esir ECOLE SUPERIEURE D'INGENIEURS DE RENNES | Université de Rennes | institut universitaire de France

Research in Privacy on the Web

Walter Rudametkin

Walter.Rudametkin@univ-rennes.fr

https://rudametw.github.io/teaching/

DiverSE | Inria informatics mathematics | UMR IRISA

Walter Rudametkin

Systèmes et logiciels | Sécurité et Vie Privée

Postes

2022: Professeur à l'Université de Rennes 1
IRISA – EPI DiverSE

2014–2022: Maître de Conférences à l'Université de Lille
CRIStAL – EPI SPIRALS

2013–2014: Chercheur postdoc l'Inria Rennes
IRISA – DIVERSE

2007–2011: Doctorat CIFRE Bull S.A.S, LIG Adèle

Diplômes

Juin 2021 : Habilitation à Diriger des Recherches
Fév. 2013 : Doctorat Université de Grenoble (LIG, équipe Adèle)
Sep. 2007 : M2R Informatique (UJF)
Sep. 2007 : Ingénieur Ensimag (INP Grenoble)
Juin 2006 : Licence (bac+4) UABC Mexique

THE WEB

Internet: a massive-scale system

- Very high quality and reliable applications
- Billions of users
  - ~3 billion users in 2014 (864 M for Facebook, 350M for YouTube, 283M for Twitter, etc.)
- Massive traffic
  - May 2013: 100 hours upload every minute on YouTube
  - 500M tweets a day
- Very heterogeneous and unpredictable environments
  - **18,796 distinct Android devices**
  - unpredictable network quality

Internet: a wonderful free world

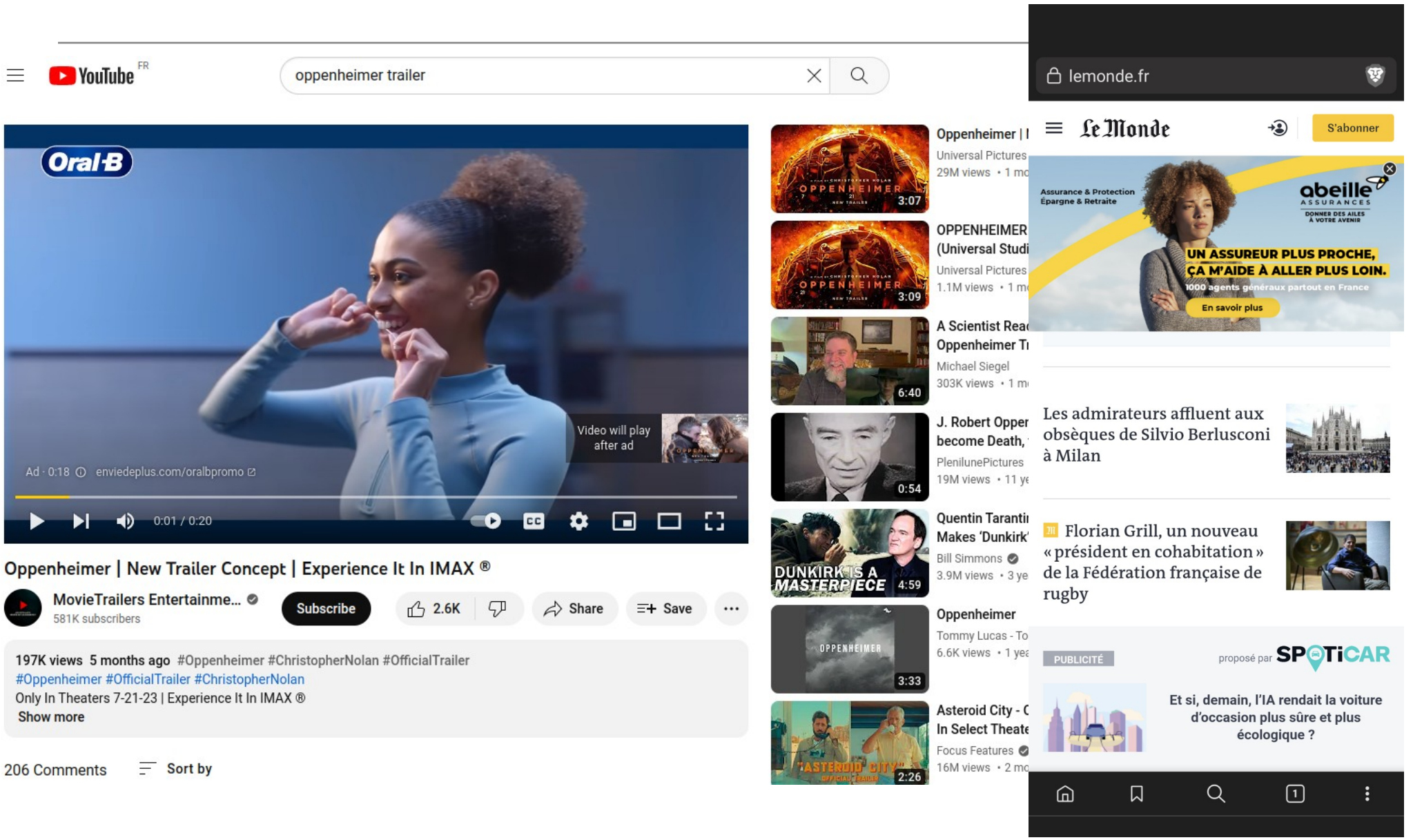
Users have access to massive quantities of services and applications for

free

THERE AINT NO SUCH THING AS A FREE LUNCH

Armies of highly qualified software, system and network engineers, designers and professional content producers do not work for free

Advertisements

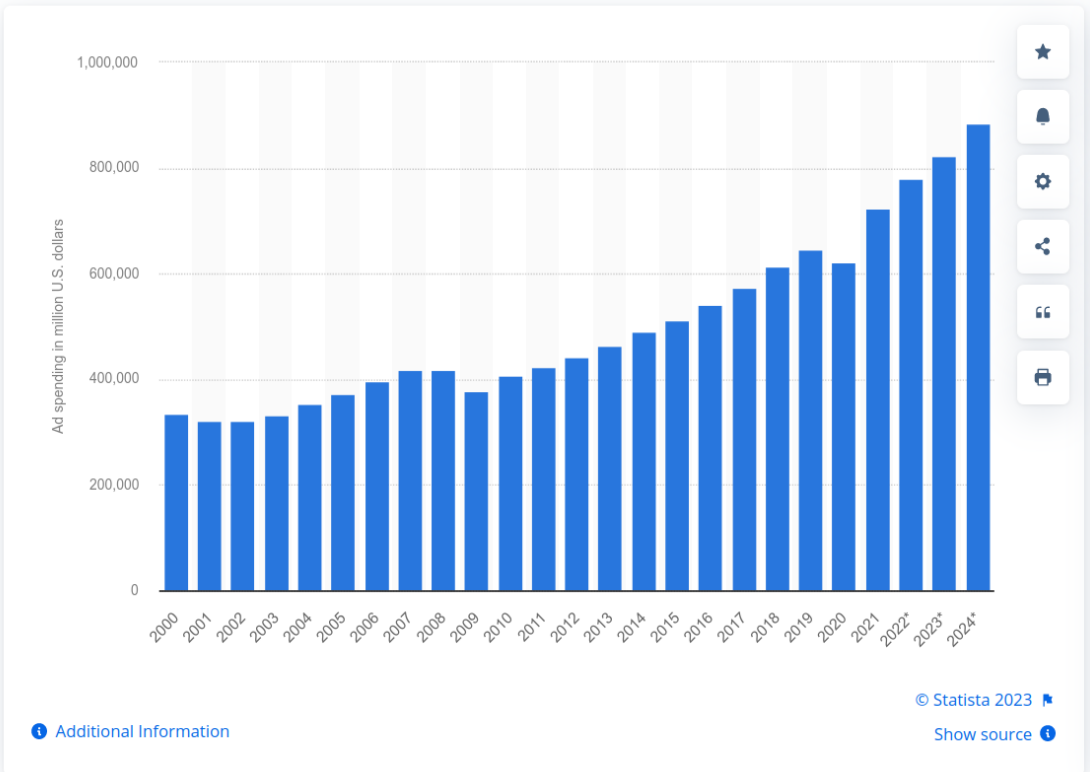


Advertisements

Advertising & Marketing › Advertising

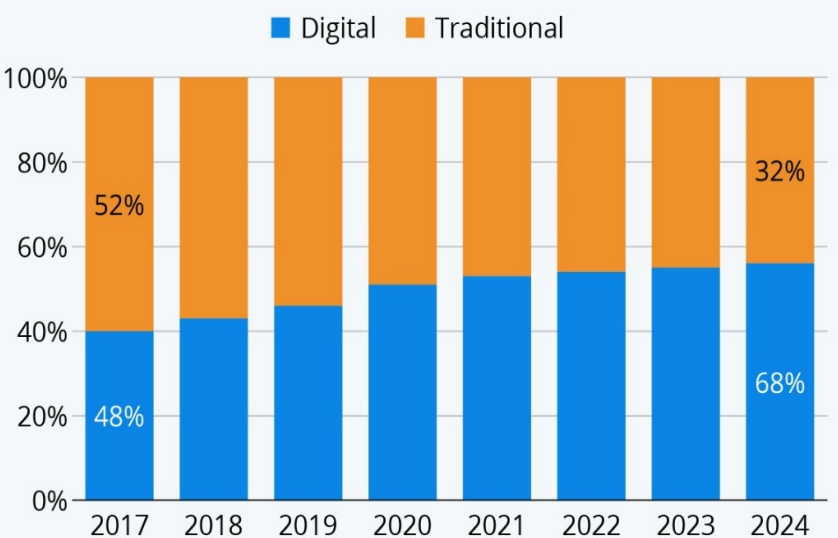
Advertising spending worldwide from 2000 to 2024

(in million U.S. dollars)



Almost Two Thirds of Ad Spending Is Digital

Digital and traditional formats as a share of ad spend in the U.S. (in %)



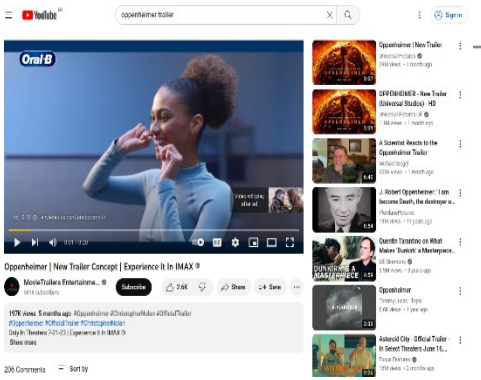
Source: Statista Advertising & Media Outlook

statista

Physical vs Digital Advertising

Physical world

- How many people saw the ad?
- How did they respond to it?
- Did it influence their spending? Increase awareness?



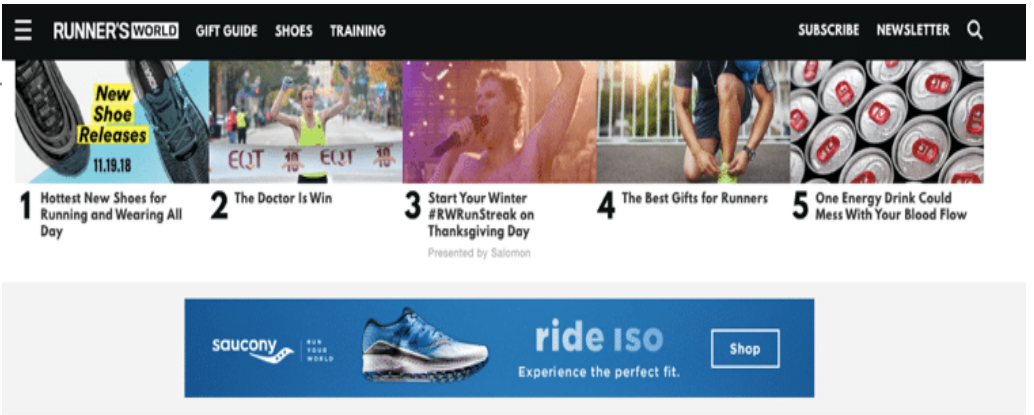
Digital world

- Ad presented to each user
- Number of **impressions**, **interactions** (clicks or taps), **purchases**
- Possible to target each ad to a person

Types of ads

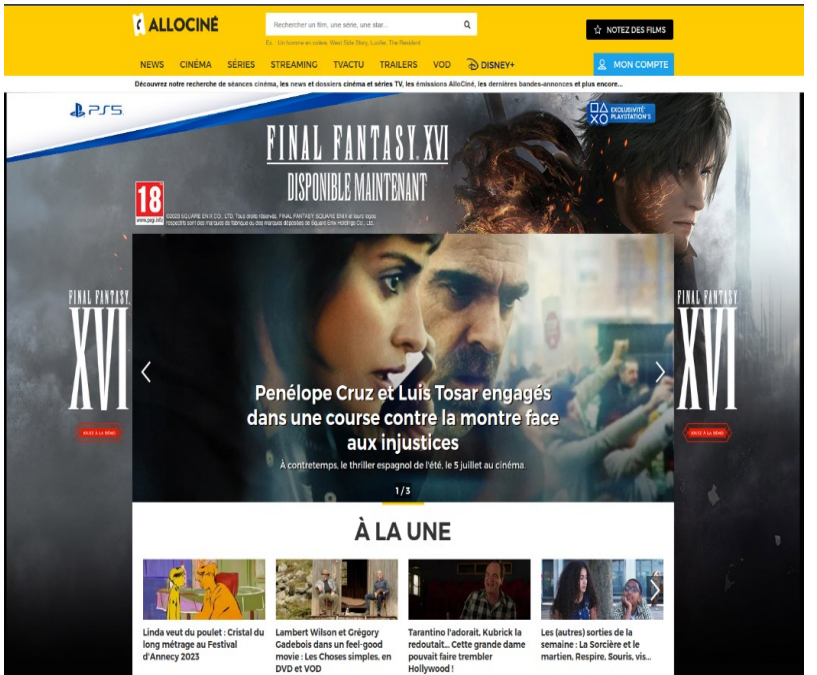
Contextual advertising

- Use the contents of the page to chose the ad



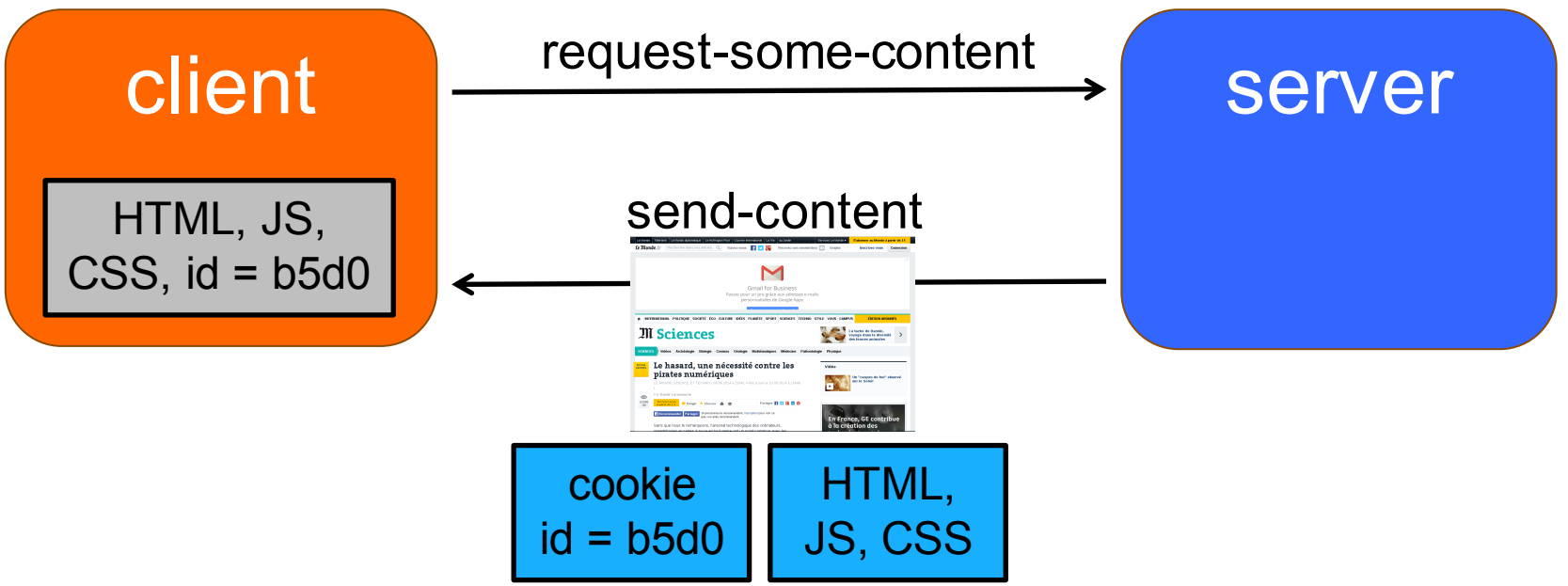
Targeted advertising

- Use the user's profile to deliver an ad



A SIMPLE WEB MADE OF COOKIES AND ADS

A Simple Web Request



La tache de Darwin, voyage dans la diversité des formes animales ›

ÉDITION ABONNÉS

Le hasard, une nécessité contre les pirates numériques

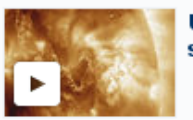
LE MONDE SCIENCE ET TECHNO | 09.06.2014 à 15h41 • Mis à jour le 10.06.2014 à 16h49

Par David Larousserie

LECTURE ZEN

Sans que nous le remarquions, l'arsenal technologique des ordinateurs, smartphones et cartes à puce en tout genre ont un point commun avec les

Vidéo

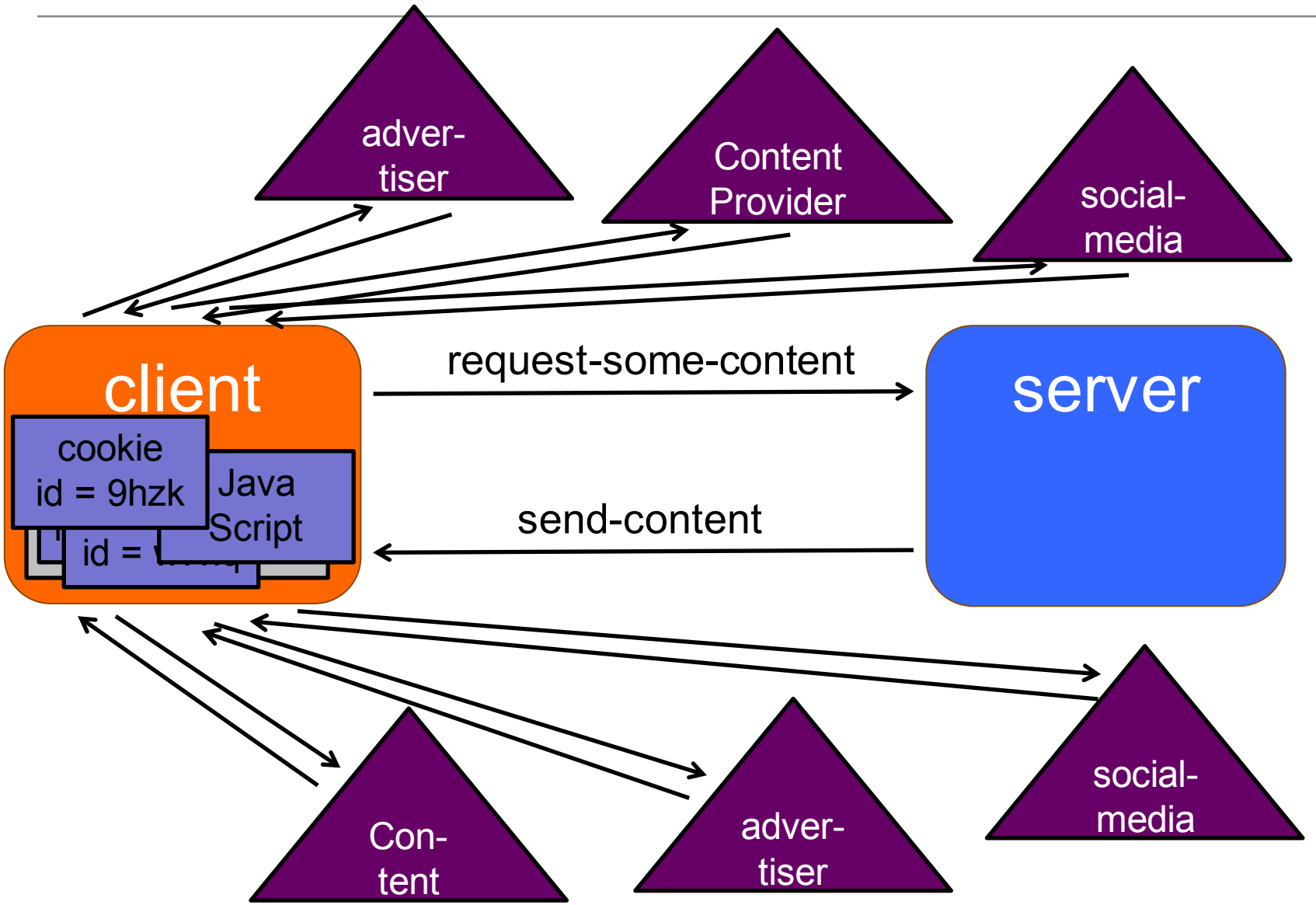


Un "canyon de feu" observé sur le Soleil

74 third-party services (most invisible)

