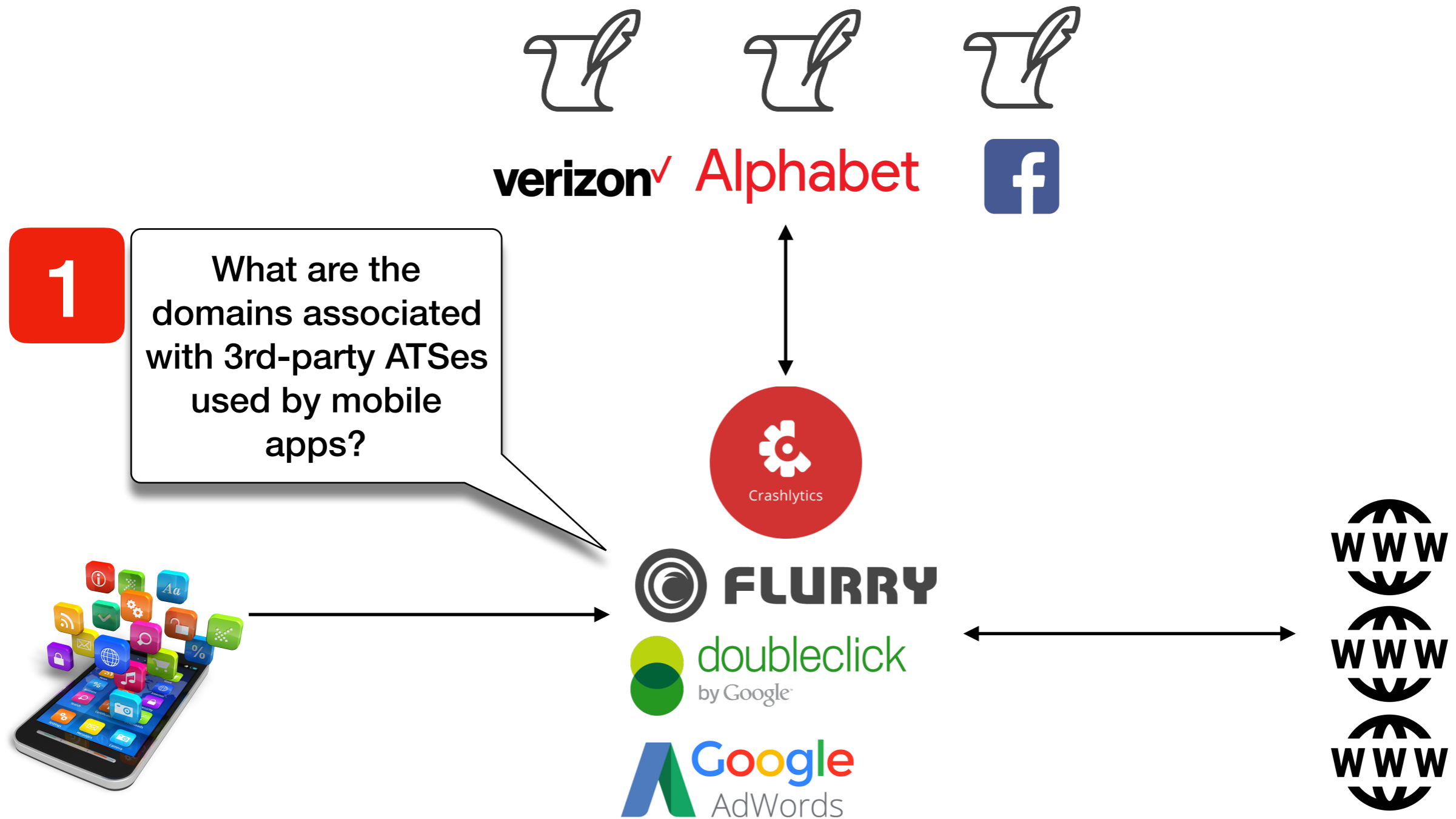
Trackers without borders



Questions to answer



Questions to answer



Questions to answer

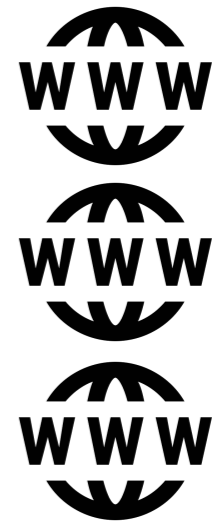
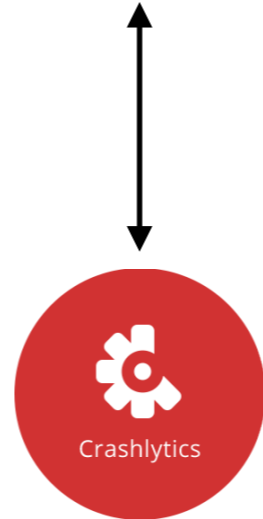
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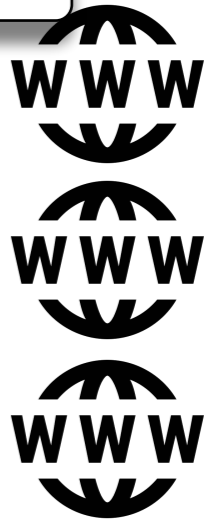
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verizon^v Alphabet

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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



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haystack.mobi