



# Discovering databrokers

Bringing to light hidden companies

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Universitat Politècnica de Catalunya (UPC)

ESNOG 32 – 25 Oct. 2024

# Third-party trackers

GOBIERNO DE COALICIÓN >

## El PSOE y Sumar alcanzan un acuerdo de Gobierno que incluye la semana laboral de 37,5 horas

El pacto para la legislatura contempla también los impuestos a la banca y las grandes energéticas, el aumento del parque público de vivienda y la ampliación de permisos retribuidos por nacimiento



Pedro Sánchez y Yolanda Díaz, durante la firma del acuerdo, este martes.  
Foto: SAMUEL SÁNCHEZ | Video: EPV

PAULA CHOUZA | CARLOS E. CUÉ | JOSÉ MARCOS

Madrid - 24 oct 2023 - 08:43 | Actualizado: 24 OCT 2023 - 21:50 CEST

[f](#) [X](#) [in](#) [274](#)

La coalición da un paso decisivo para la investidura de Pedro Sánchez, a la espera de cerrar un pacto con los demás aliados de la mayoría. El PSOE y Sumar han sellado su acuerdo de

POLÍTICA

## La intrahistoria del pacto PSOE-Sumar: "matices de matices" hasta la madrugada y sin concreciones para otros pactos "en cascada"

PREMIUM

RAÚL PIÑA

@\_raulpina\_  
Madrid

Actualizado Miércoles,  
25 octubre 2023 -  
09:26



Sánchez y Díaz sellan un acuerdo sin mención a la amnistía ni a Cataluña



Pedro Sánchez y Yolanda Díaz, en la presentación del pacto de Gobierno PSOE-Sumar. ALBERTO DI LOLLÍ

Coalición PSOE y Sumar sellan en su pacto de

Suele decirse que lo que no se nombra no existe. Quizás sea eso lo que explique que el pacto de Gobierno entre el PSOE y

# Third-party trackers

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+ 33Across IAB TCF	Block	Authorize
+ 3Q GmbH IAB TCF	Block	Authorize
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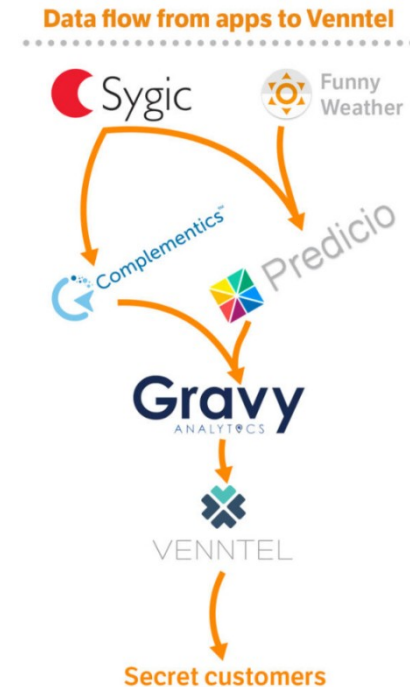


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+Active Agent (Virtual Minds GmbH)IAB TCF	+AdheseIAB TCF	+AdomikIAB TCF	+AdTiming Technology Company LimitedIAB TCF	+AlgoriX Technology Pte. Ltd.,IAB TCF	+AragoIAB TCF	+Audienz AGIAB TCF
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+ad6mediaIAB TCF	+Adjust Digital A/SIAB TCF	+Adrino Mobile Sp. z o.o.IAB TCF	+ADventori SASIAB TCF	+AdverlineIAB TCF	+AREIA (ADLOOP)IAB TCF	+AudionIAB TCF
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			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Arrivalist Co.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+ArtChaos s.r.o.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Artefact Deutschland GmbHIAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Arpeely Ltd.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Arrivalist Co.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+ArtChaos s.r.o.IAB TCF	
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			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+ArtChaos s.r.o.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Artefact Deutschland GmbHIAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Arpeely Ltd.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Arrivalist Co.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+ArtChaos s.r.o.IAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Artefact Deutschland GmbHIAB TCF	
			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+Arpeely Ltd.IAB TCF	
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			+Adverticum cPlc.IAB TCF	+Advertising.Tech FZ-LLCIAB TCF	+ArtChaos s.r.o.IAB TCF	
			+Adverticum cPlc.I			

# Data brokers

- Companies or business units whose primary source of revenue is selling user personal information in data market places [1]
- Dangers for the user
  - Profiles may be (most surely) incorrect
  - There is no easy way to discover and correct it (despite GDPR)
  - There is no easy way to know to whom our info was sold to [2,3]
  - There is no easy way to know how this is impacting us!!