Accuen Media, Acuity Ads, Adap.tv, Adify, Adroit Digital Solutions, AdScale, ADTECH, Advertising.com, Aggregate Knowledge, AppNexus, AT Internet, Atlas, BidSwitch, Casale Media, Cedexis Radar, Chango, ChartBeat, Connexity, Criteo, Datalogix, DataXu, Digilant, Dotomi, DoubleClick, DoubleClick Bid Manager, DoubleClick Spotlight, EQ Advertising, Eulerian, Experian Marketing Services, eyeReturn Marketing, Ezakus, Facebook Connect, Facebook Exchange (FBX), Facebook Social Plugins, Google Adsense, Google Analytics, Improve Digital, Integral Ad Science, Jumptap, Kameleoon, Ligatus, Lijit, Magnetic, Media Innovation Group, Media Optimizer (Adobe), Media6Degrees, MediaMath, Netmining, Neustar AdAdvisor, OpenX, Optimix Media Delivery, Outbrain, OwnerIQ, PubMatic, PulsePoint, Quantcast, Right Media, Rocker Fuel, Rubicon, ScoreCard Research Beacon, SiteScout, Sizmek, SMART AdServer, SpotXchange, TradeDesk, TubeMogul, Turn, Twitter Button, Veruta, Videology, Video Step, Visual Revenu, Yandex.Metrics, Yieldr

A Simple Web Request



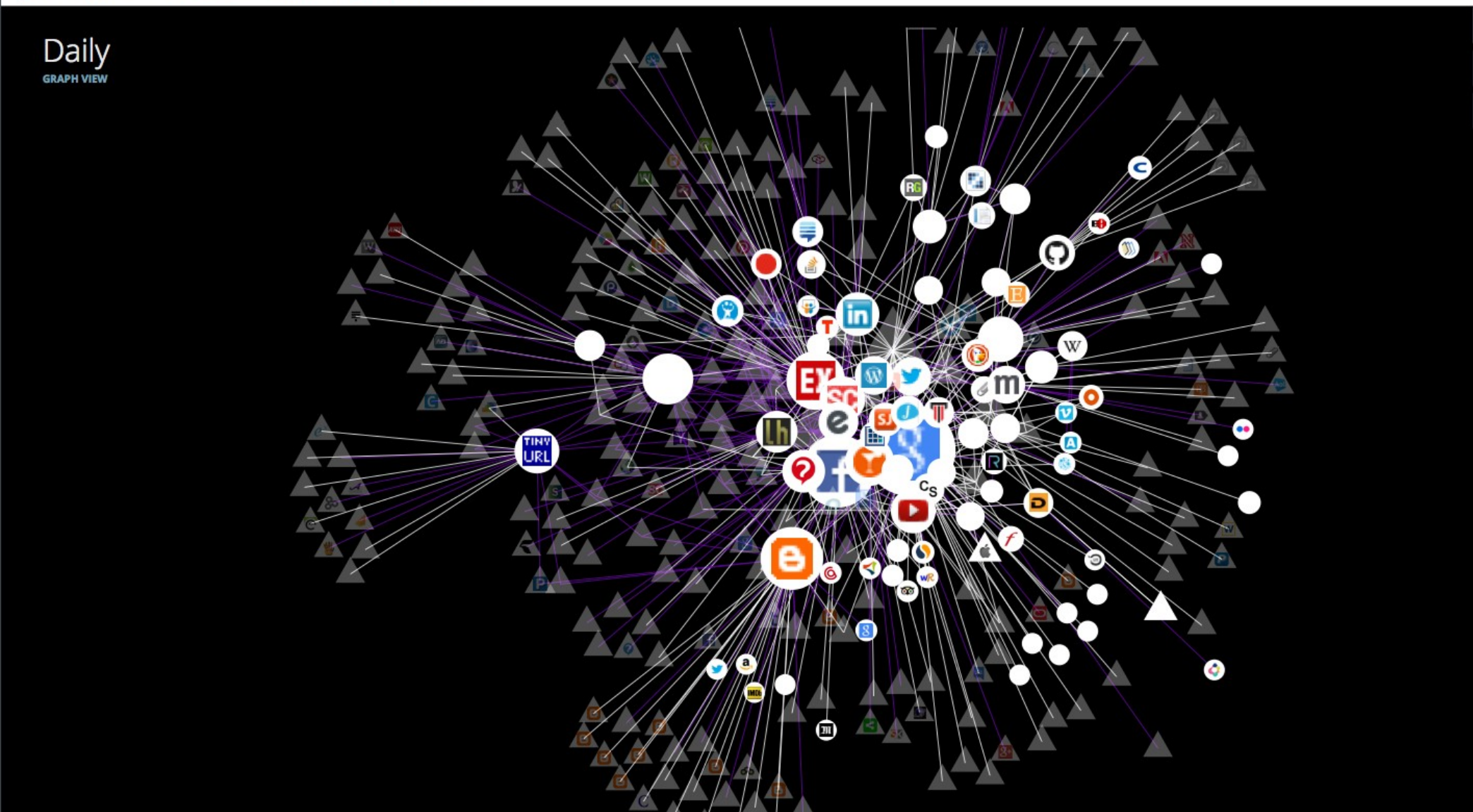
Lightbeam

DATA GATHERED SINCE
JAN 15, 2015

YOU HAVE VISITED
132 SITES

YOU HAVE CONNECTED WITH
396 THIRD PARTY SITES

Daily
GRAPH VIEW



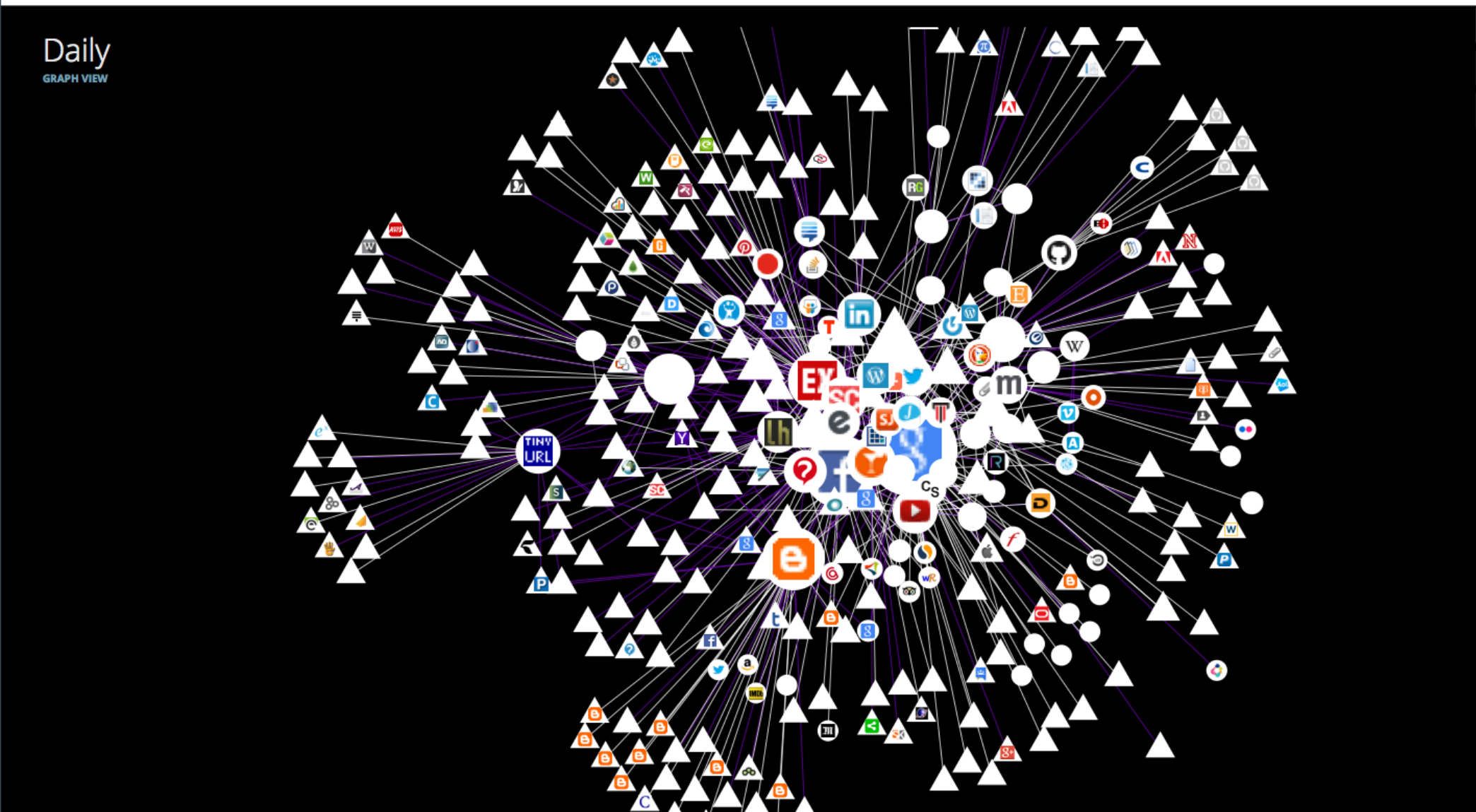
Lightbeam

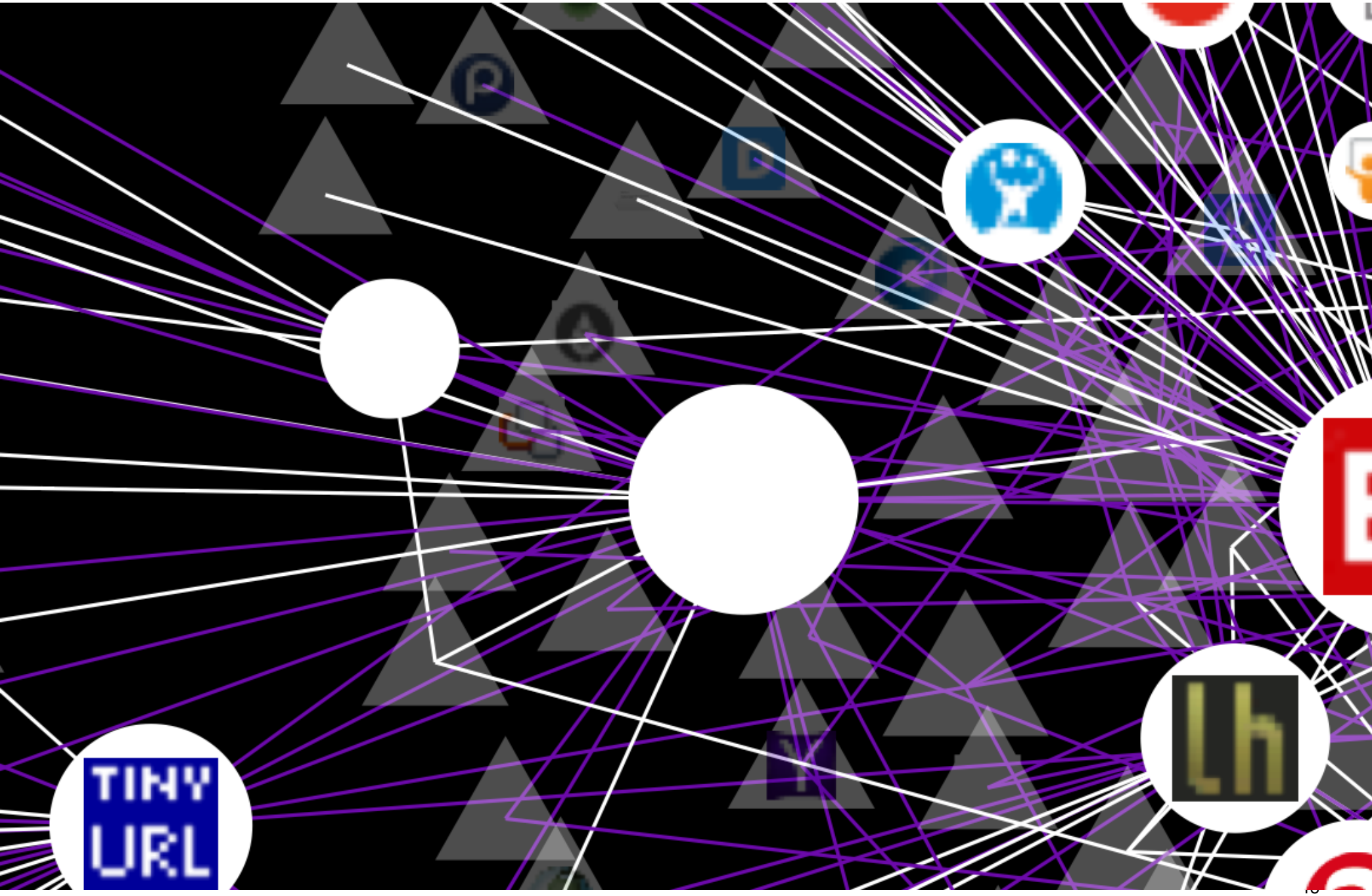
DATA GATHERED SINCE
JAN 15, 2015

YOU HAVE VISITED
132 SITES

YOU HAVE CONNECTED WITH
396 THIRD PARTY SITES

Daily
GRAPH VIEW




TINY
URL

chiefmartec.com

April 2020

Marketing Technology Landscape

The Martech 5000

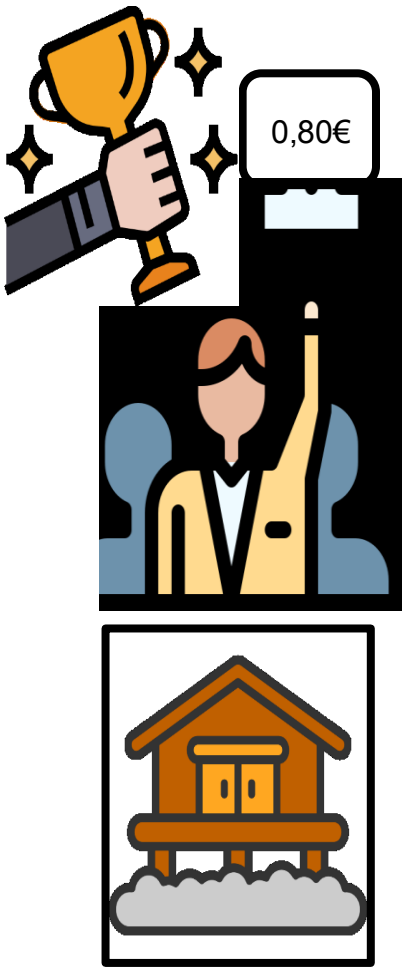
Total Solutions	8,000
Advertising & Promotion	922
Content & Experience	1,936
Social & Relationships	1,969
Commerce & Sales	1,314
Data	1,258
Management	601

Access all the data of this landscape & more at **martech5000.com**

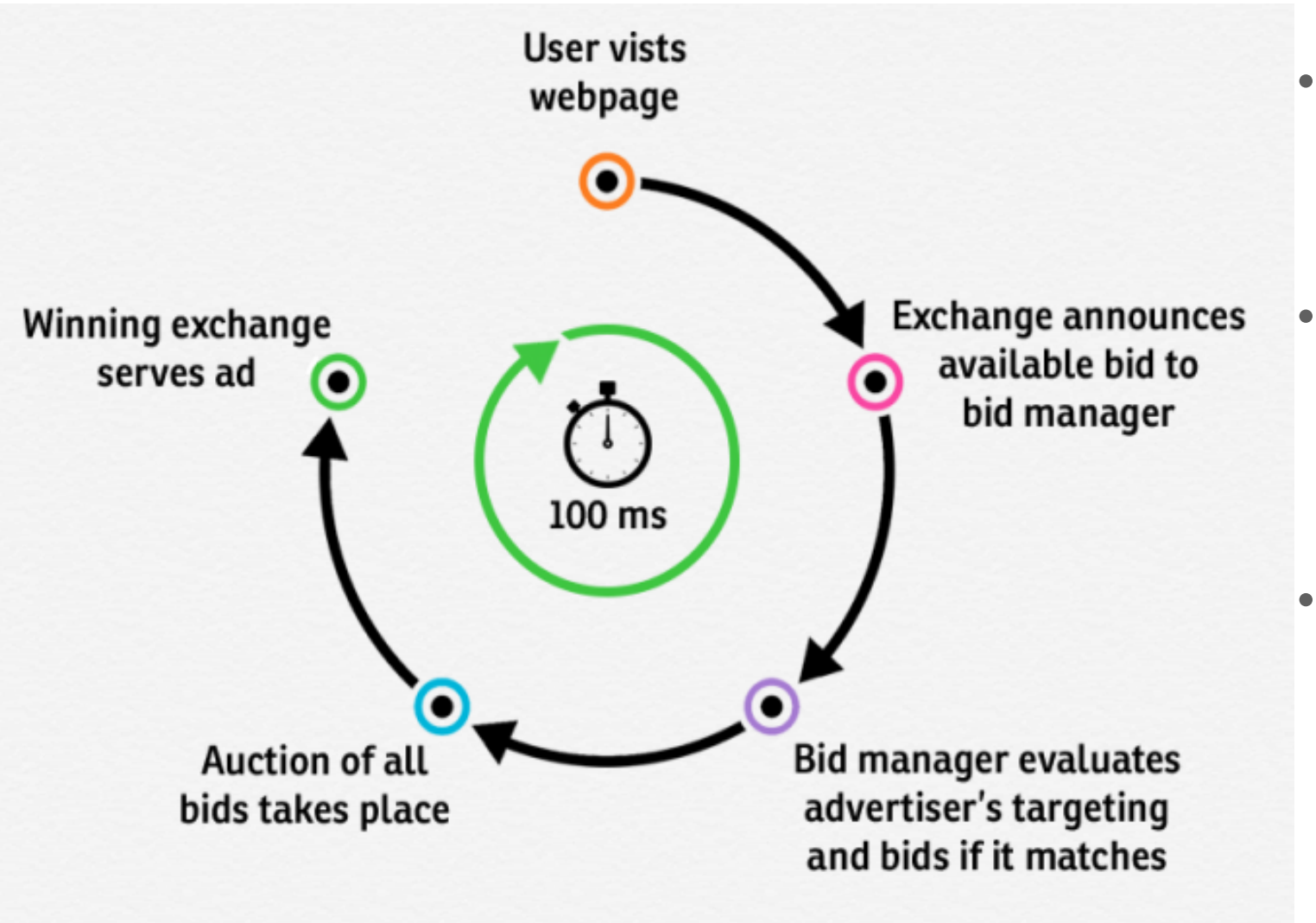
Produced by Scott Brinker (

How is an ad delivered?

Real-time bidding

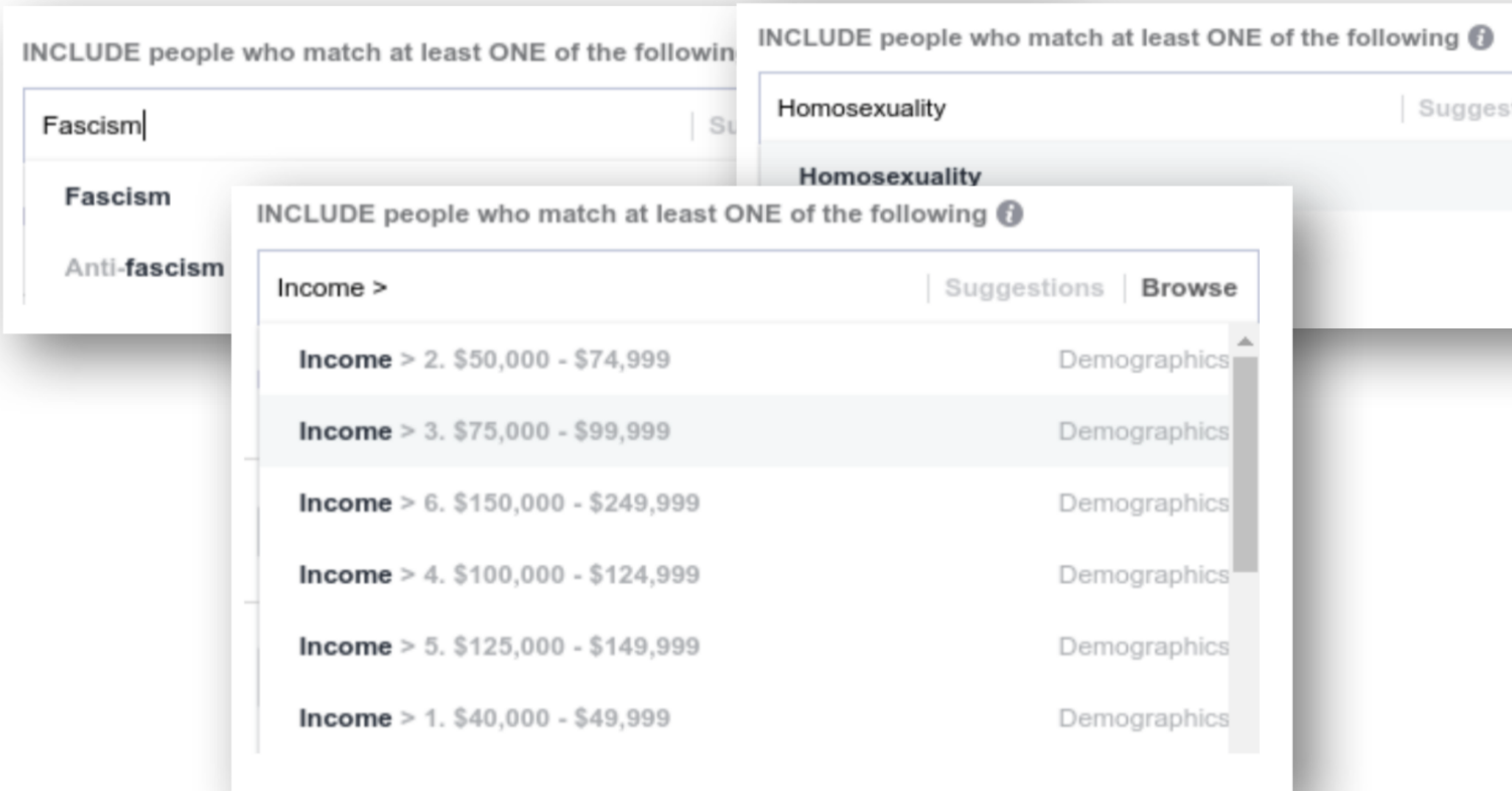


How is an ad TRULY delivered?



- SSP: Supply Side Platform, it supplies ad space
- DSP: Demand Side Platform, it demands ad space
- DMP: Data Management Platform, it provides client data in real time

Attributes can be invasive



Slide of Oana Goga

Andreou, M. Silva, F. Benevenuto, O. Goga, P. Loiseau, A. Mislove. Measuring the Facebook Advertising Ecosystem, NDSS 2019

Can we block **third party** cookies?

CHROME

Building a more private web

Aug 22, 2019 · 3 mins read

Justin Schuh
Director, Chrome Engineering

encouraging opaque techniques such as fingerprinting.

Second, blocking cookies without another way to deliver relevant ads significantly reduces publishers' primary means of funding, which jeopardizes the future of the vibrant web.

https://www.blog.google/products/chrome/building-a-more-private-web/

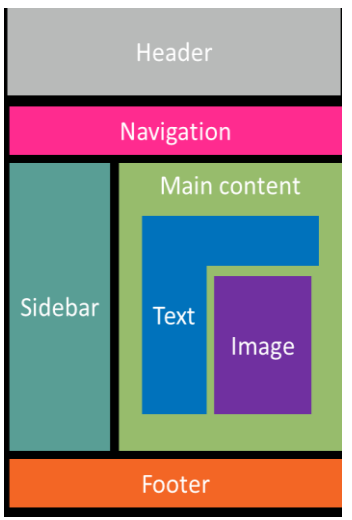
BROWSER FINGERPRINTING

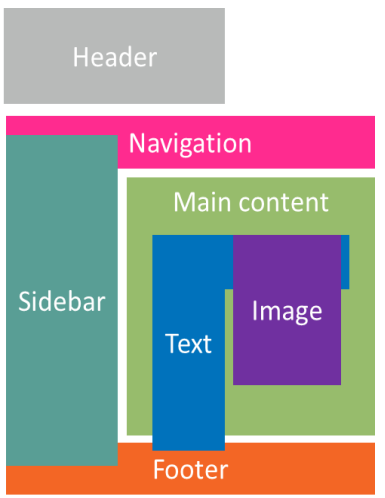
Supporting device diversity

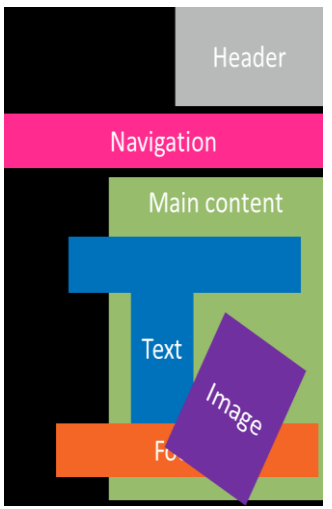
Browsers send device-specific information

Windows 7
1920x1080

Android v6.0
2560x1440





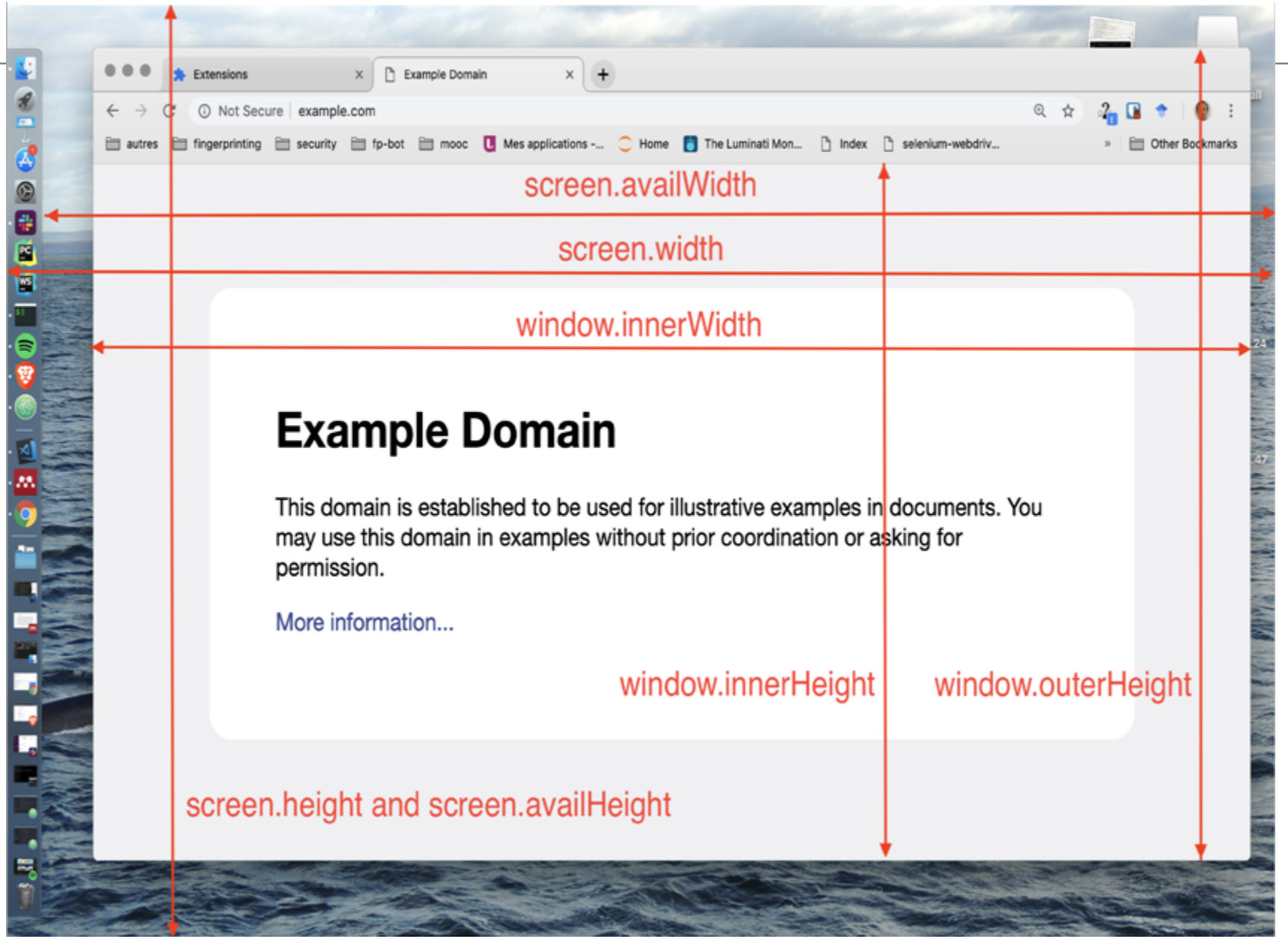


A browser fingerprint

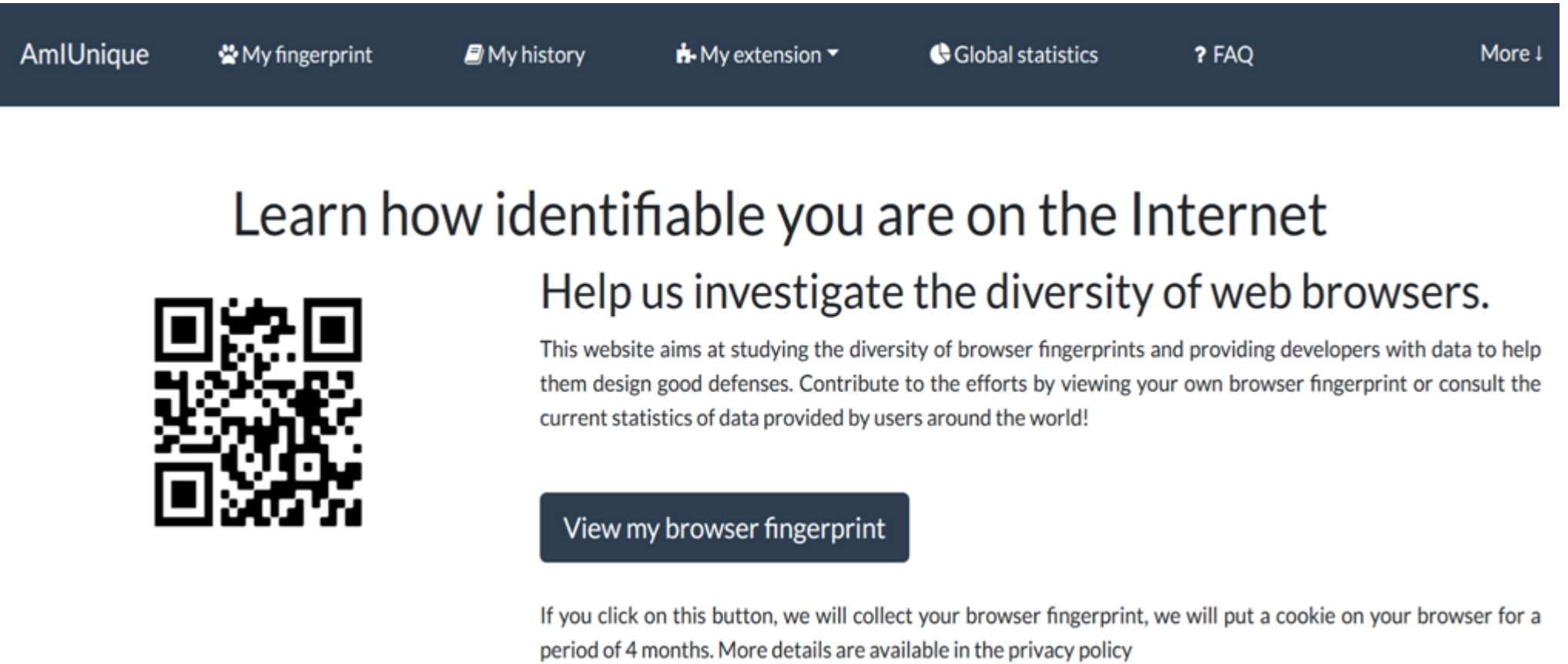
Attribute	
User agent	
HTTP accept	.8
OS	
Screen resolution	
Timezone	
DOM Session storage	
DOM Local storage	
I.E. User data	

Create a unique fingerprint for each device

Screen resolution



https://amiunique.org (Launch: 2014)



Research & Dissemination

http://amiunique.org (Am I Unique?)

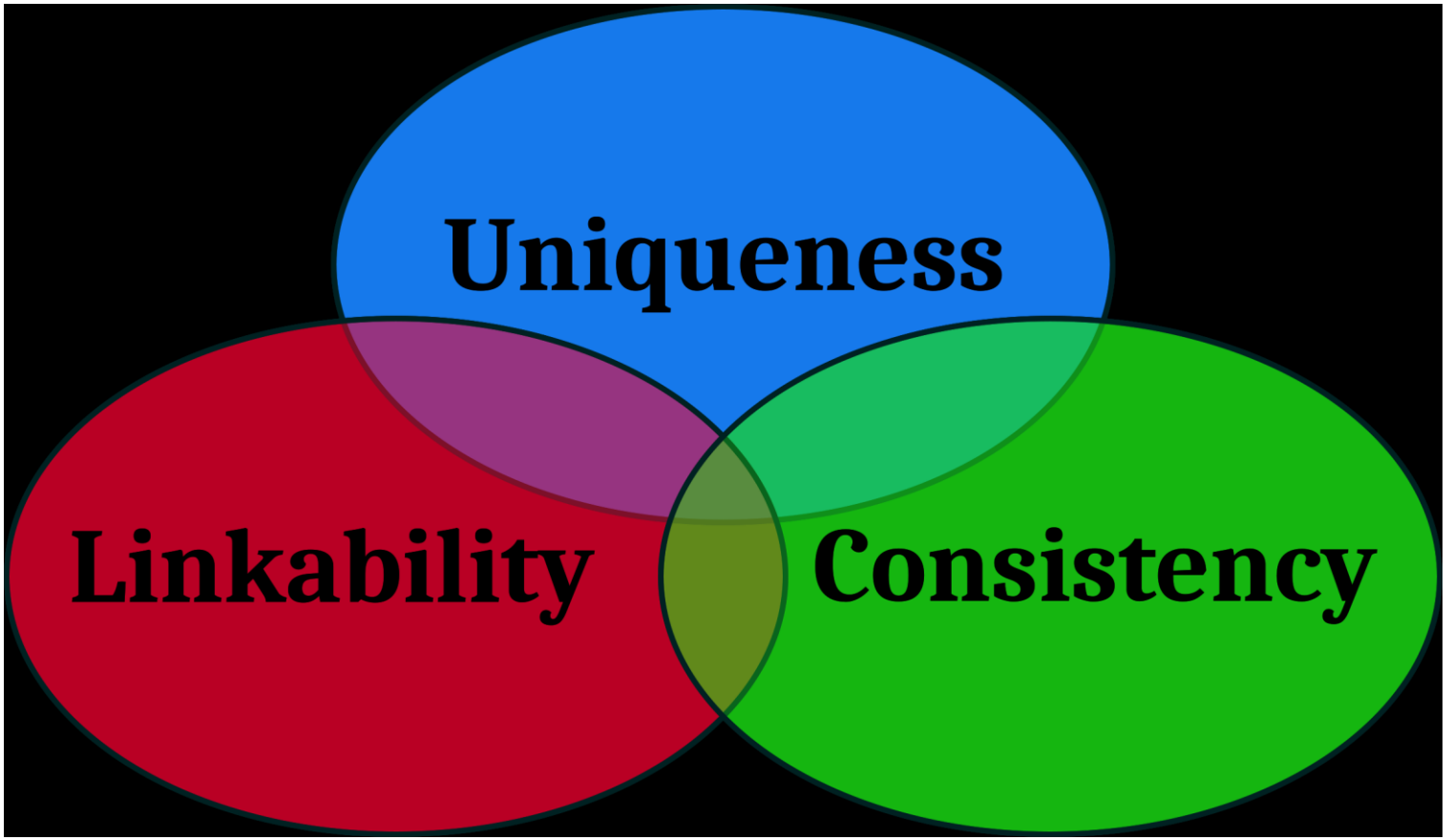
- Website, browser extensions, research papers
- Long-term data acquisition
  - ➔ 20K visits per week
  - ➔ 5M+ fingerprints
  - ➔ 4K extension users
- 1 PhD 2017, 1 PhD 2019, 2 PhDs 2021, 1 PhD 2024, 3 ongoing PhDs

Media coverage and dissemination

- FIC, Framablog, Slashdot, Clubic, fOSSa, NextImpact, Arstechnica, CPDP, …

Collaborations

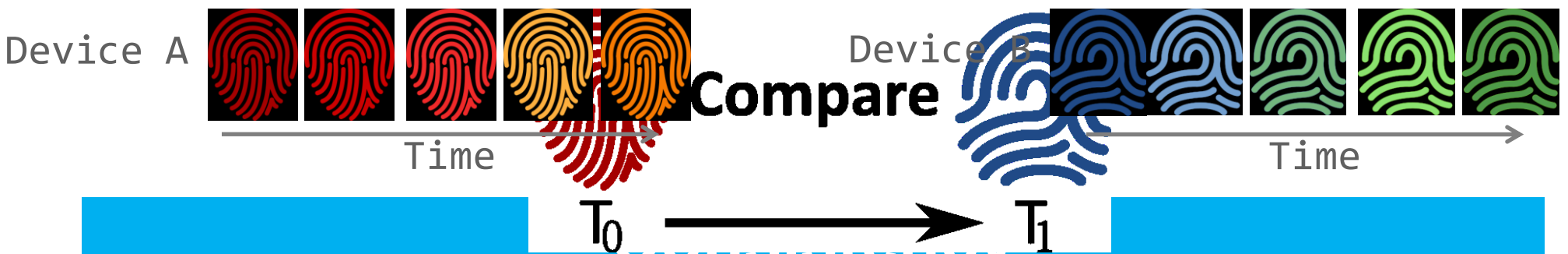
Browser Fingerprint
Trifecta



Browser fingerprint properties

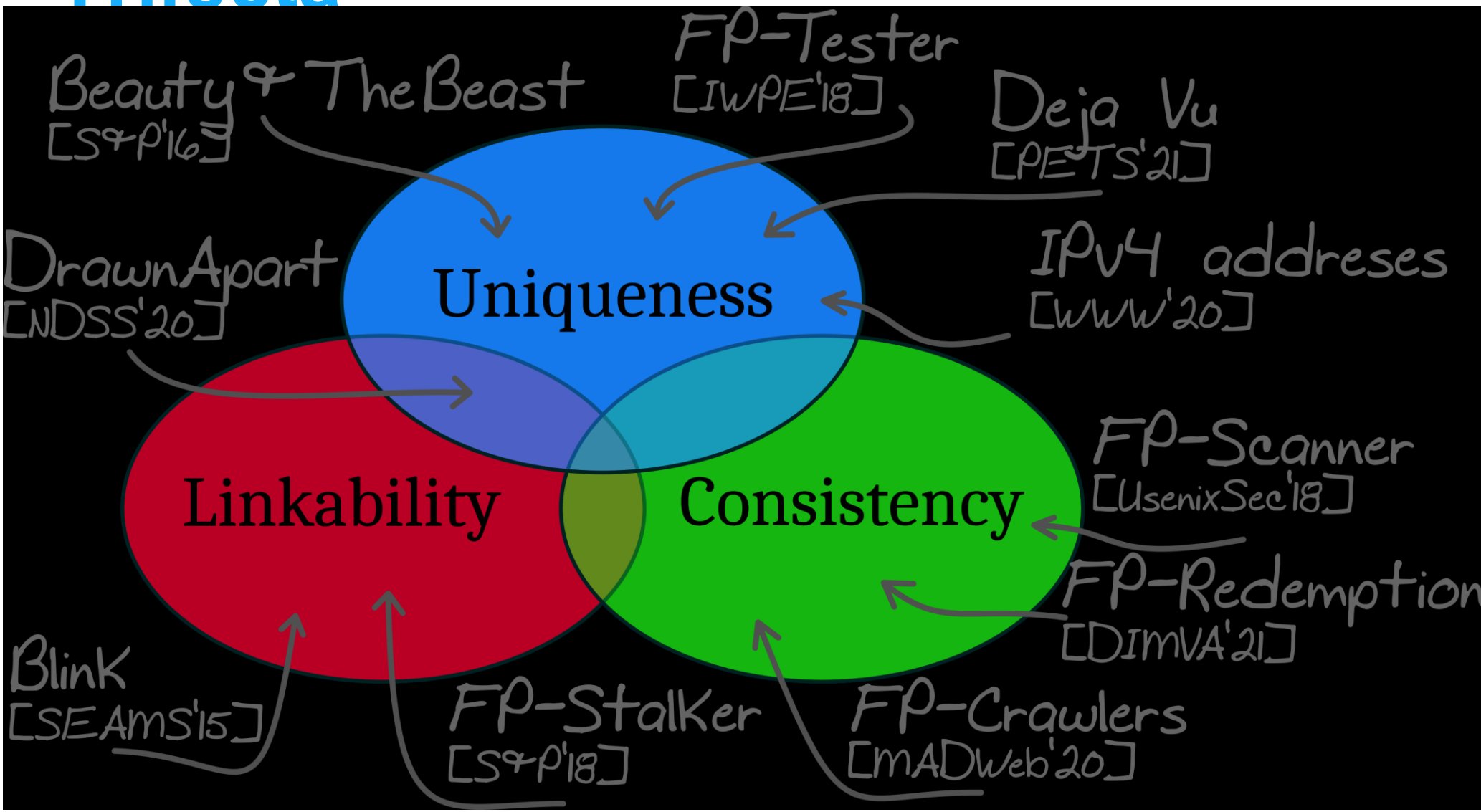
Uniqueness

Linkability



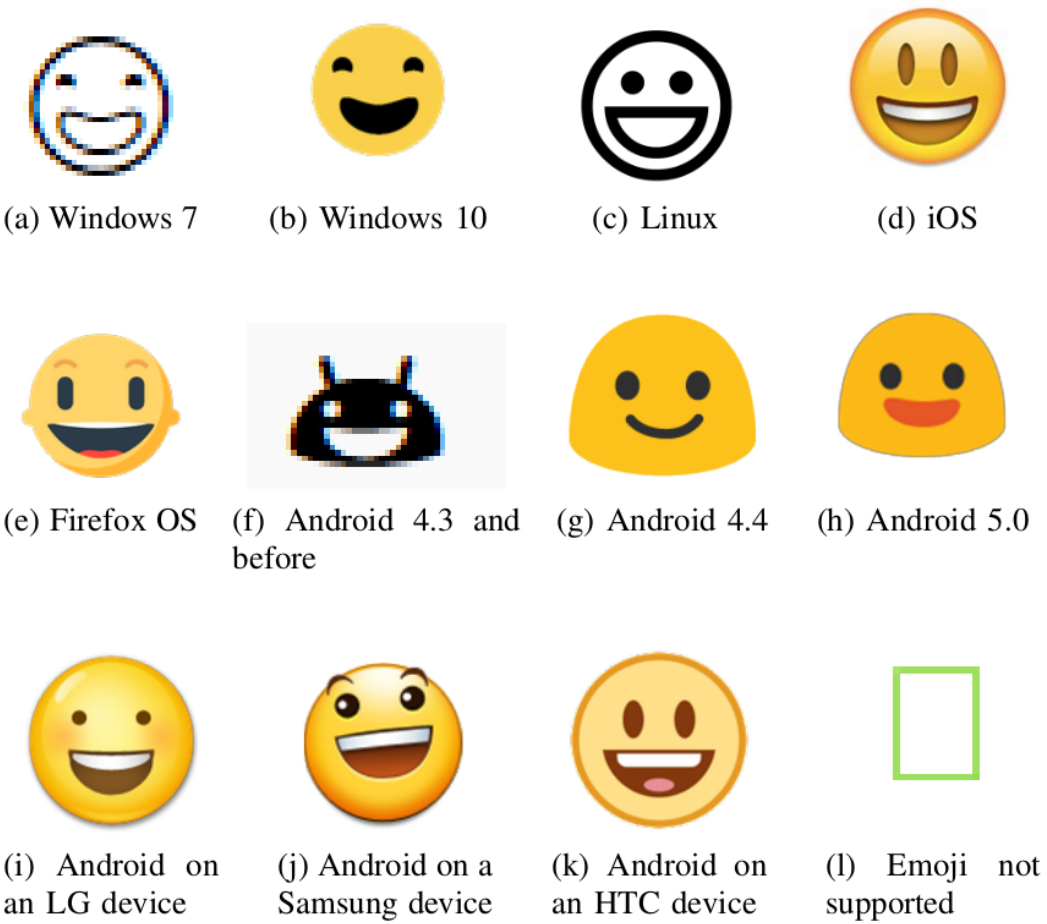
Consistency

Browser Fingerprint Trifecta



Finding: Mobile fingerprints are also unique [IEEE S&P'16]