[1] A. Rieke, H. Yu, D. Robinson, and J. van Hoboken, "Data Brokers in an Open Society", Open Society Foundations 2016  
[2] <https://nrkbeta.no/2020/12/03/my-phone-was-spying-on-me-so-i-tracked-down-the-surveillants/>  
[3] <https://techcrunch.com/2023/05/21/the-government-cant-seize-your-data-but-it-can-buy-it/>

# Cybercrime



## The Conti Leaks: A Case of Cybercrime's Commercialization

**99%**

of over 1,000 studied executive members have their personal information available on more than three dozen online data broker websites, with a large percentage listed on more than 100

# Tracking purposes

- Purposes and implications
  - Targeted advertising
  - Price discrimination [4]
  - Insurance coverage [5]
  - Credit rating [6]
  - Phishing/identity theft (e.g. Conti Leaks)
  - Political interests (e.g. Cambridge Analytica)



Issue: September 21, 2021

## **IMF report suggests credit scores could soon be based on web browsing history**

Dystopian future.

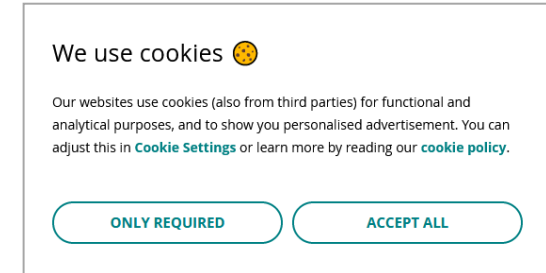
[4] J. Mikians, L. Gyarmati, V. Erramilli, and N. Laoutaris, "Crowd-assisted search for price discrimination in e-commerce: first results," in Proceedings of the ninth ACM conference on Emerging networking experiments and technologies, ser. CoNEXT '13

[5] The Economist, "Insurance data: Very personal finance," 2012. [Online]. Available: <http://www.economist.com/node/21556263>

[6] Reclaim the Net, [Online] <https://reclaimthenet.org/imf-report-suggests-credit-score-browsing-history>

# Tracking methods

- Stateful methods
  - Cookies
  - HTML5 storage [7]
  - Web cache [8], DNS cache [9], Redirect cache [10]
- Stateless methods (fingerprinting)
  - Combine device properties to form a unique identifier
  - Canvas fingerprinting [11]
  - Audio fingerprinting [12]
  - 3D rendering fingerprinting [13]
  - Mouse fingerprinting [14]



	Device Fingerprinting	OS Fingerprinting	Browser Fingerprinting
IP Address	✓		
Geolocation	✓		
OS version	✓	✓	
Screen resolution	✓	✓	
Timezone	✓		
Fonts	✓	✓	
Browser version	✓	✓	✓
Browser language	✓		✓
Multitouch capabilities	✓		
Pointer capabilities	✓		
Keyboard layout	✓		
Microphone	✓		
Camera	✓		
TCP timestamp	✓		
OS architecture		✓	
System language		✓	
Color depth		✓	
Audio capabilities	✓		
CPU brand	✓		
GPU brand	✓		
System drivers	✓		
Browser instance			✓
Browser plugins			✓
Accepted media formats			✓
Cookies enabled			✓
Supercookies limitations			✓

[7] G. Acar, C. Eubank, S. Englehardt, M. Juarez, A. Narayanan, and C. Diaz, "The Web Never Forgets: Persistent Tracking Mechanisms in the Wild," in ACM CCS, 2014.

[8] G. Fleischer, "Implementing Web Tracking," Proc. Black Hat USA Conf. Briefings, pp. 1–37, Jul. 2002.

[9] A. Klein and B. Pinkas, "DNS Cache-Based User Tracking." [Online]. Available: <https://www.ndss-symposium.org/ndss-paper/dns-cache-based-user-tracking/>

[10] E. Bursztein, "Tracking users that block cookies with a http redirect," Jul. 2011.