- High uniqueness
  - Depends on vendor/model
- Different attributes
  - User agent, Emojis, Canvas



(a) Windows 7 (b) Windows 10 (c) Linux (d) iOS

(e) Firefox OS (f) Android 4.3 and before (g) Android 4.4 (h) Android 5.0

(i) Android on an LG device (j) Android on a Samsung device (k) Android on an HTC device (l) Emoji not supported

Canvas fingerprint [IEEE S&P'16]

```
canvas = document.createElement("canvas");
canvas.height = 60;
canvas.width = 400;
canvasContext = canvas.getContext("2d");
canvas.style.display = "inline";
canvasContext.textBaseline = "alphabetic";
1 canvasContext.fillStyle = "#f60";
  canvasContext.fillRect(125, 1, 62, 20);
2 canvasContext.fillStyle = "#069";
  canvasContext.font = "11pt no-real-font-123";
  canvasContext.fillText("Cwm fjordbank glyphs vext quiz, \ud83d\ude03", 2, 15);
3 canvasContext.fillStyle = "rgba(102, 204, 0, 0.7)";
  canvasContext.font = "18pt Arial";
  canvasContext.fillText("Cwm fjordbank glyphs vext quiz, \ud83d\ude03", 4, 45);
canvasData = canvas.toDataURL();
```

Cwm fjordbank glyphs vext quiz, 😃

Cwm fjordbank glyphs vext quiz, 😃

Canvas fingerprint [IEEE S&P'16]

K. Mowery and H. Shacham. Pixel perfect: Fingerprinting canvas in HTML5. W2SP 2012.

Finding: Fingerprints can be linked

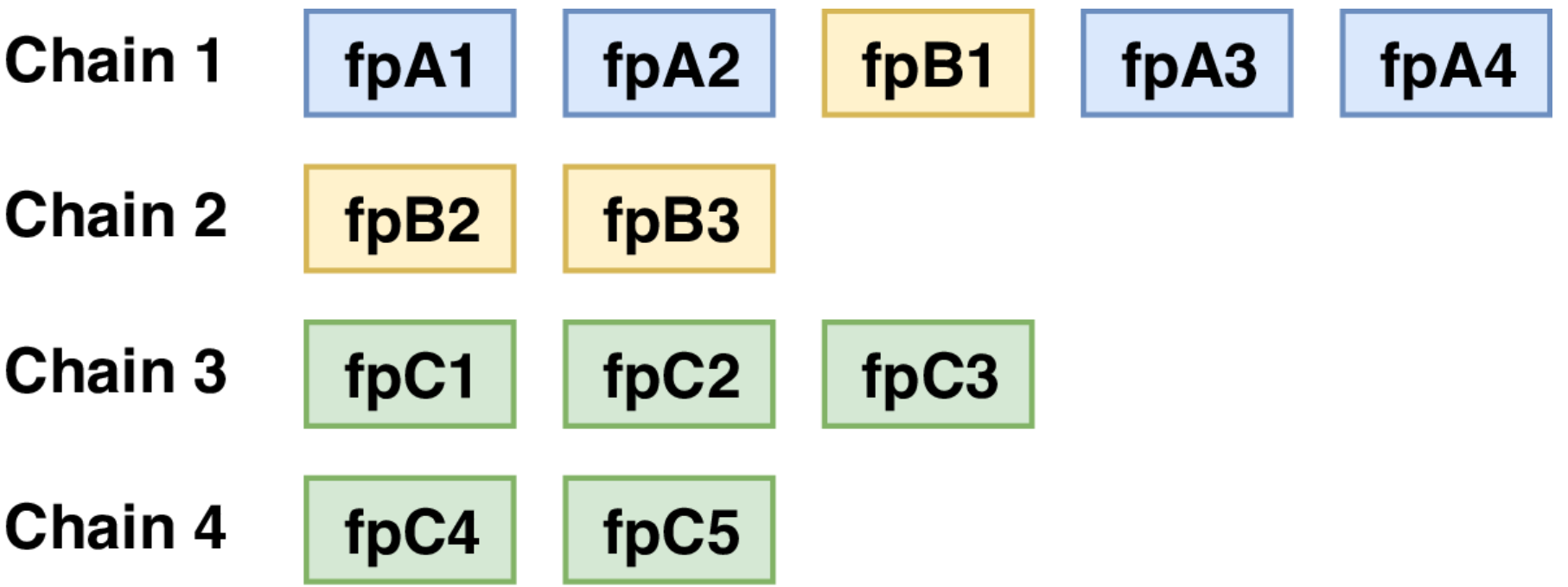
- ~20% of browsers are "*untrackable*"
  - Fingerprints too similar
  - Unpredictable evolutions
- ~26% of browsers are highly trackable
  - Unusual configurations (e.g. multiple languages)
  - Specialized hardware or software

FPStalker Machine learning for tracking fingerprint evolutions [IEEE S&P'18]

Linking fingerprints [IEEE S&P'18]

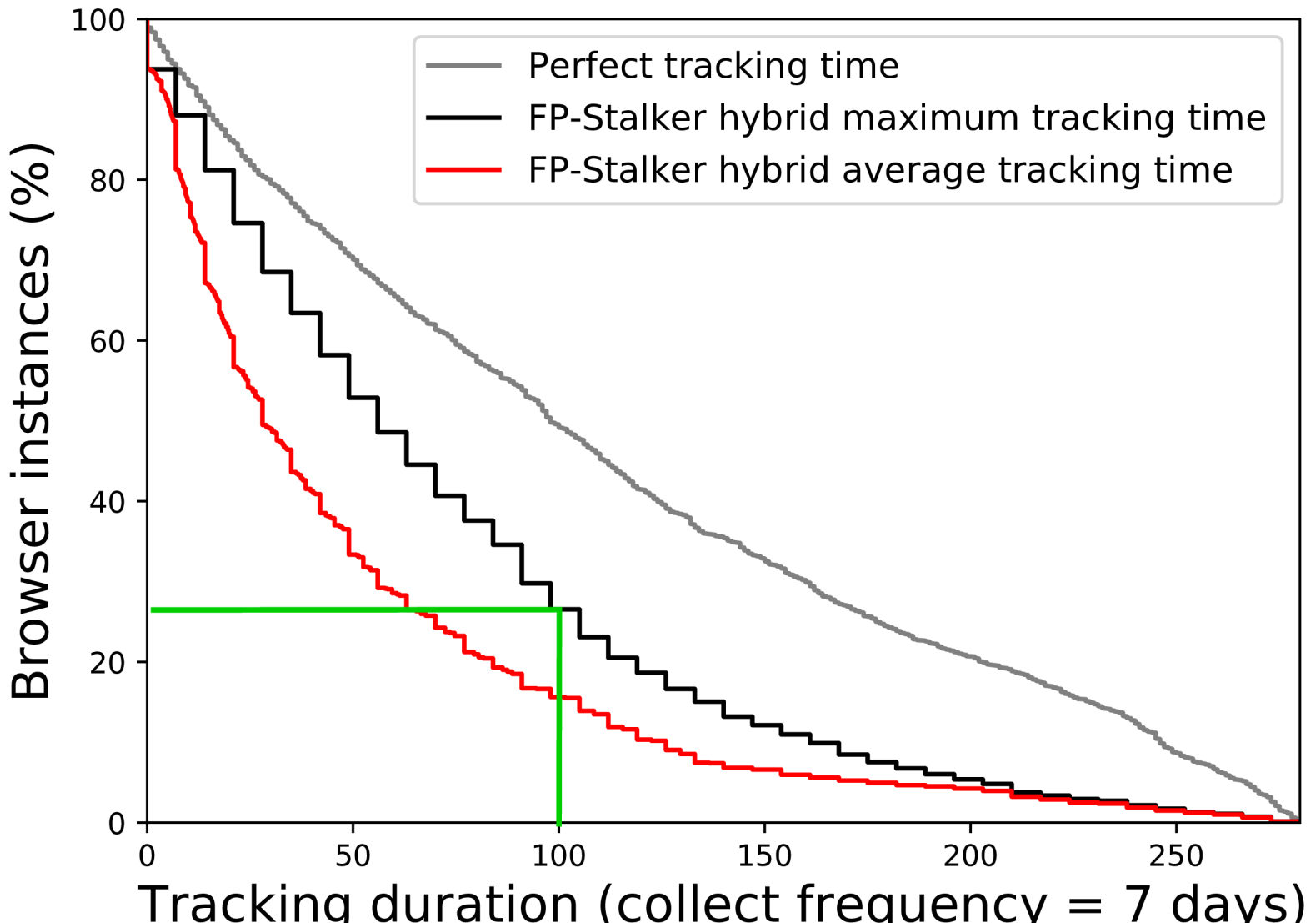
Fingerprints (chronological collection order)

Result of linking algorithm (mistakes shown)

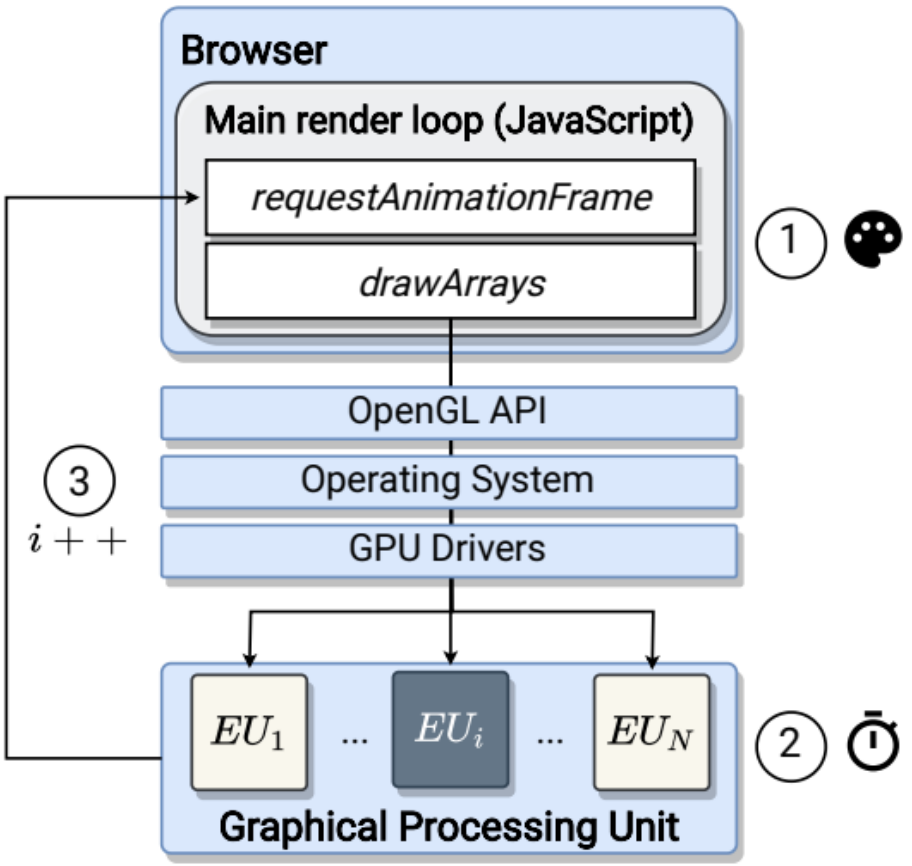


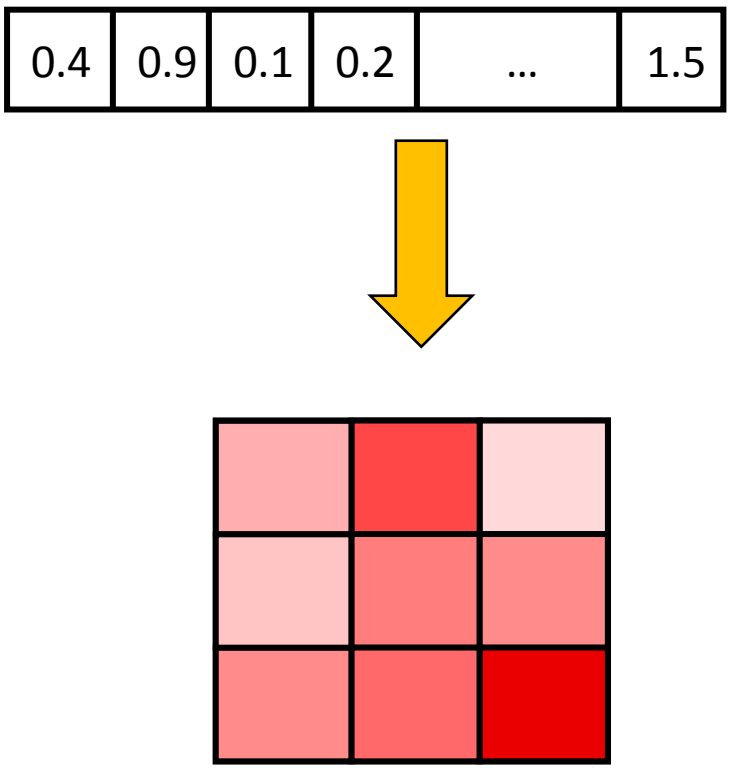
Fingerprint tracking duration

[IEEE S&P'18]



DrawnApart : GPU Fingerprinting [NDSS'22]





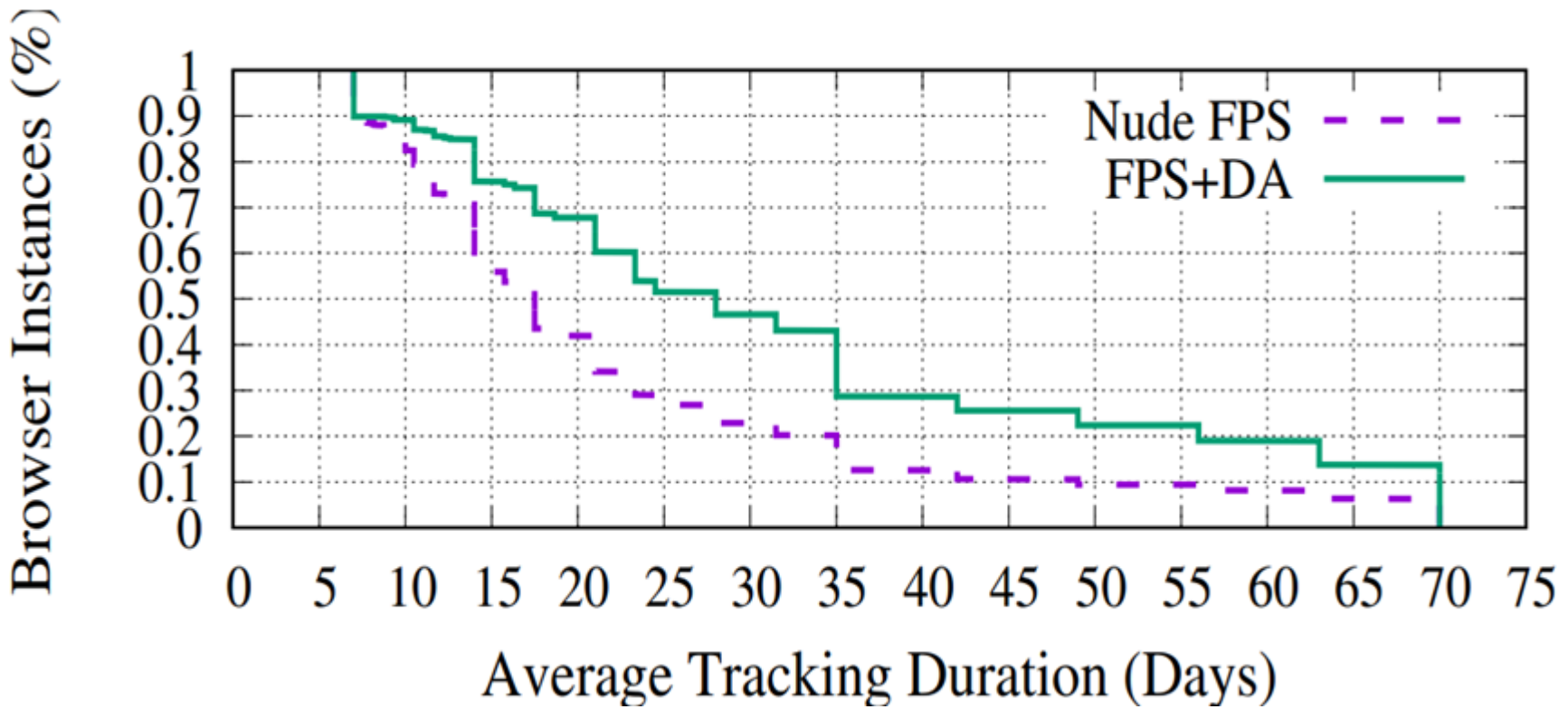
66% re-identification increment over SOA

Bug Bounty

Spec update

1st Place – Applied Research

DrawnApart : GPU Fingerprinting [NDSS'22]



66% improvement over FP-Stalker (FPS: 17 days - FPS+DA 27.5 days)

What about fingerprinting consistency?

FP-Scanner : Detecting incoherencies in countermeasures

[USENIX Security'18]

Key takeaways

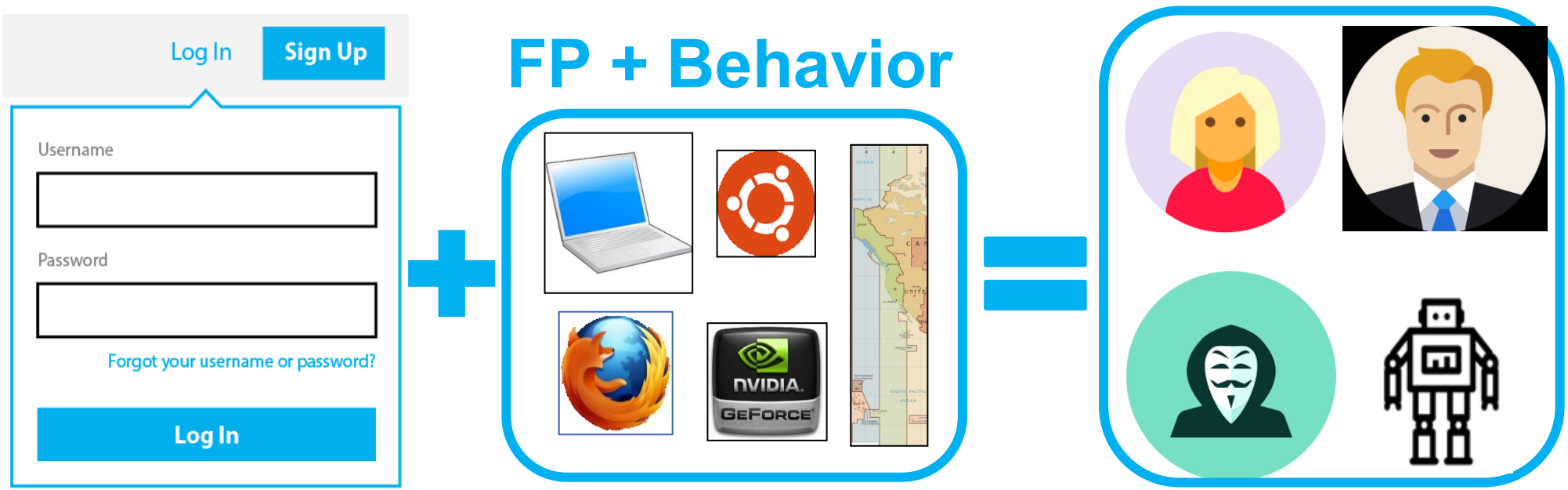
Fingerprinting is a threat to privacy [S&P'16]

- But not the *ultimate tracking technology* [S&P'18]
  - Complements cookies (e.g., cookie respawning)
- Few "good" defenses [UsenixSec'18]
  - But better ones can be made [IWIP'18, SEAMS'15]
- Many more risks to explore [WWW'20, NDSS'22]

➔ **Fingerprinting can be used for security**

Bot detection [MADWeb'20] MFA [DIMVA'21]

FP-Locker : Multi-Factor Authentication Systems with Browser Fingerprinting



Design of a novel authentication system

CAS Protoype

Technology Readiness Level 6 (*Demo in Relevant Environment*)

Identify new privacy risks

institut universitaire de France

Battery of Tests

Web technologies

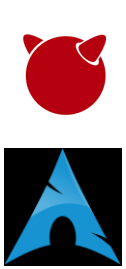
Models / Reports

How do we consistently identify new risks ?

From new features, changes to browser code, extensions

Systematically exploring configurations

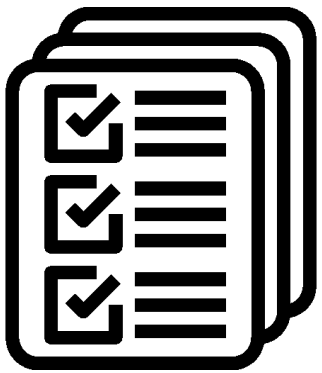
Fingerprint to identify privacy bugs



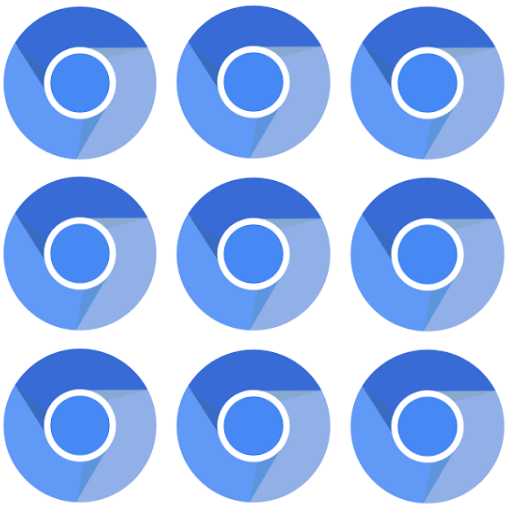
- Browser Runtime Configuration
- Environment Configuration
- Operating System Configuration
- Firmware Configuration
- Hardware Configuration

Thousands of configuration options

Systematically exploring configurations



Compile options



Identify privacy bugs

Browser Runtime Configuration

Environment Configuration

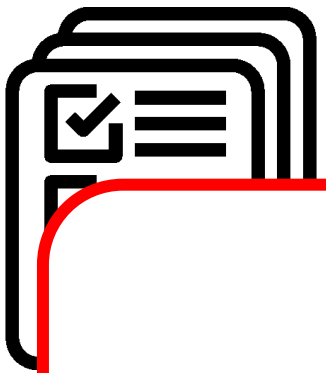
Operating System Configuration

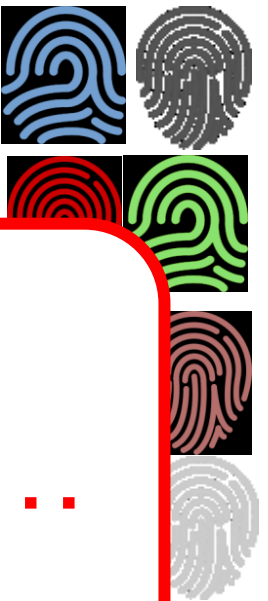
Firmware Configuration

Hardware Configuration

Thousands of configuration options

Systematically exploring configurations





Identify privacy bugs

And don't forget the 200k extensions in the Chrome Store… and Android apps

Environment Configuration

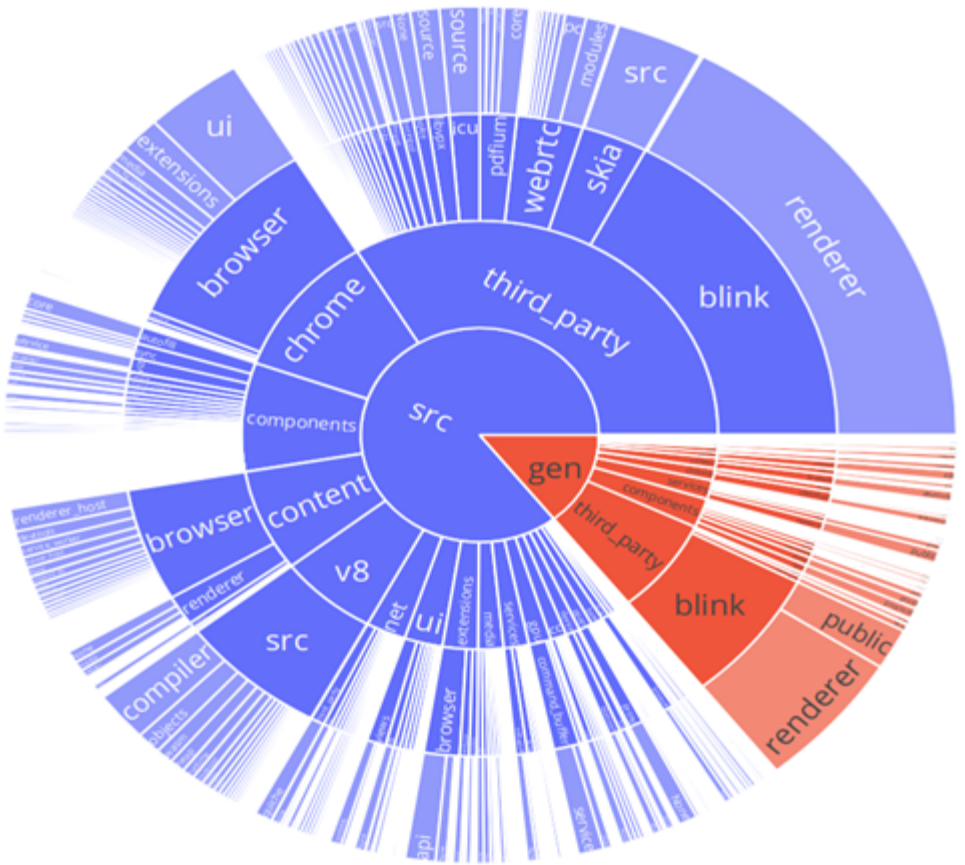
Operating System Configuration

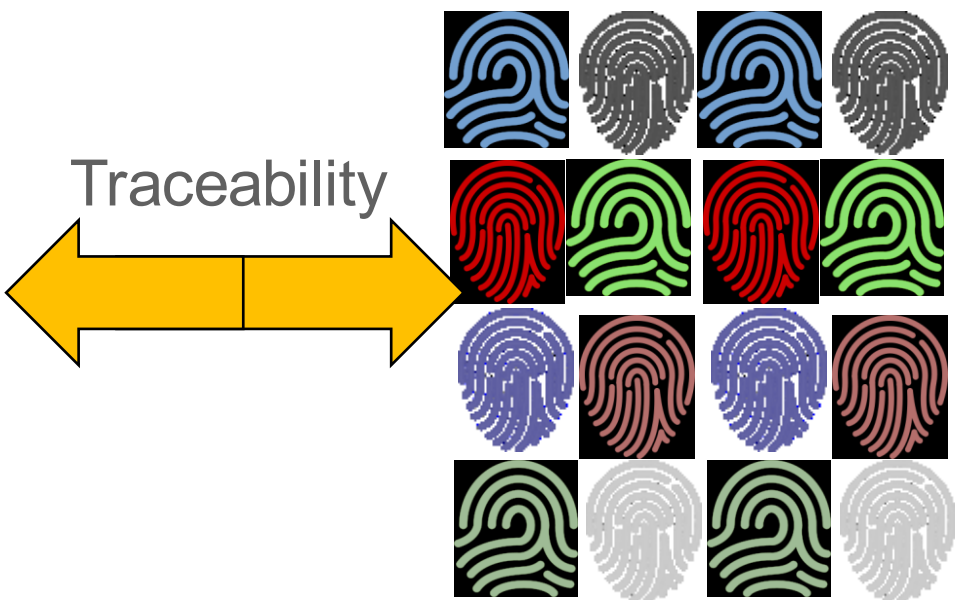
Firmware Configuration

Hardware Configuration

Thousands of configuration options

It’s all in the source code !

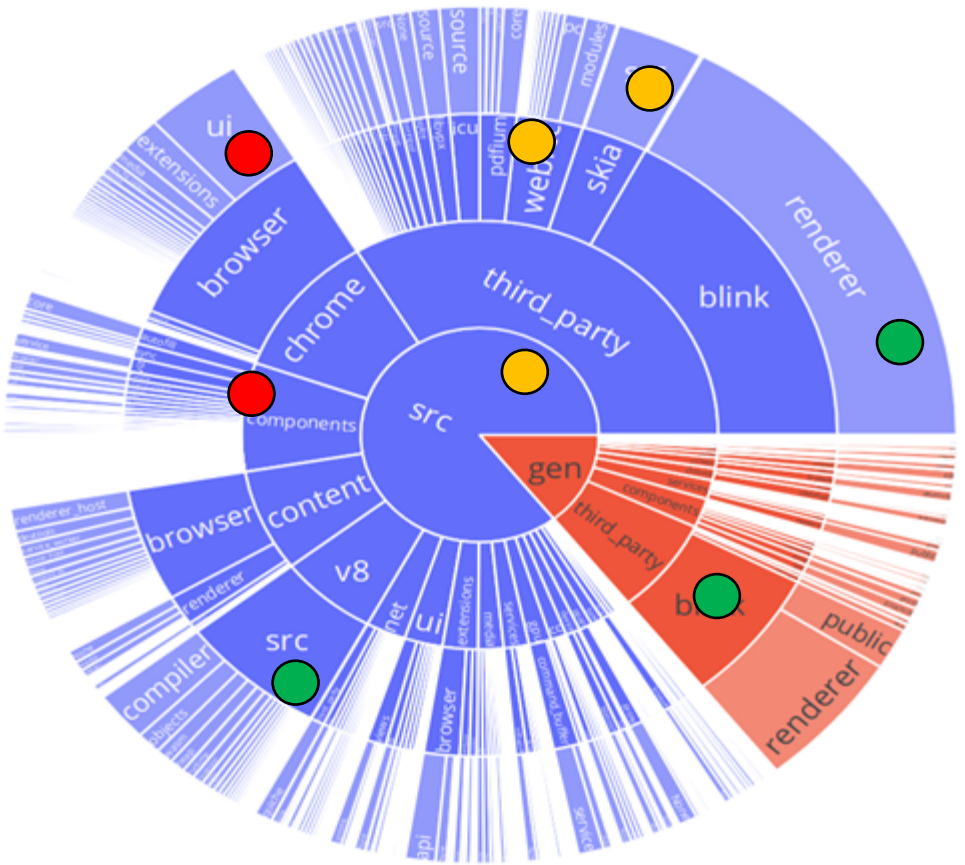




How can we identify fingerprint attributes in source code ?

From commit history, component, functions, …

It’s all in the source code !



Traceability

How can we identify fingerprint attributes in source code ?

From commit history, software component, functions, variables, …

Paper under review

FP-Rainbow : Fingerprint-based Browser Configuration Identification

Maxime Huyghe[1], Clément Quinton[1] and Walter Rudametkin[2]

[1] Univ. Lille, CNRS, Inria, Centrale Lille, UMR 9189 CRIStAL, F-59000 Lille, France
{maxime.huyghe,clement.quinton}@univ-lille.fr
[2] University of Rennes, IRISA, IUF
walter.rudametkin@irisa.fr

FP-Rainbow : Pipeline

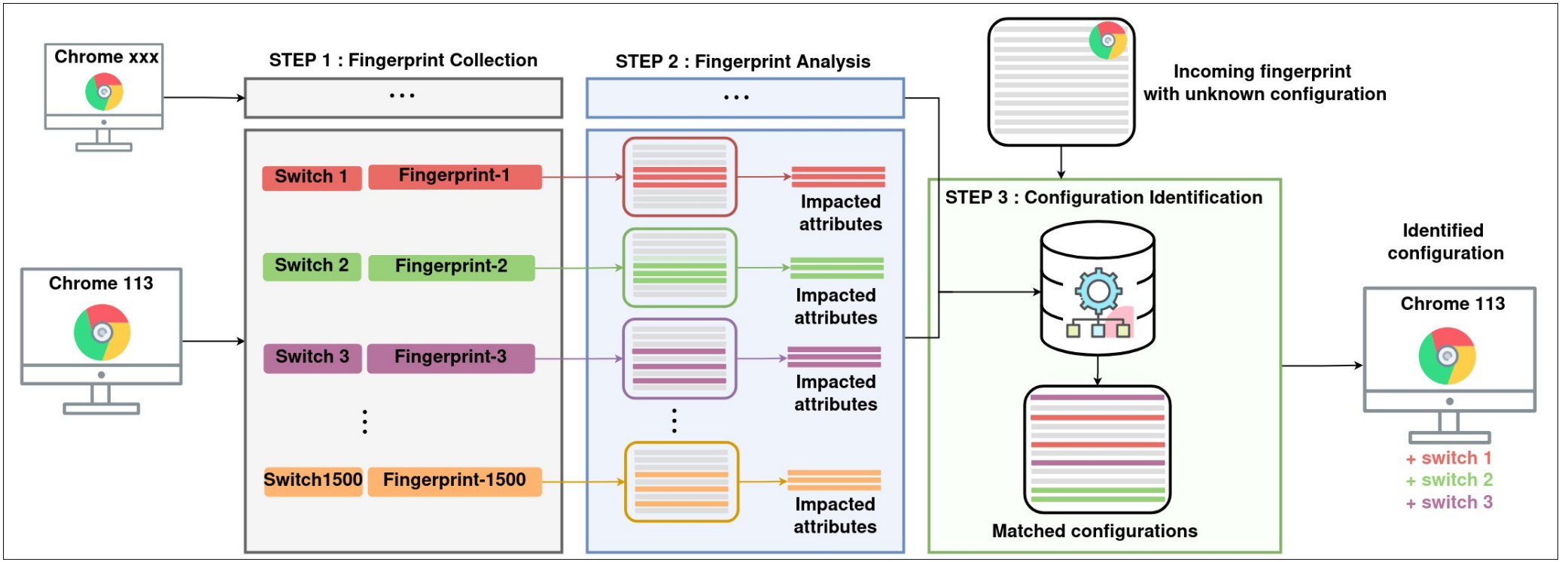
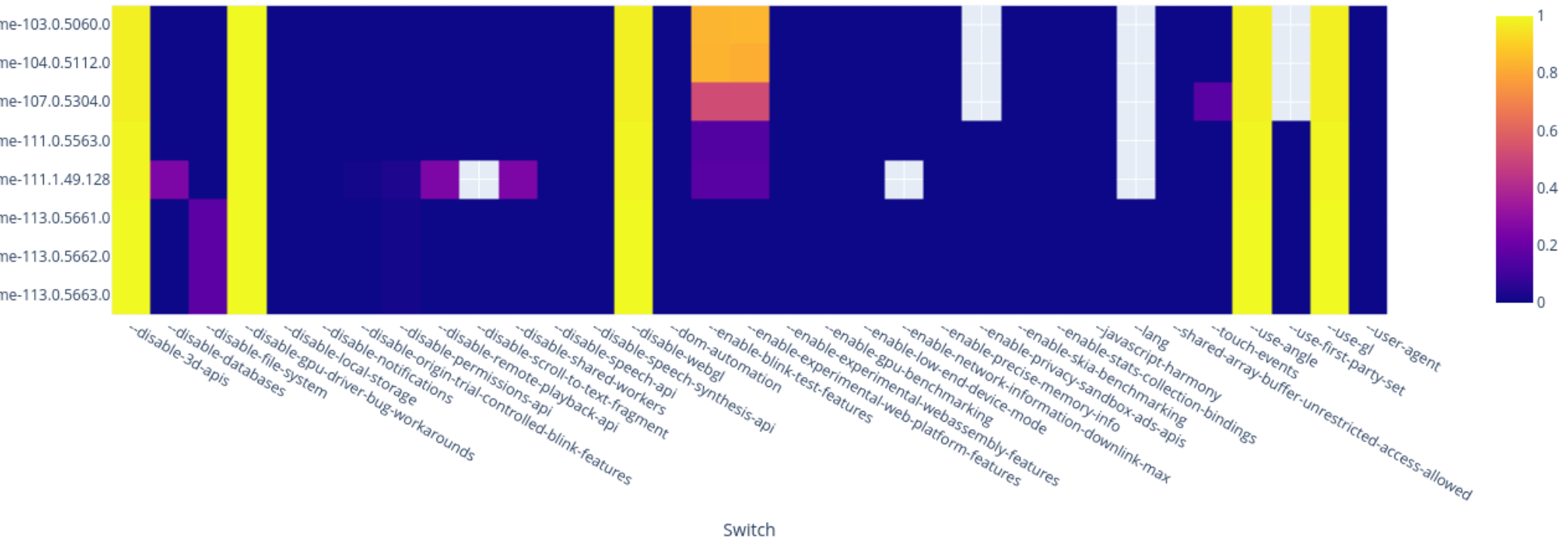


Table 1. Analysis of the effects of switches on the BOM and the FingerprintJS, including the generation of browser fingerprints, the frequency of timeouts, and the attribute density for specific browser versions

Browser Version	Number of switches that impact the BOM	Number of switches that impact FingerprintJS	Fingerprint Generated	Timeout during the test	Attributes per Fingerprint	Attributes on reference Fingerprint
109.0.5413.0	48	17	1477	4	12875-15750	14924
110.0.5476.0	49	18	1478	5	12871-15829	14963
111.0.5563.0	47	17	1478	4	12895-15903	15015
112.0.5607.0	47	17	1478	4	12895-15870	15015
113.0.5669.0	47	17	1478	4	12894-15888	15014
114.0.5731.0	47	17	1478	4	12910-15938	15059
115.0.5788.0	47	17	1478	4	13014-16018	15163
Headless109.0.5413.0	36	13	1491	4	12315-15242	14403
Headless110.0.5476.0	38	14	1491	5	12311-15321	14364
Headless111.0.5563.0	37	13	1492	4	12335-15395	14364
Headless112.0.5607.0	37	13	1492	4	12335-15362	14455
Headless113.0.5669.0	38	14	1492	4	12334-15380	14545
Headless114.0.5731.0	38	14	1492	4	12396-15430	14454
Headless115.0.5788.0	38	14	1492	4	12500-15510	14924

FP-Rainbow : Detect configurations

Use cases ?



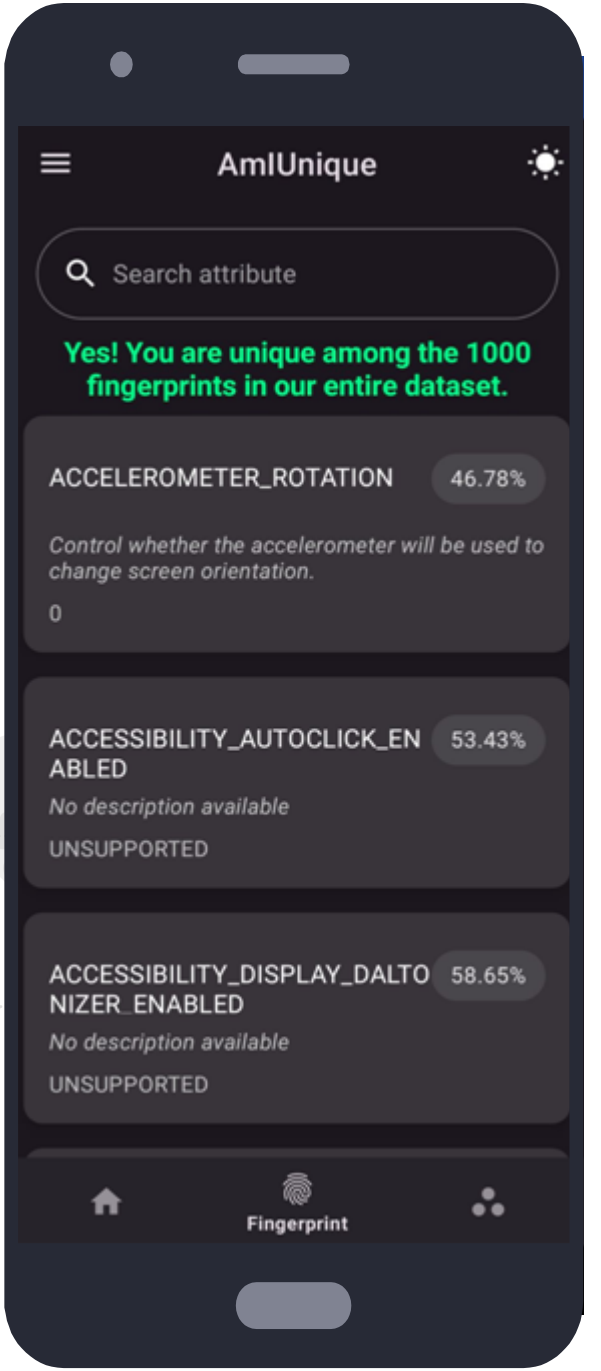
What about Android ?

PhD Sihem BOUHENNICHE (2024-2027)

Semi-exhaustive method to retrieve zero-permission attributes

Querying Android API using different techniques like Java Reflection

~280 native attributes retrievable by an Android application

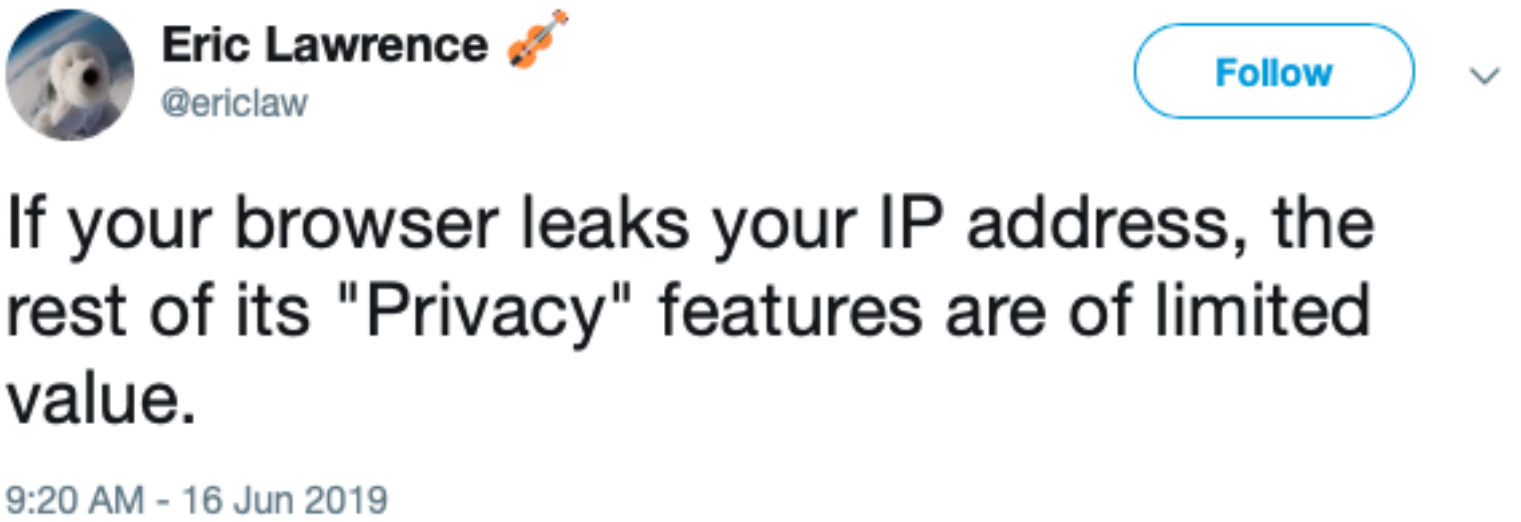


More alternatives to **tracking** cookies?