[11] K. Mowery and H. Shacham, "Pixel Perfect : Fingerprinting Canvas in HTML 5," in Proceedings of Web 2.0 Security and Privacy (W2SP), 2012

[12] S. Englehardt and A. Narayanan, "Online Tracking: A 1-million-site Measurement and Analysis," in ACM CCS, 2016

[13] Y. Cao, S. Li, and E. Wijmans, "(Cross-)Browser Fingerprinting via OS and Hardware Level Features," NDSS Symposium, 2017

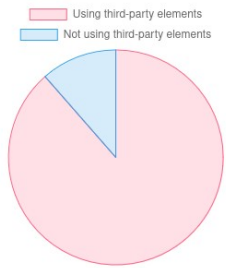
[14] M. Urpí, I. Castell and P. Barlet. "Detecting and Analyzing Mouse Tracking in the Wild," IEEE EuroS&PW, 2023



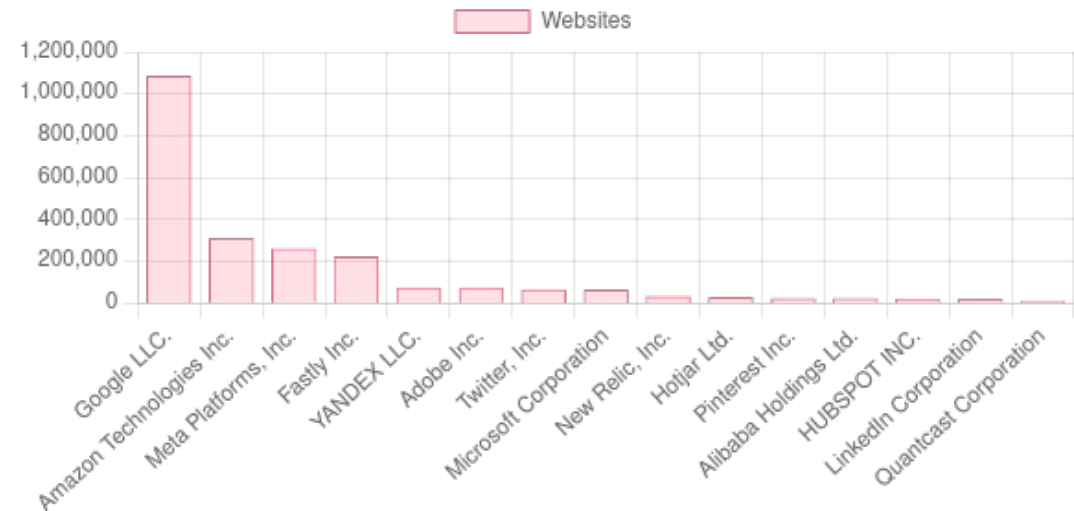
# Web tracking

- Third-party trackers are present in >90% of the websites
- They can track us even if we delete cookies, use private mode, VPN, etc.