A Survey on Web Tracking: Mechanisms, Implications, and Defenses

Tomasz Bujlow, *Member, IEEE,* Valentín Carela-Español, Josep Solé-Pareta, and Pere Barlet-Ros

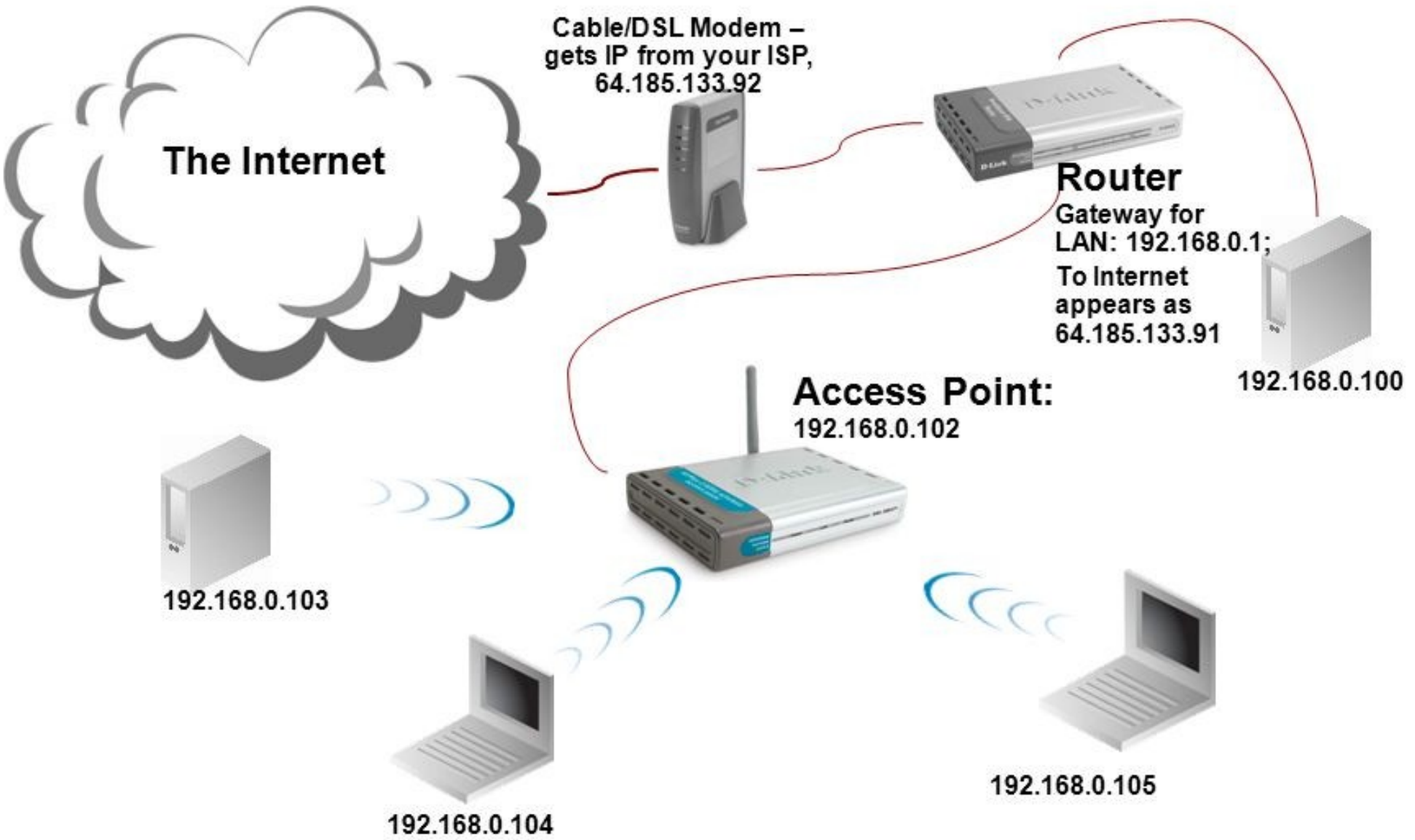
IPV4 ADDRESS



IPv4 Addresses

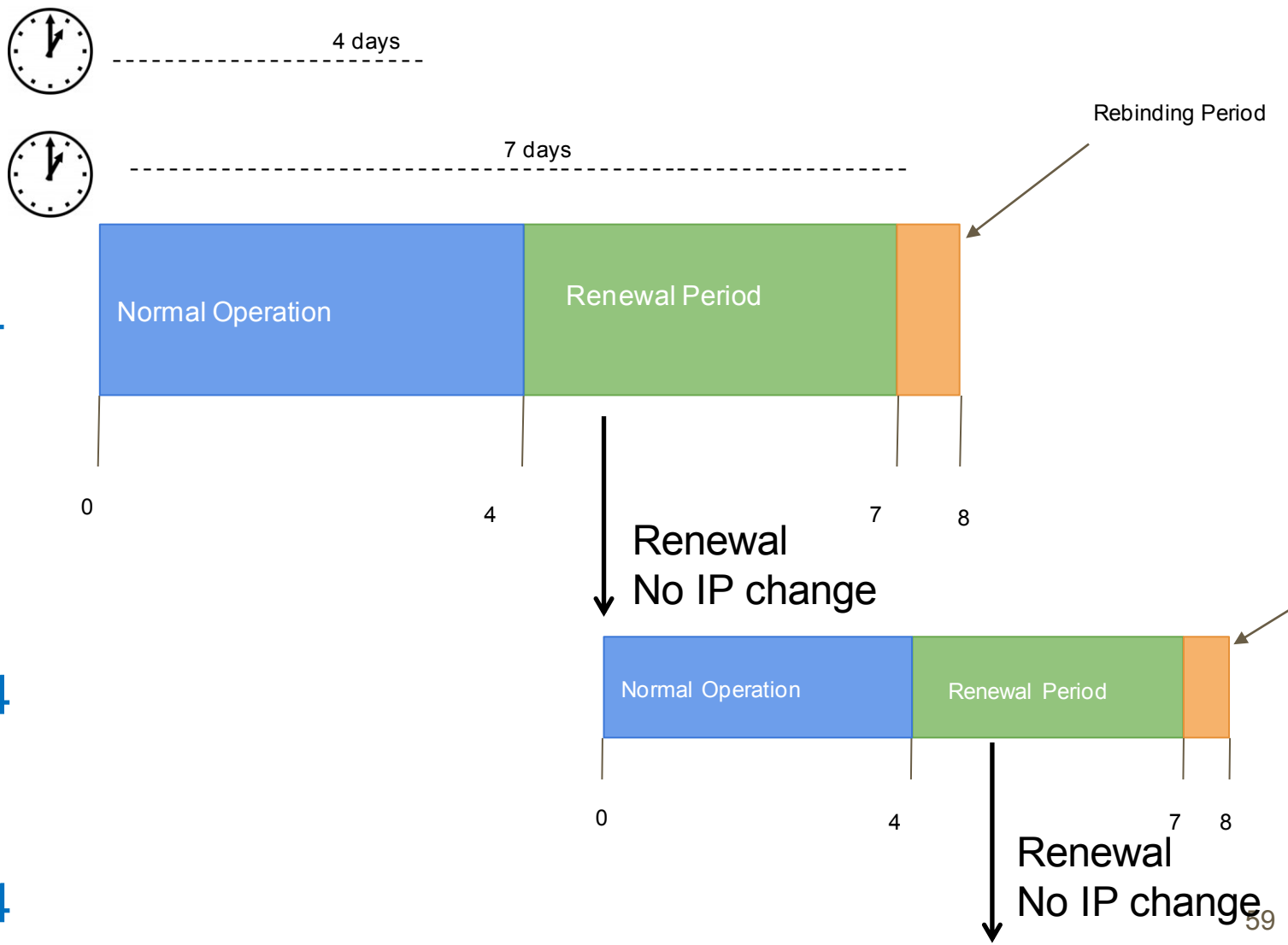
- IPv4 (32 bit)
  - 193.51.236.124
  - 4 billion, distributed across regions
- Types
  - Static Address
  - Dynamic Address
- DHCP (Dynamic Host Configuration Protocol)
  - DHCP leases
  - Duration of ‘lease’ negotiated, then address released back to server

Home Network- IP Addresses



DHCP Lease Cycle

Renewal T1
50% of Lease time



IP transitions: Antoine

193.51.236.160 -> 77.128.127.191, 2018-05-24 08:00:00
77.128.127.191 -> 193.51.236.160, 2018-06-01 13:00:00
193.51.236.160 -> 77.128.127.191, 2018-06-10 17:00:00
77.128.127.191 -> 193.51.236.160, 2018-06-15 09:00:00
193.51.236.160 -> 77.128.127.191, 2018-07-05 15:00:00
77.128.127.191 -> 193.51.236.160, 2018-07-10 13:00:00

Lille

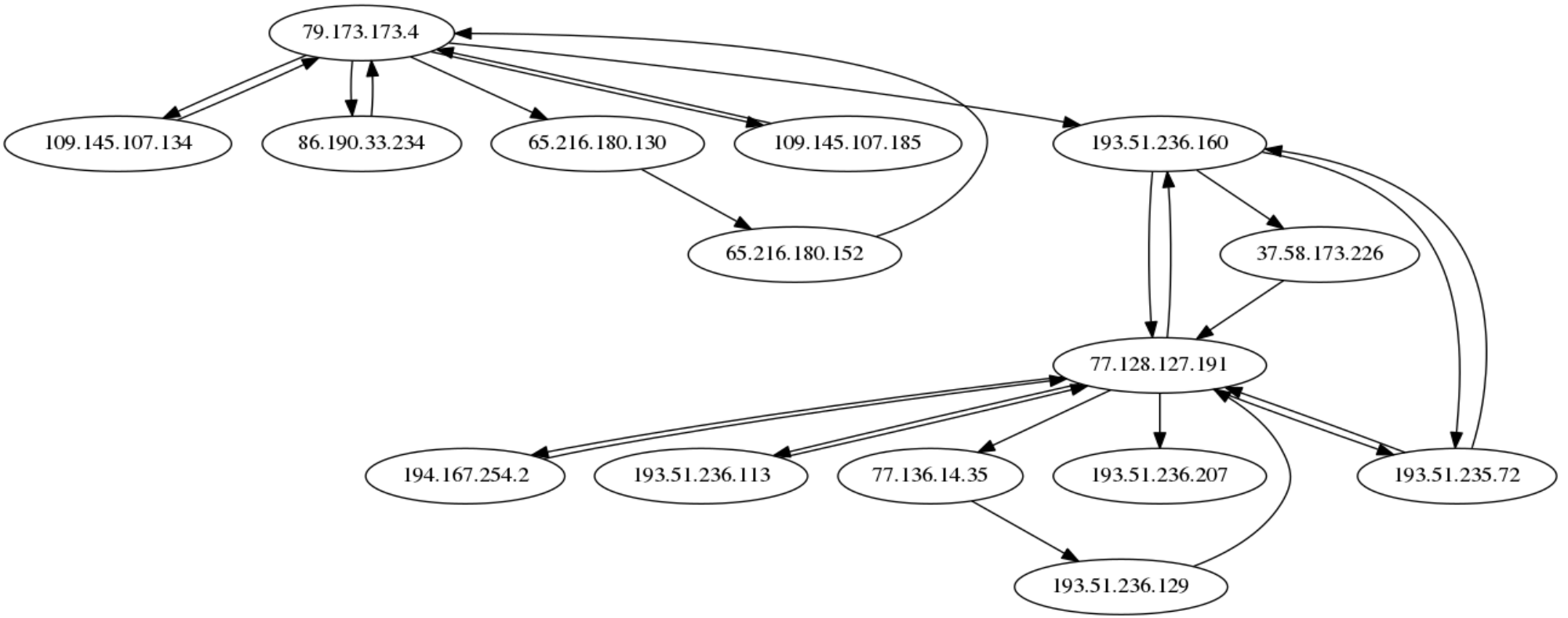
79.173.173.4 -> 109.145.107.134, 2018-07-12 20:00:00
109.145.107.134 -> 79.173.173.4, 2018-07-16 11:00:00
79.173.173.4 -> 109.145.107.134, 2018-07-30 18:00:00
109.145.107.134 -> 79.173.173.4, 2018-07-31 09:00:00
79.173.173.4 -> 86.190.33.234, 2018-08-11 16:00:00
86.190.33.234 -> 79.173.173.4, 2018-08-13 12:00:00

London

193.51.236.160 -> 77.128.127.191, 2018-09-06 17:00:00
77.128.127.191 -> 193.51.236.160, 2018-09-07 13:00:00
193.51.236.160 -> 77.128.127.191, 2018-09-07 17:00:00
77.128.127.191 -> 194.167.254.2, 2018-09-12 13:00:00
194.167.254.2 -> 77.128.127.191, 2018-09-12 18:00:00
77.128.127.191 -> 193.51.236.160, 2018-09-13 13:00:00

Lille

Antoine's IP transitions [WWW'2018]



Some repeated addresses

Some long-lived addresses

Cookie reconstruction ?

Don't Count Me Out: On the Relevance of IP Address in the Tracking Ecosystem

Vikas Mishra
Inria / Univ. Lille
vikas.mishra@inria.fr

Pierre Laperdrix
CNRS / Univ. Lille / Inria
pierre.laperdrix@univ-lille.fr

Antoine Vastel
Univ. Lille / Inria
antoine.vastel@inria.fr

Walter Rudametkin
Univ. Lille / Inria
walter.rudametkin@univ-lille.fr

Romain Rouvoy
Univ. Lille / Inria / IUF
romain.rouvoy@univ-lille.fr

Martin Lopatka
Mozilla
mlopatka@mozilla.com

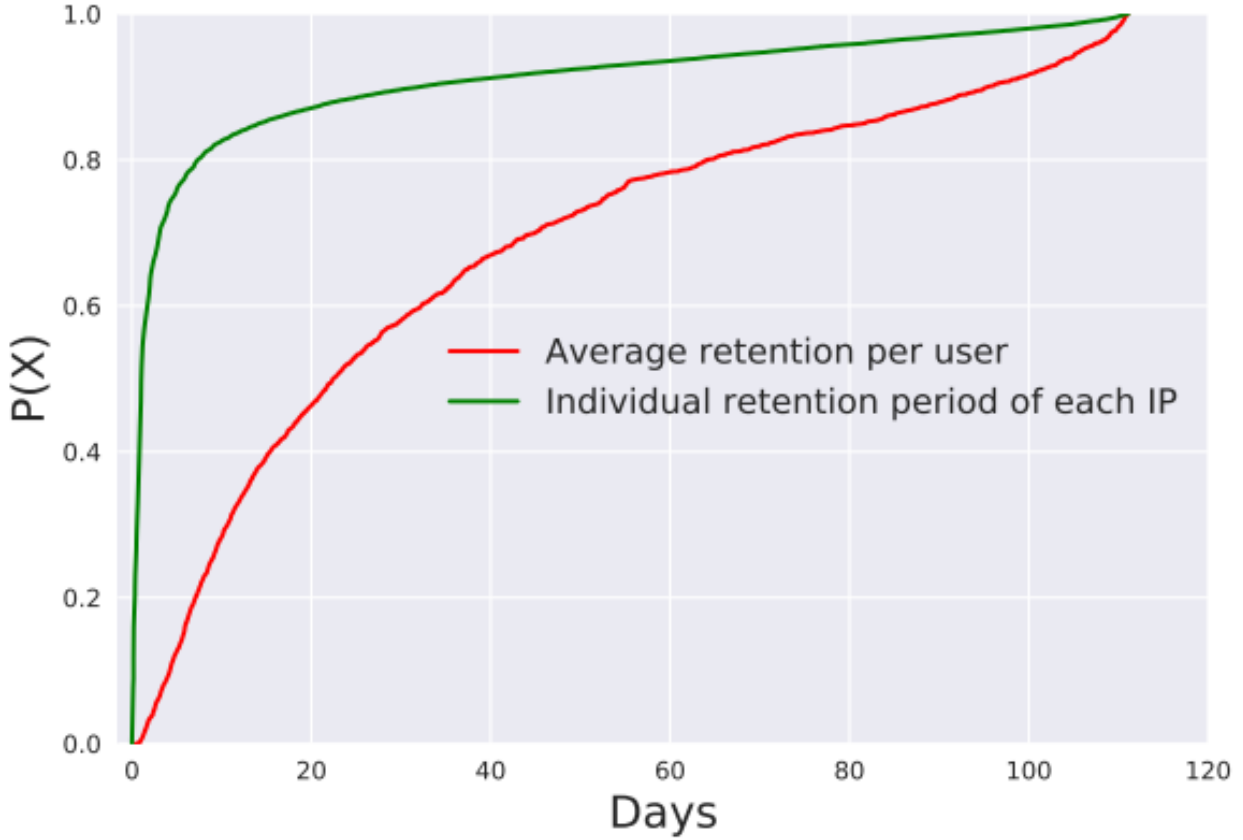
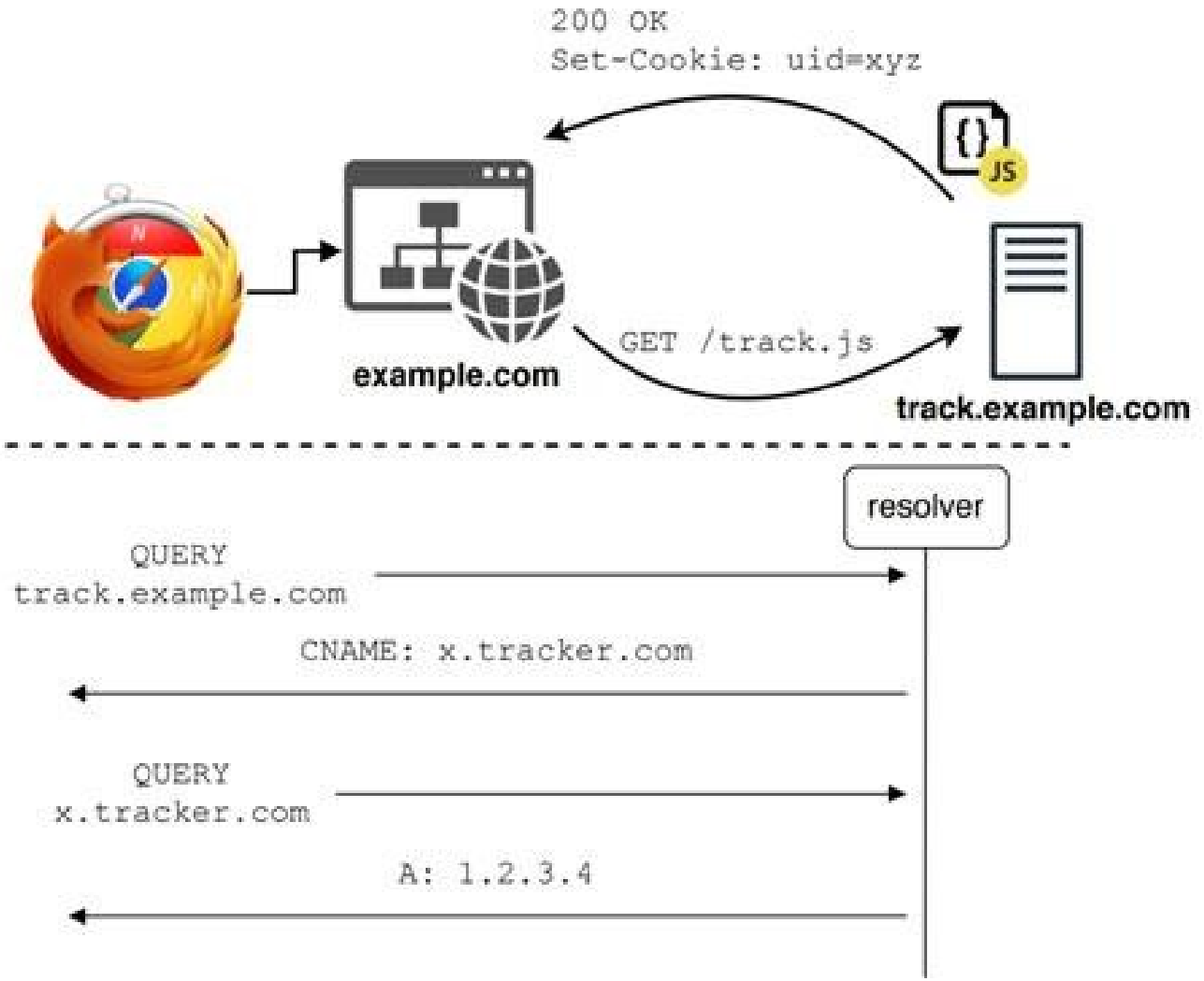


Figure 4: Retention period of IP addresses. The green line

CNAME Cloaking

DNS-based Tracking Evasion



But… Same Origin Policy ?

Device Linking:
Personal Identifiable Information

Did you leak anything ?

Login
Email
Telephone
Name
Location
Home address
ZIP Code
Date of birth
IP Address
…

Client-side vs Server-side tracking

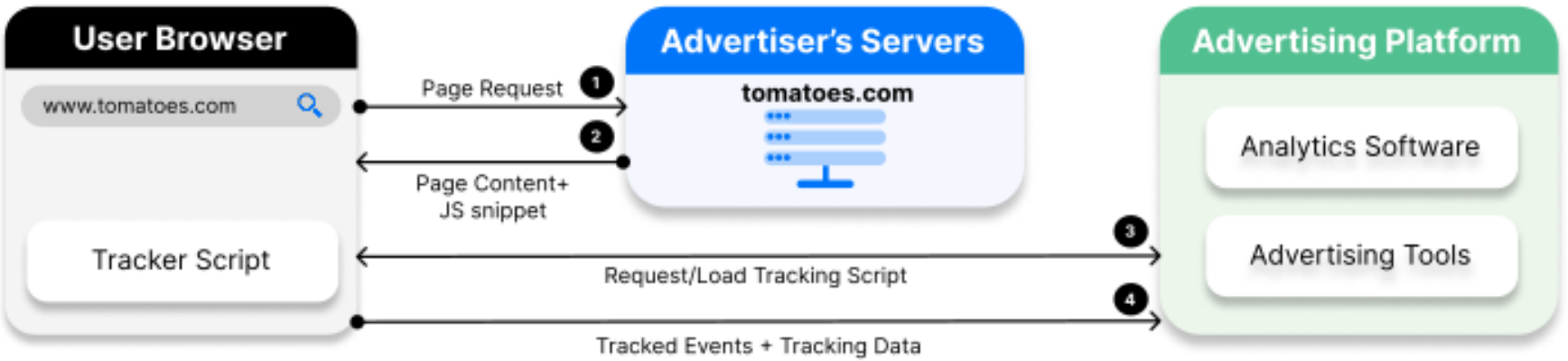


Figure 1: Client-side tracking.