Percentage of domains using web tracking



Websites using third-party elements



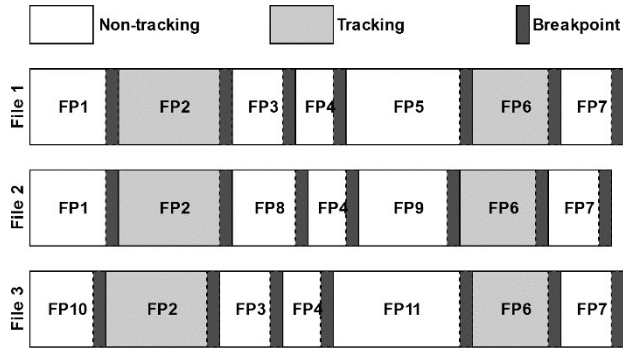
# Research: Web tracking detection

- Automatic web tracking discovery

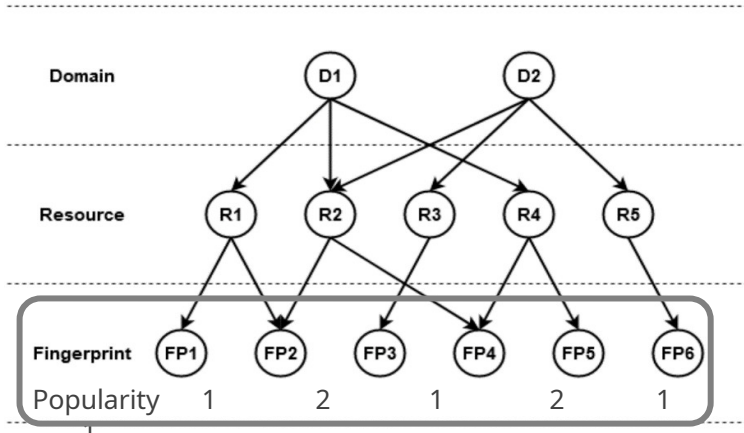


# TrackSign & ATrack

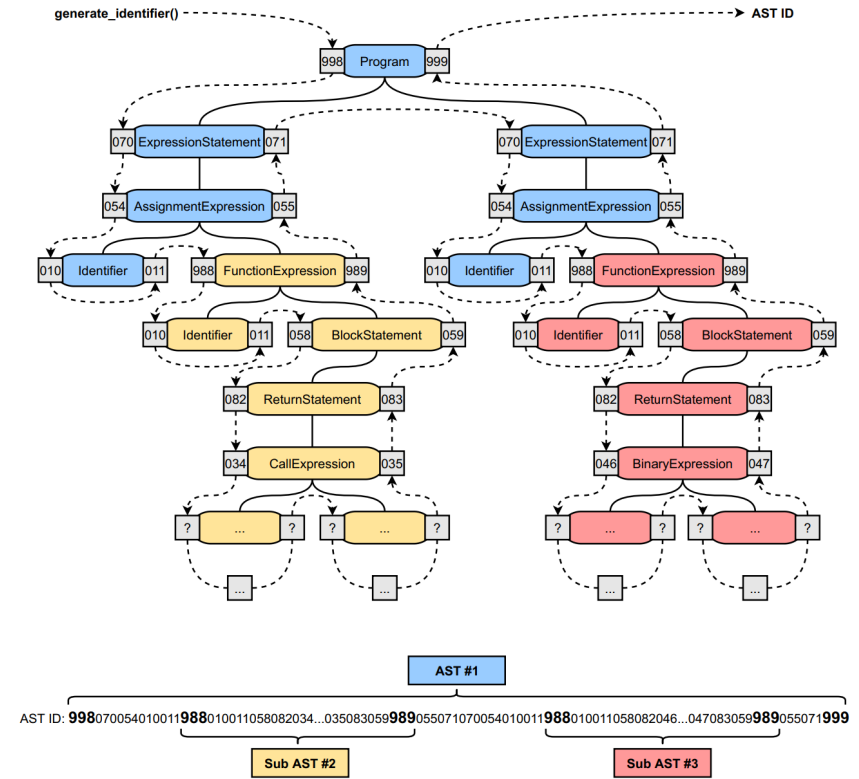
- TrackSign



3-Mode Website Graph



- ATrack

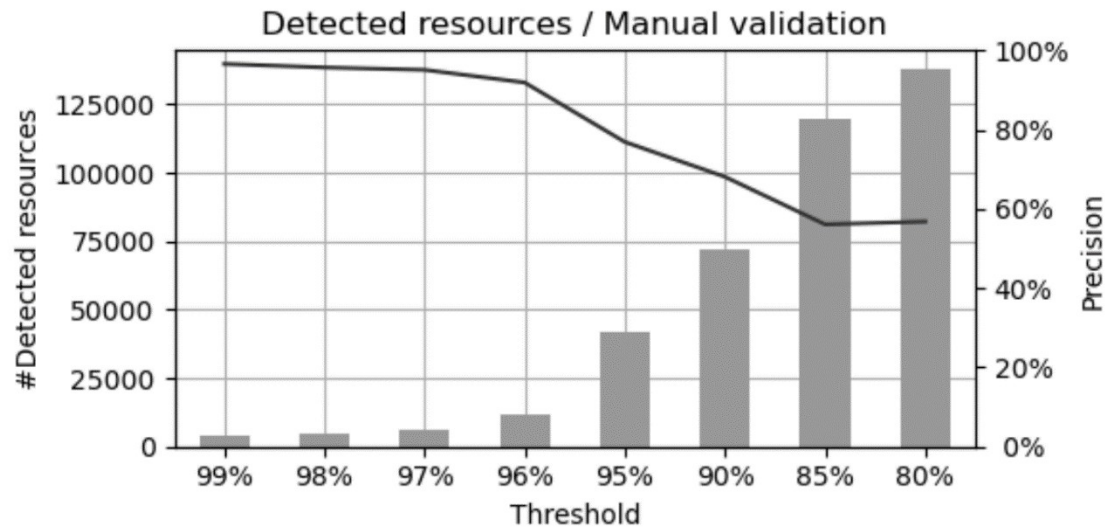


"TrackSign: Guided Web Tracking Discovery," *IEEE INFOCOM*, 2021. <https://personals.ac.upc.edu/pbarlet/papers/TrackSign.Infocom2021.pdf>

"ATrack: Automatic Detection and Removal of Web Tracking Code with Minimal Functionality Loss," *IEEE INFOCOM*, 2023. <https://arxiv.org/pdf/2301.10895.pdf>

# Evaluation


- TrackSign



- ATrack

	Static evaluation	Dynamic evaluation
<b>Domains</b>		8,179
<b>URLs</b>		615,780
<b>JavaScript URLs</b>		161,593
<b>Tracking URLs</b>		41,274
<b>Unique ASTs</b>		7,015,542
<b>Shared ASTs</b>		2,683,586
<b>New tracking URLs</b>	3,409	2,183
<b>New tracking JavaScript files</b>	3,109	2,093
<b>Tracking ASTs</b>	49,453	41,114
<b>Precision</b>	98.52%	98.47%

ePrivo Search History trackers Research About



## Welcome to ePrivo Observatory

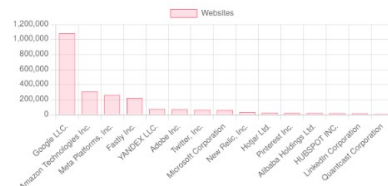
Search a domain to analyze with ePrivo

ePrivo is a tool designed to explore the privacy-friendliness of any given website. ePrivo explores all the internal URLs and resources, looking for web tracking systems running in the background. The detection is based in a state-of-the-art algorithm called TrackSign which is able to heuristically detect web tracking code inside JavaScript and HTML files.

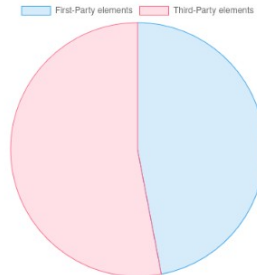
### Why is data privacy important?

Data privacy is crucial to protect individuals' personal information and prevent it from being misused. With the increasing amount of personal data being collected and shared online, it's essential to ensure that this information is kept secure and only used for its intended purposes.


Percentage of domains using web tracking



### First-Party vs Third-Party

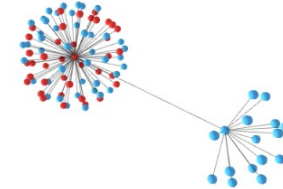


### Website tracking



Domain info	
Domain name	elpais.com
Elements	100
Intrusion level	100%
First-Party elements	47
Third-Party elements	53