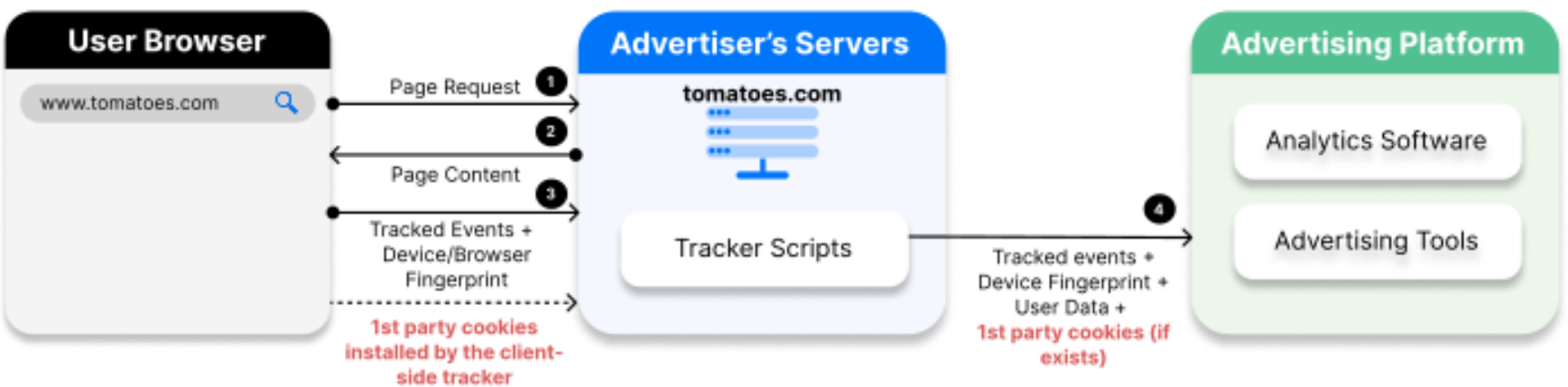


Figure 2: Server-side tracking.

Server-side tracking

- Two main SST technologies
  - Google Tag Manager (GTM)
  - Meta Conversions API (CAPI)
    - Often combined with Meta Pixel (client-side)
    - Uses Personal Identifiable Information to retarget you !!!

How effective is Meta at tracking?
[PETS 2024]

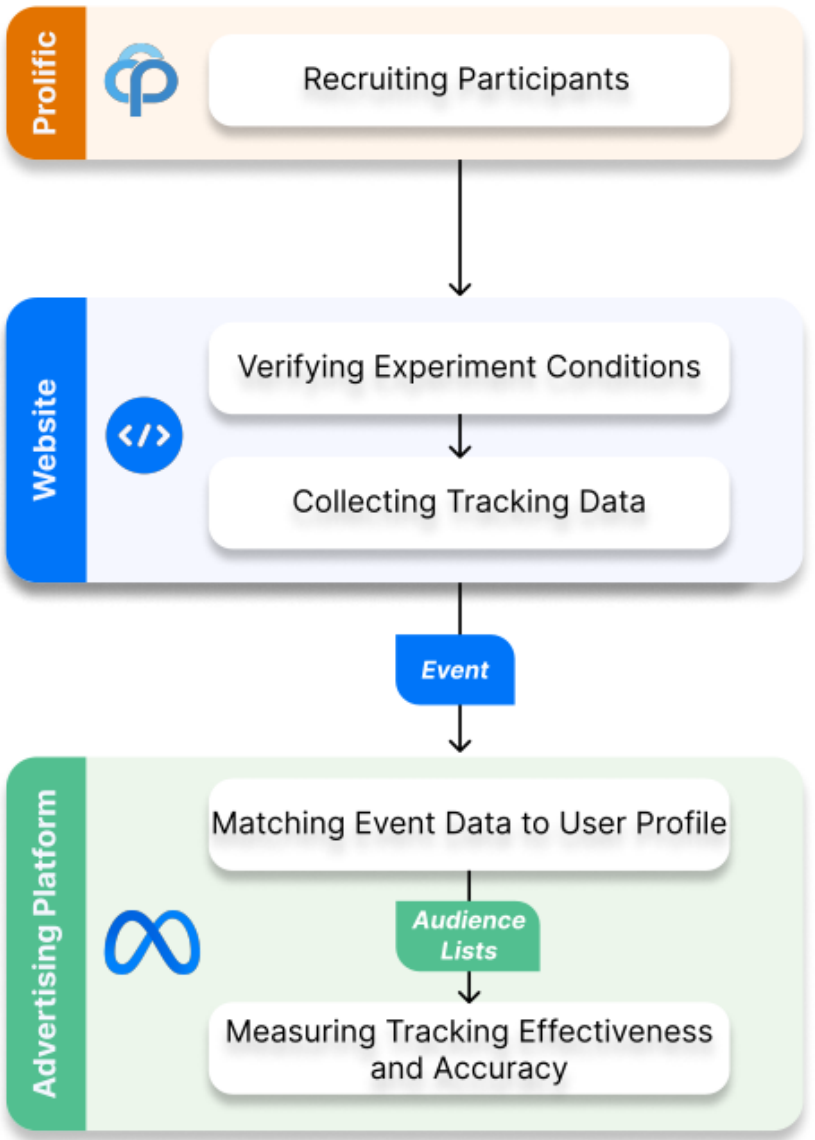


Figure 3: General workflow of experiments.

How effective is Meta at tracking? [PETS 2024]

Table 7: Examples of cookies installed by Meta's client-side trackers used for advertising.

Cookies	Domain	Content
c_user	Facebook	The Facebook account ID of the user currently connected on the browser. Lifespan of 1 year.
fr	Facebook	Stores Facebook account details. Used for ad delivery and improving ads relevancy. Lifespan of 90 days.
sb	Facebook	Used to store browser details. Lifespan of 373 days.
_fbp	First-party	Facebook Browser ID. A **unique ID** saved under the website domain when the user first visits the website. Used for advertising and site analytics. Lifespan of 90 days.
_fbc	First-party	Facebook Click ID. When users click on ads on Facebook, the link includes a "fbclid" query parameter. When users land on the target website, the Meta Pixel automatically this query parameter to the _fbc cookie. It is used to report actions, such as purchases, generated through Facebook ads. Lifespan of 90 days.
usida	Facebook	A session cookie that collects a combination of the user's browser and unique identifiers. Used for tailored advertisi
oo	Facebook	Used for Facebook advertisement and behavioral targeting. Lifespan of 5 years.

How effective is Meta at tracking? [PETS 2024]

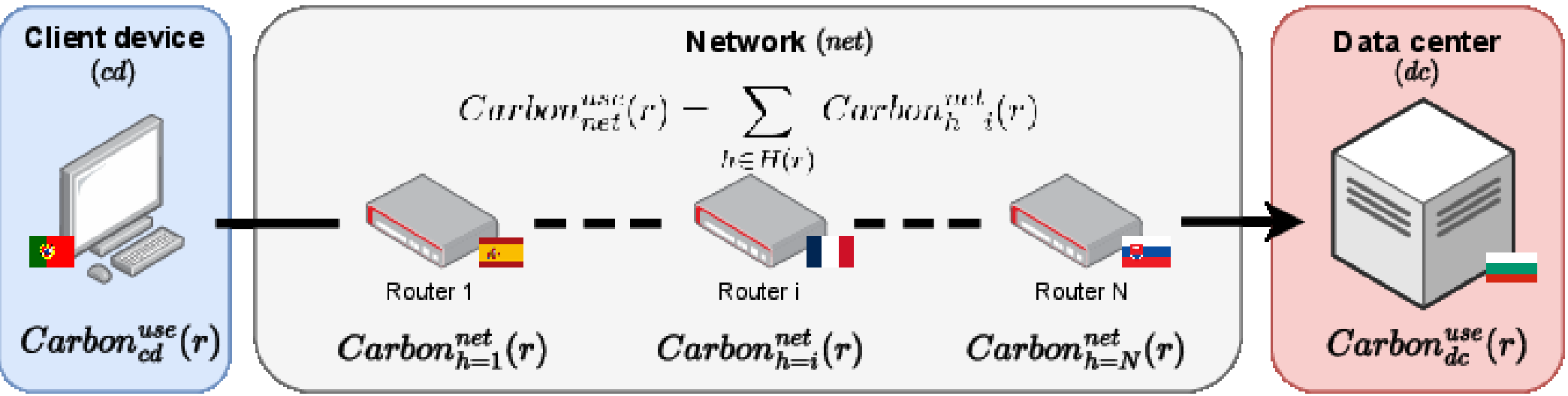
Experiment	#	fbp	Users	Pixel	CAPI	Overlap
Desktop: Chrome	1	No	400	46%	51%	43%
	2	No	1000	43%	44%	48%
	3	Yes	500	44%	45%	73%
	4	Yes	500	42%	45%	74%
Mobile: Chrome	1	No	300	61%	34%	50%
	2	No	250	N/A	51%	N/A
	3	No	175	N/A	50%	N/A

- N/A indicates that the tracker was not implemented on the website.

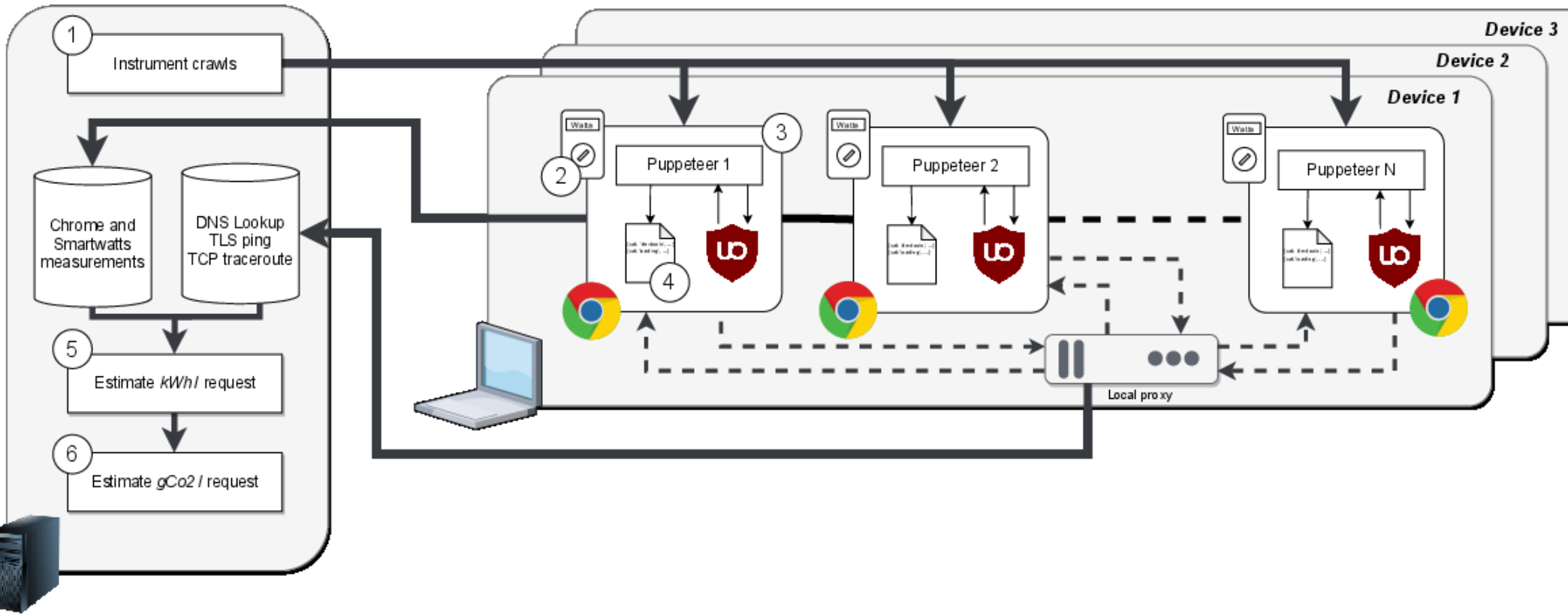
Implementation	Events	Reach	Accuracy	Overlap
Pixel 1	1722	61.09%	81.45%	52%
CAPI 1	1833	19.74%	64.80%	
Pixel 2 (isolated)	812	63.30%	100%	58%
CAPI 3 (isolated)	958	16.32%	59.6%	

MORE FUN STUFF !!!

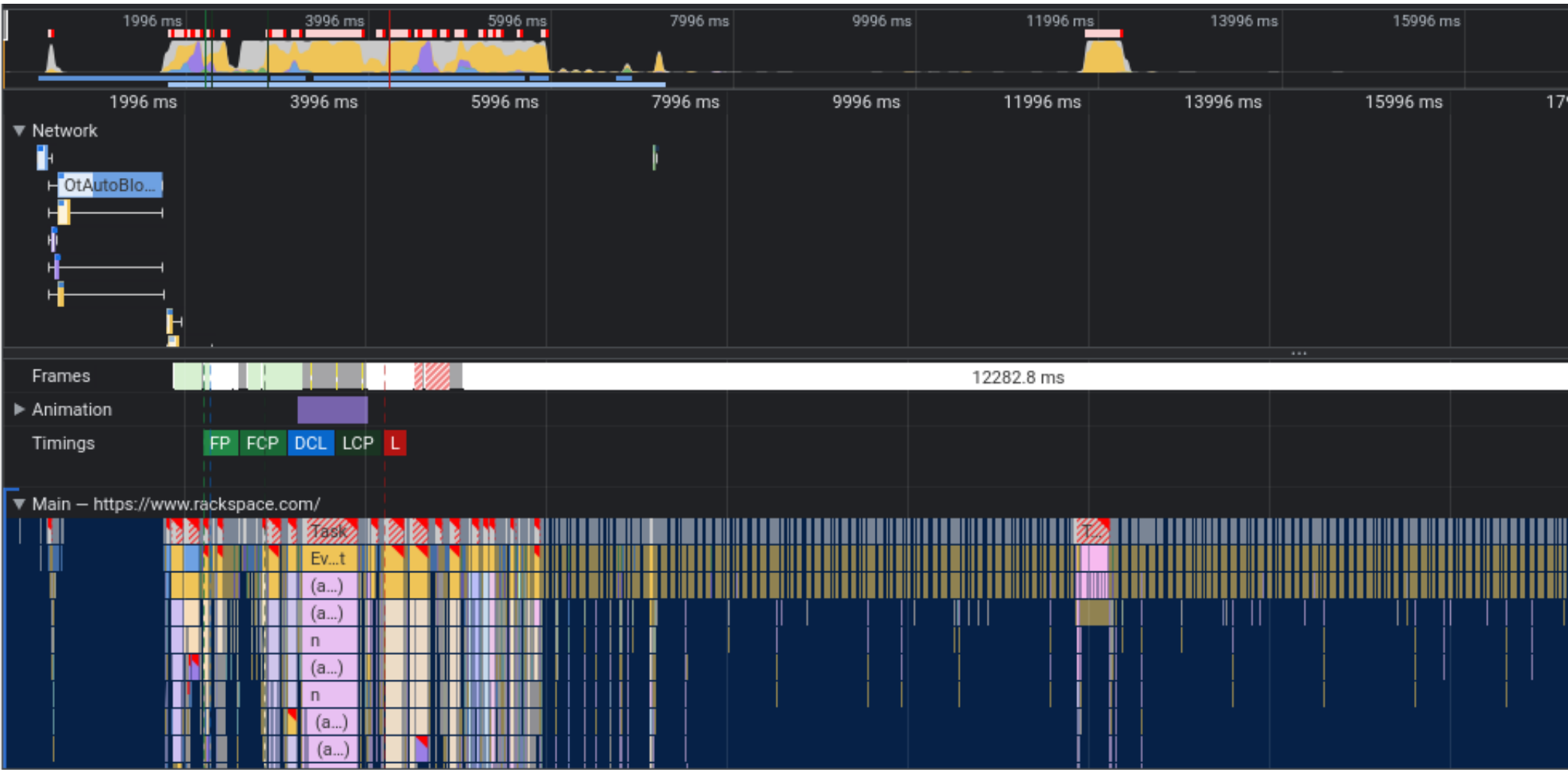
Ad-Carbon : End-to-End analysis of the Carbon Footprint of Advertising



Ad-Carbon : End-to-End analysis of the Carbon Footprint of Advertising



Ad-Carbon : End-to-End analysis of the Carbon Footprint of Advertising



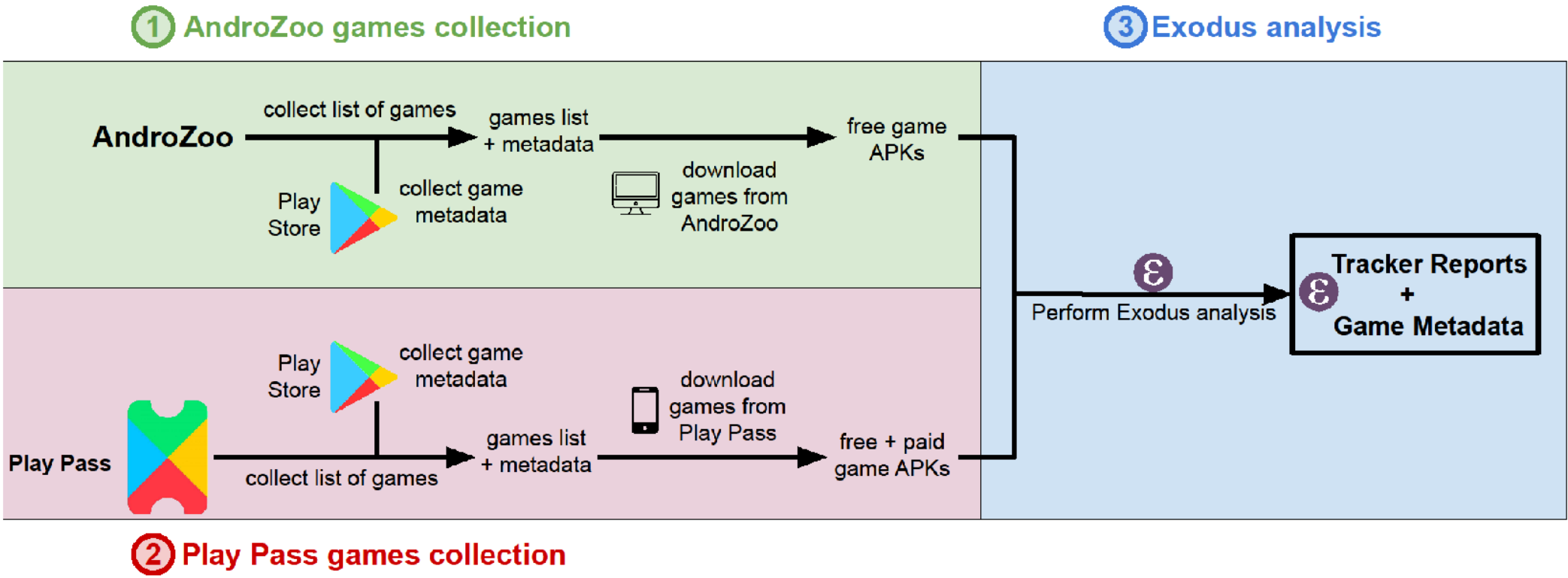
Ad-Carbon : End-to-End analysis of the Carbon Footprint of Advertising

We crawled 10,562 domains

- 31,394 pages

- Advertising increases carbon emissions by **144%** for our crawls
- Accepting cookie banners
  - 90% carbon footprint increase
  - 38.8% more advertising requests

Do free Android games track you more ?



The Price to Play: a Privacy Analysis of Free and Paid Games in the Android Ecosystem

Pierre Laperdrix, Naif Mehanna, Antonin Durey, Walter Rudametkin

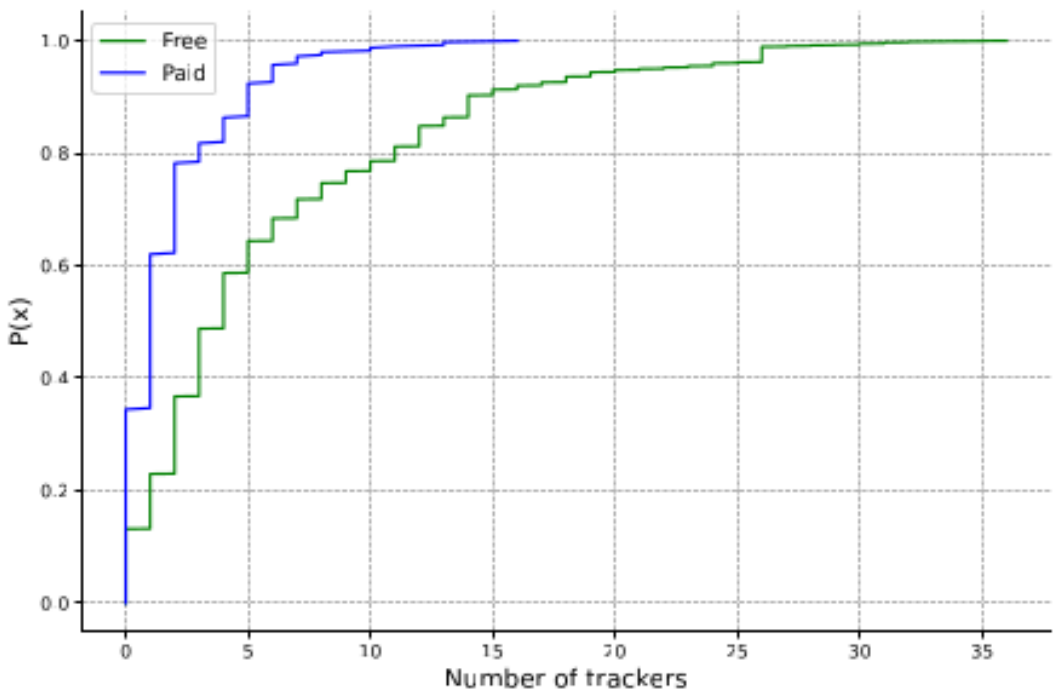


Figure 2: Distribution of trackers across free and paid games.