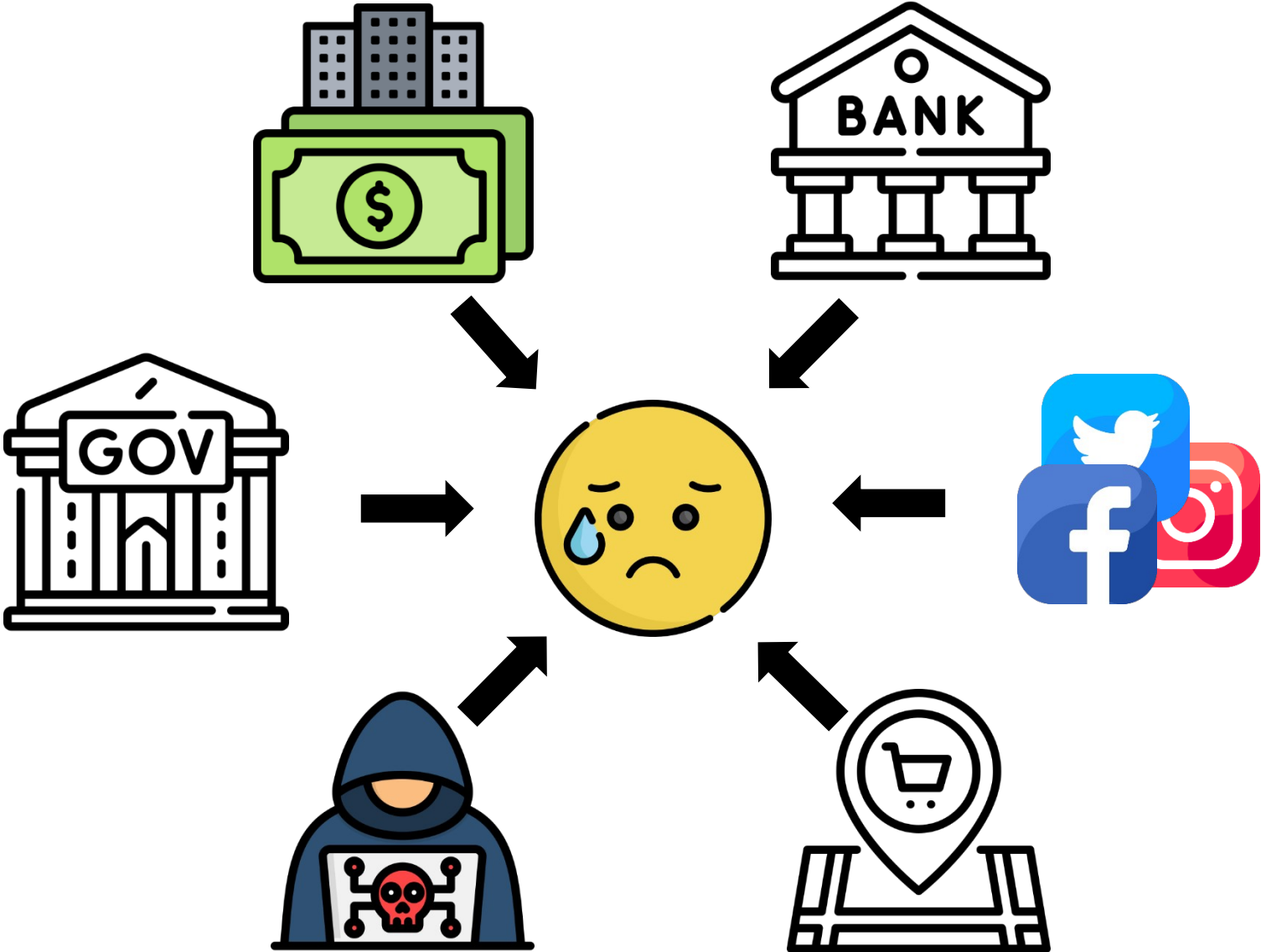
Tracking Third-Party Type



Left-click: rotate, Mouse-wheel/middle-click: zoom, Right-click: pan

● Not-Tracking ● Tracking

# Privacy vs. Profit



# Privacy regulations

	<b>GDPR</b>	<b>CCPA</b>	<b>PIPL</b>
<b>Year</b>	2018	2020	2021
<b>Under protection</b>	People living in Europe	People born in California	People living in China
<b>Target</b>	For-profit and non-profit national or private	For-profit companies (with conditions)	For-profit and non-profit national or private
<b>Area of effect</b>	World	State of California	World
<b>Restricted collection scenarios</b>	Yes (6)	No	Yes (7)
<b>Required consent</b>	Yes	No	Yes
<b>Forces service without consent</b>	Yes	No	Yes
<b>Opt-out available</b>	Yes	Partially (data selling processes)	Yes
<b>Access right</b>	Yes	Yes	Yes
<b>Amendment right</b>	Yes	Yes	Yes
<b>Deletion right</b>	Yes	Partially	Yes
<b>Right to be forgotten</b>	Yes	No	Yes
<b>Exemptions for national agencies</b>	No	Yes	Yes
<b>Limits data retention</b>	Yes	No	Yes
<b>Policies on automated algorithms</b>	Yes	No	Yes

# Consent Manager Providers (CMP)

## Make a choice for your data

We and [our 263 partners](#) use cookies or equivalent technology to store and/or access information on your device. Other partners use this personal information to present personalized advertising and content to you; to measure advertising and content performance and learn more about their audience; and to develop and improve their products. In order for some of these purposes to work, pa

To learn more, please read

You can change your preferences in the "Cookie Settings" link at the bottom of the page.



## What Do You Typically Do When You See a Pop-Up Asking You To Accept Cookies?



Based on a survey of 1,000 U.S. adults.

I ricavi derivanti dalla pubblicità personalizzata ci aiutano a supportare il lavoro della nostra redazione che lavora ogni giorno per garantirti una informazione di qualità. Per questo chiediamo il tuo consenso all'utilizzo di cookie o tecnologie simili per finalità diverse da quelle strettamente necessarie, come specificato nella Cookie Policy. Sei libero di rifiutare in qualsiasi momento, ma in tal caso ti chiederemo di sottoscrivere uno dei nostri abbonamenti.