Table 1: Source of the games present in our dataset.

	Free games	Paid games	Total
AndroZoo	6,035	0	6,035
Play Pass	320	396	716
Total	6,355	396	6,751

Table 2: Overview of the presence of trackers in the games of our dataset

	Percentage of games with trackers	Average number of trackers per game	Standard deviation
Free	86.79%	6.11	6.65
Paid	65.31%	1.80	2.38

CONCLUDING REMARKS
(ONLY 5 MORE SLIDES)

Surveillance Capitalism

The Age of Surveillance Capitalism. S. Zuboff

Surveillance Capitalism

Adtech 2024

~$800B USD

Areas of academic interest

Large scale monitoring

Identifying and repairing new privacy risks

Recommender systems

- AI Bias, Influence, Manipulation, Targeting

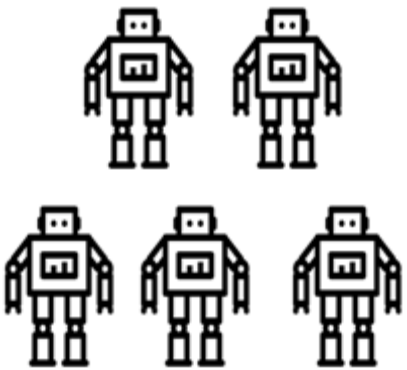
Legislation to protect privacy

- GDPR, ePrivacy, Digital Markets Act

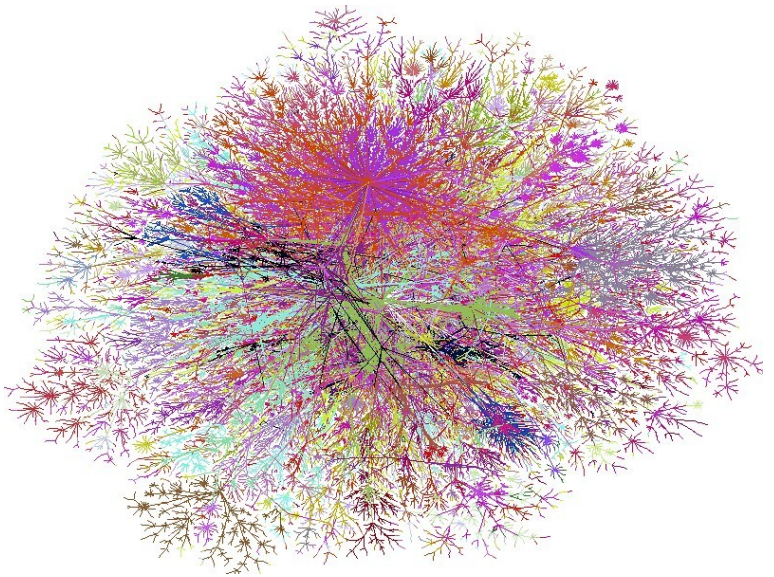
Societal impact of omnipresent surveillance

- Social cooling

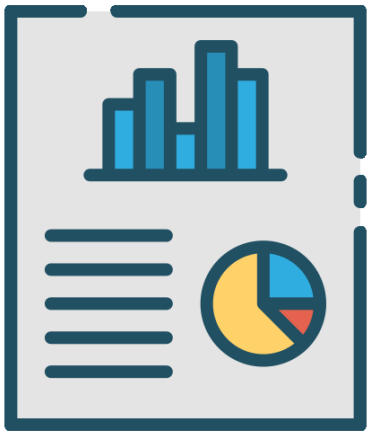
Large scale Web monitoring



Infrastructure



The Web 1998



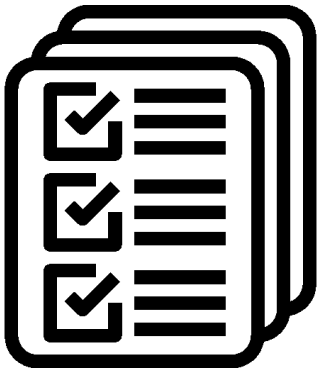
Security and Privacy

How do we study complex systems ?

[DIMVA 21]
[MADWeb 20]
[WWW 20a]
[WWW 20b]

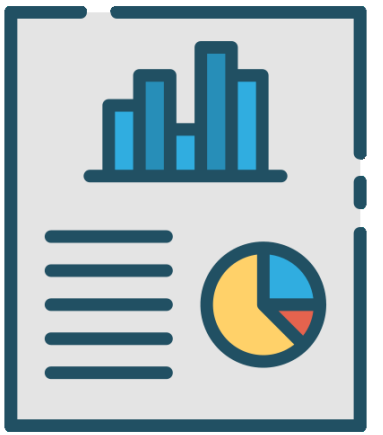
New privacy risks

Battery of Tests



Web technologies

Models / Reports



How do we consistently identify new risks ?

[NDSS 22]
[Bug Bounty Mozilla]
[UsenixSec'18]
[PETS'21]

Ben-Gurion University of the Negev

THE UNIVERSITY of ADELAIDE

The end

Backup slides

Next Steps

Release the App to collect real world fingerprints

1

Run experiments in controlled environments on different emulators

The impact of permissions on fingerprinting

2

3

Longitudinal study: the impact of the Android API evolution on fingerprinting

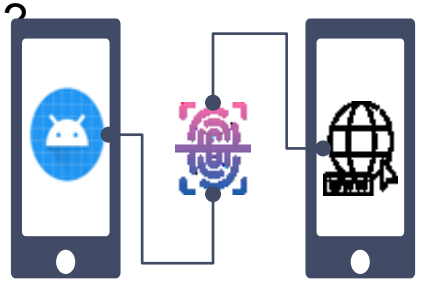
Other Directions

Device fingerprinting in the iOS ecosystem

What is the impact of the device's settings on the fingerprint ?

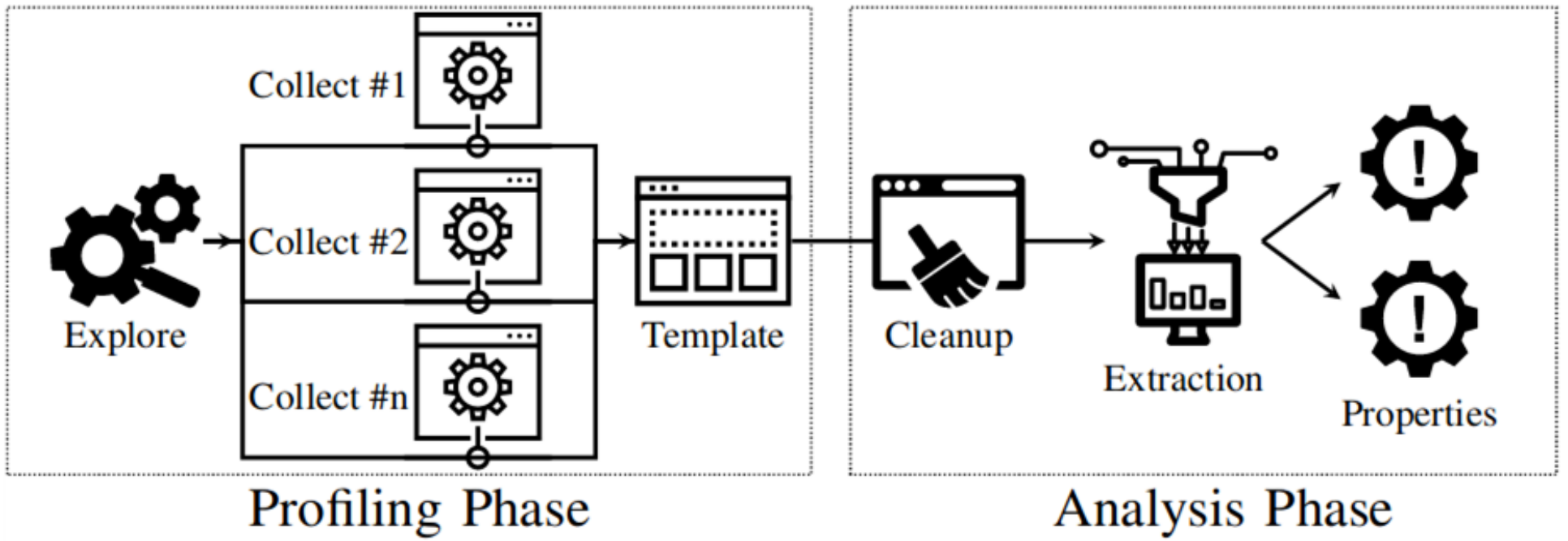
Do Android applications use device fingerprinting?

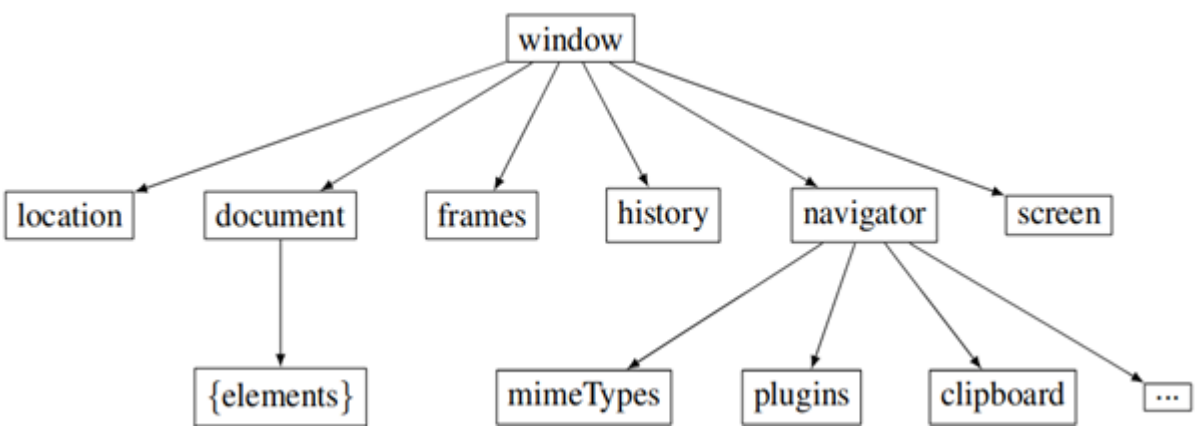
Can we link browser fingerprints and device fingerprints to the same device ?



JavaScript Template Attacks [NDSS19] :

Systematic fingerprint attributes extraction (no function calls)





JavaScript Template Attacks [NDSS19] :
Results

Documented **vs.** discovered properties

Browser	MDN	JavaScript Template
Firefox	2247	15 709
Chrome	2698	13 570
Edge	1806	9666
Firefox Android	2104	15 612
Chrome Android	2676	13 119
Tor browser	2247†	15 639

Some properties are random or duplicates

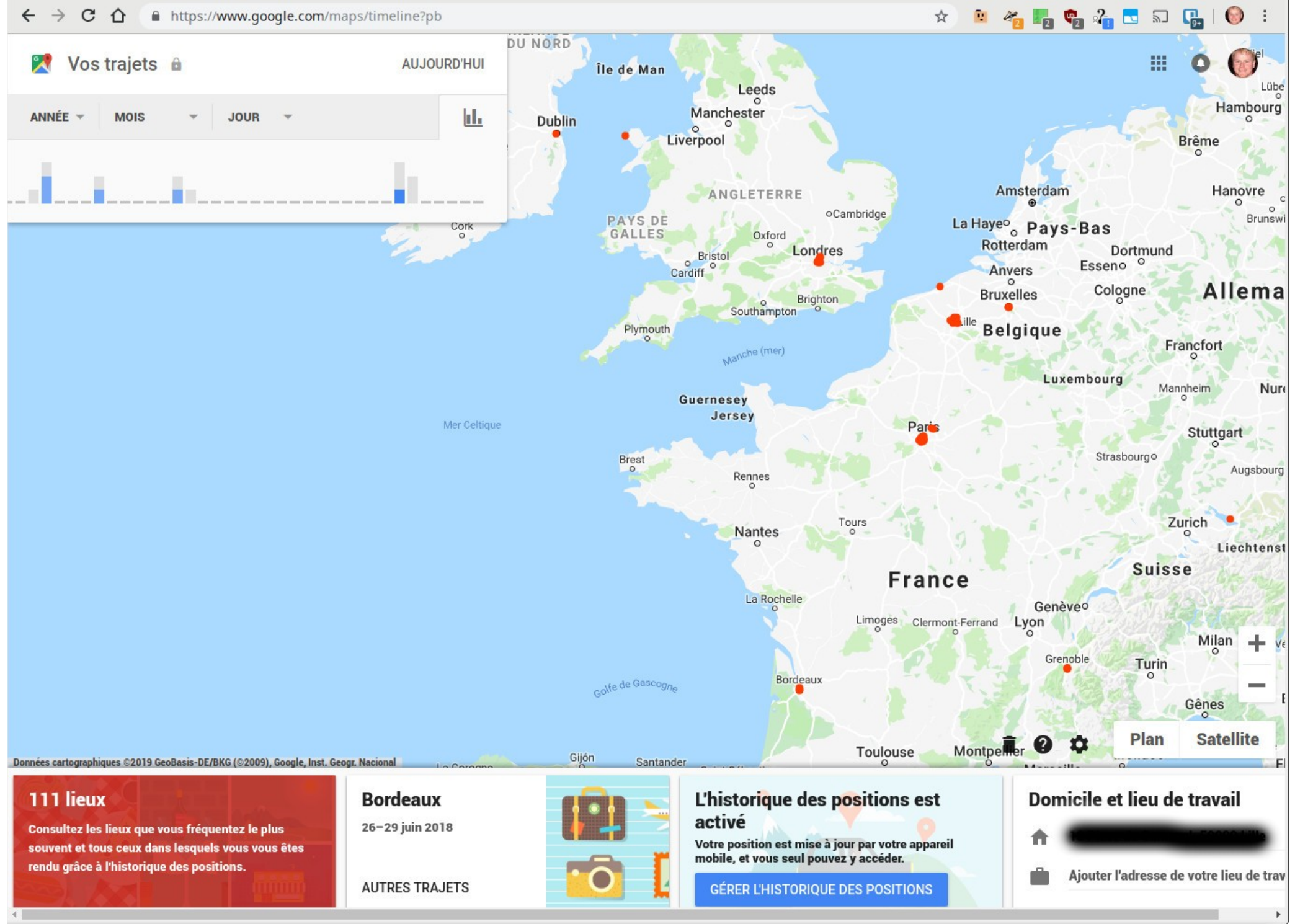
Browser	Exploration	Without duplicates	Usable
Firefox	18 443	16 450	15 709
Chrome	15 585	13 604	13 570
Edge	13 752	11 850	9666
Firefox Android	18 214	16 296	15 612
Chrome Android	15 556	13 608	13 119
Tor browser	17 217	15 645	15 639

"It will be very hard for people to watch or consume something that has not in some sense been tailored for them."

Eric Schmidt, Google

Exercise 1: Your location

- If activated, Google constantly stores your location and creates a timeline
- https://www.google.com/maps/timeline?pb
- Show it to your colleague!


https://www.google.com/maps/timeline?pb
Vos trajets
AUJOURD'HUI
ANNÉE
MOIS
JOUR
Île de Man
Leeds
Manchester
Liverpool
Dublin
Cork
ANGLETERRE
PAYS DE GALLES
Cambridge
Oxford
Londres
Bristol
Cardiff
Brighton
Southampton
Plymouth
Manche (mer)
Guernesey
Jersey
Mer Celtique
Brest
Rennes
Nantes
Tours
La Rochelle
Limoges
Clermont-Ferrand
Bordeaux
Golfe de Gascogne
Gijón
Santander
Toulouse
Montpellier
Paris
Amsterdam
La Haye
Rotterdam
Pays-Bas
Anvers
Bruxelles
Belgique
Lille
Dortmund
Essen
Cologne
Brême
Hambourg
Hanovre
Francfort
Luxembourg
Mannheim
Stuttgart
Strasbourg
Augsbourg
Zurich
Suisse
France
Genève
Lyon
Grenoble
Milan
Turin
Gênes
Plan
Satellite
Données cartographiques ©2019 GeoBasis-DE/BKG (©2009), Google, Inst. Geogr. Nacional
111 lieux
Consultez les lieux que vous fréquentez le plus souvent et tous ceux dans lesquels vous vous êtes rendu grâce à l'historique des positions.
Bordeaux
26–29 juin 2018
AUTRES TRAJETS
L'historique des positions est activé
Votre position est mise à jour par votre appareil mobile, et vous seul pouvez y accéder.
GÉRER L'HISTORIQUE DES POSITIONS
Domicile et lieu de travail
Ajouter l'adresse de votre lieu de trav

https://www.google.com/maps/timeline?pb=!1m2!1m1!1s2018-05-25

Vos trajets

AUJOURD'HUI

2018 | mai | 25

Après-midi dans le lieu suivant : Electronic Frontier Foundation

Vendredi 25 Mai 2018

10,4 km
2 h 46 min

Ajouter un lieu

À pied - 2,4 km — 24 min

Lower Nob Hill — 11:15 – 11:49

San Francisco, Californie, États-Unis

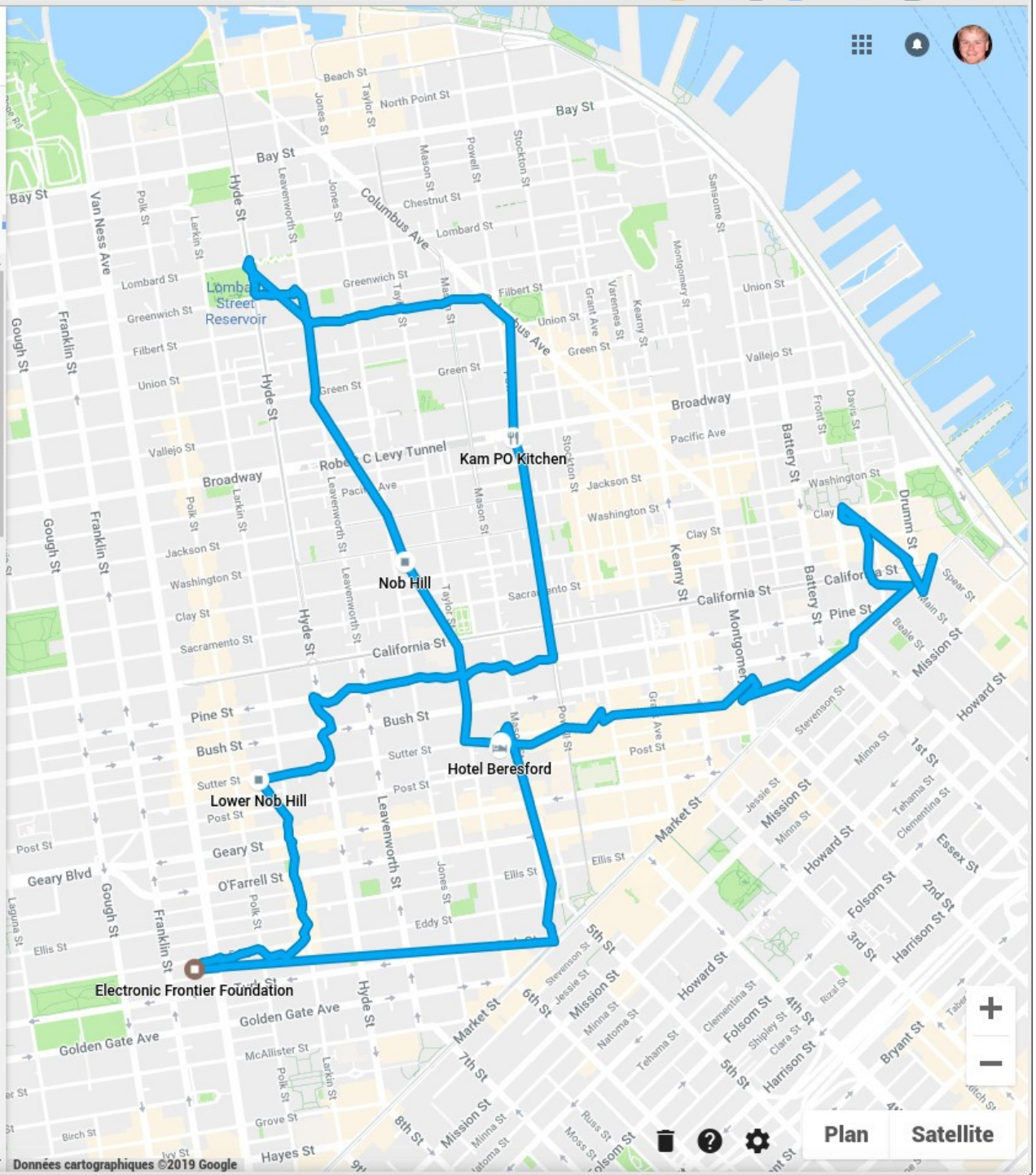
À pied - 700 m — 6 min

Nob Hill — 11:55 – 12:12

San Francisco, Californie, États-Unis



+ 2 AUTRES



IP Address Dataset

- AmIUnique browser extensions for Chrome and Firefox
- June 6, 2019 - September 25, 2019
- 41,566 unique IP addresses from 5,443 browser instances
- Frequency 4 hours
- Desktop Devices
- IPv4 addresses

- IP sharing behind NAT
  - 1,046 users share at-least 1 IP with another user

- However, a set of IP addresses retained by a user over a long duration are highly discriminating
  - pair-wise comparison
  - 93% users had a unique set of long-lived IP Addresses

Uniqueness of IP Address

- IP sharing behind NAT
  - 1,046 users share at-least 1 IP with another user

- However, a set of IP addresses retained by a user over a long duration are highly discriminating
  - pair-wise comparison
  - Jaccard Similarity (J) = 0 for 99.97% of pairs of users.
  - 93% users had a unique set of long-lived IP Addresses