With your agreement, we and [our 855 partners](#) use cookies or similar technologies to store, access, and process personal data like your visit on this website, IP addresses and cookie identifiers. Some partners do not ask for your consent to process your data and rely on their legitimate business interest. You can withdraw your consent or object to data processing based on legitimate interest at any time by clicking on "Learn More" or in our Privacy Policy on this website.

AGREE AND CLOSE

Learn More →

+ Cookies técnicas

+ Crear perfiles para publicidad personalizada

+ Crear un perfil para personalizar el contenido

+ Desarrollo y mejora de los servicios

OBLIGATORIO

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar

Rechazar Aceptar



... anteriores, también permites que este procesamiento de los siguientes datos: Cotejo y combinación de datos procedentes de otras fuentes de información, Garantizar la seguridad, evitar y detectar fraudes, y eliminar fallos, Guardar y comunicar las preferencias de privacidad, Identificación de dispositivos en función de la información transmitida de forma automática, Ofrecer y presentar publicidad y contenido, y Vincular diferentes dispositivos

+ Sobre el almacenamiento de sus elecciones

Ver nuestros socios



Rechazar todo

Aceptar todo

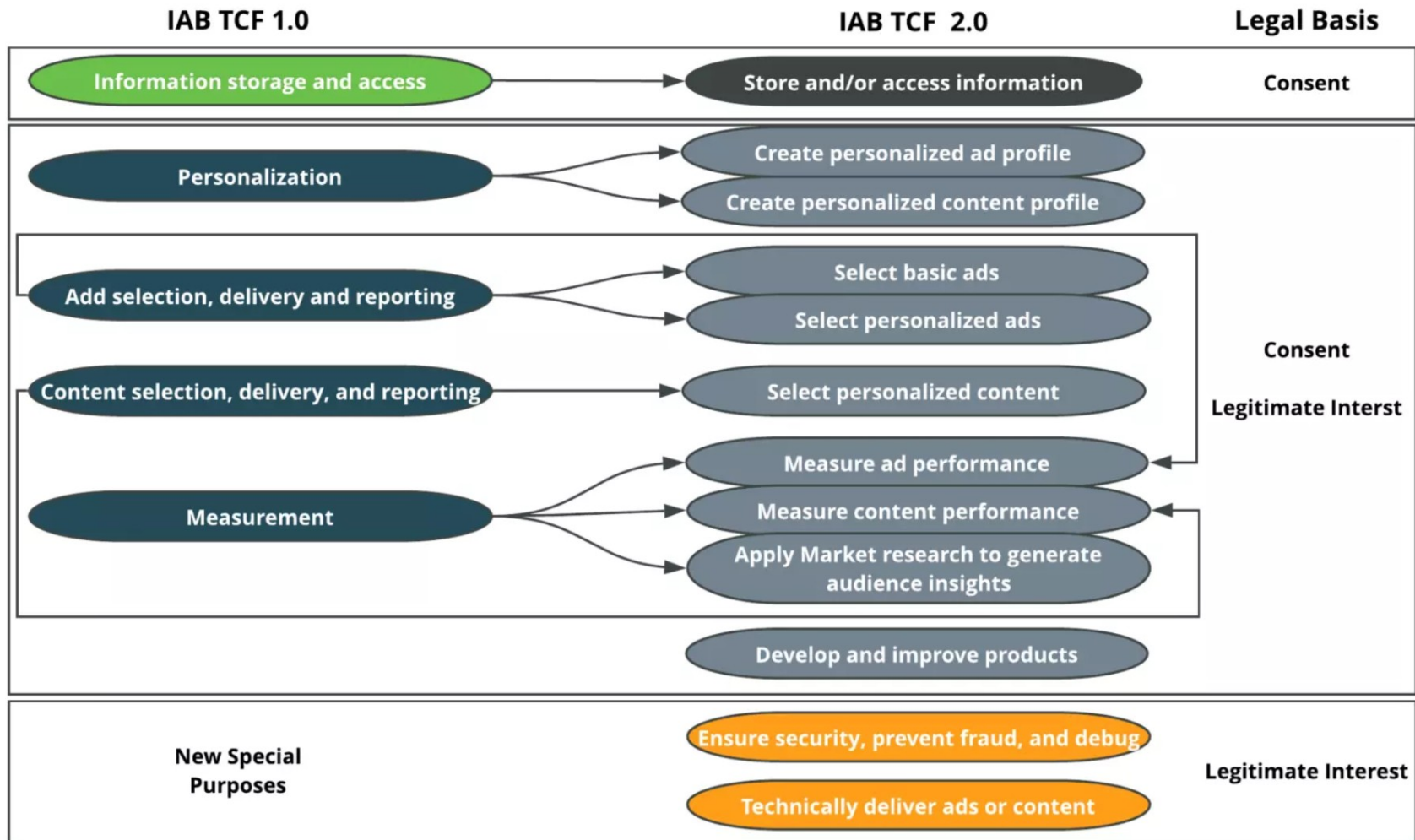


# CMP Standardization

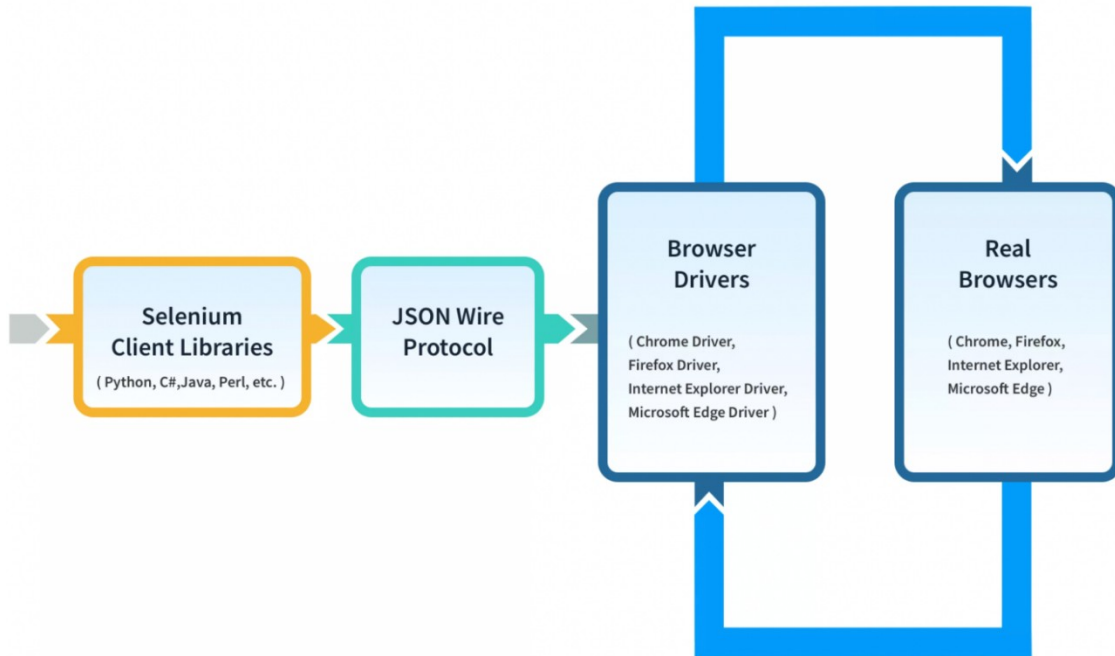


interactive  
advertising  
bureau

# Transparency and Consent Framework



# CMP Explorer



+

XPath expression	Search result
<code>//div[@id='lw-banner']</code>	A div element whose id attribute is equal to 'lw-banner'
<code>//iframe</code>	Any iframe
<code>//li/button/div/*</code>	Any element preceded by a li, button and div elements
<code>//h4[contains(@class, 'consentableItemTitle')]</code>	An h4 element whose class attribute contains the text 'consentableItemTitle'
<code>//div[@class='cmpTitle']</code>	A div with a class named 'cmpTitle'

# CMP Explorer

The screenshot displays a Selenium IDE test runner window. The top part shows a browser window with the URL `https://www.lavanguardia.com`. A consent dialog titled "Seleccionar socios para La Vanguardia" is open, allowing users to manage their preferences for various data processing purposes. The dialog includes sections for "Todos los socios" (listing B2B Media Group GmbH) and "Procesamiento de datos basado en consentimiento" (listing "Tratamiento de datos adicional", "Categorías de datos", and "Almacenamiento en dispositivo"). A "Guardar" button is visible at the bottom right of the dialog.

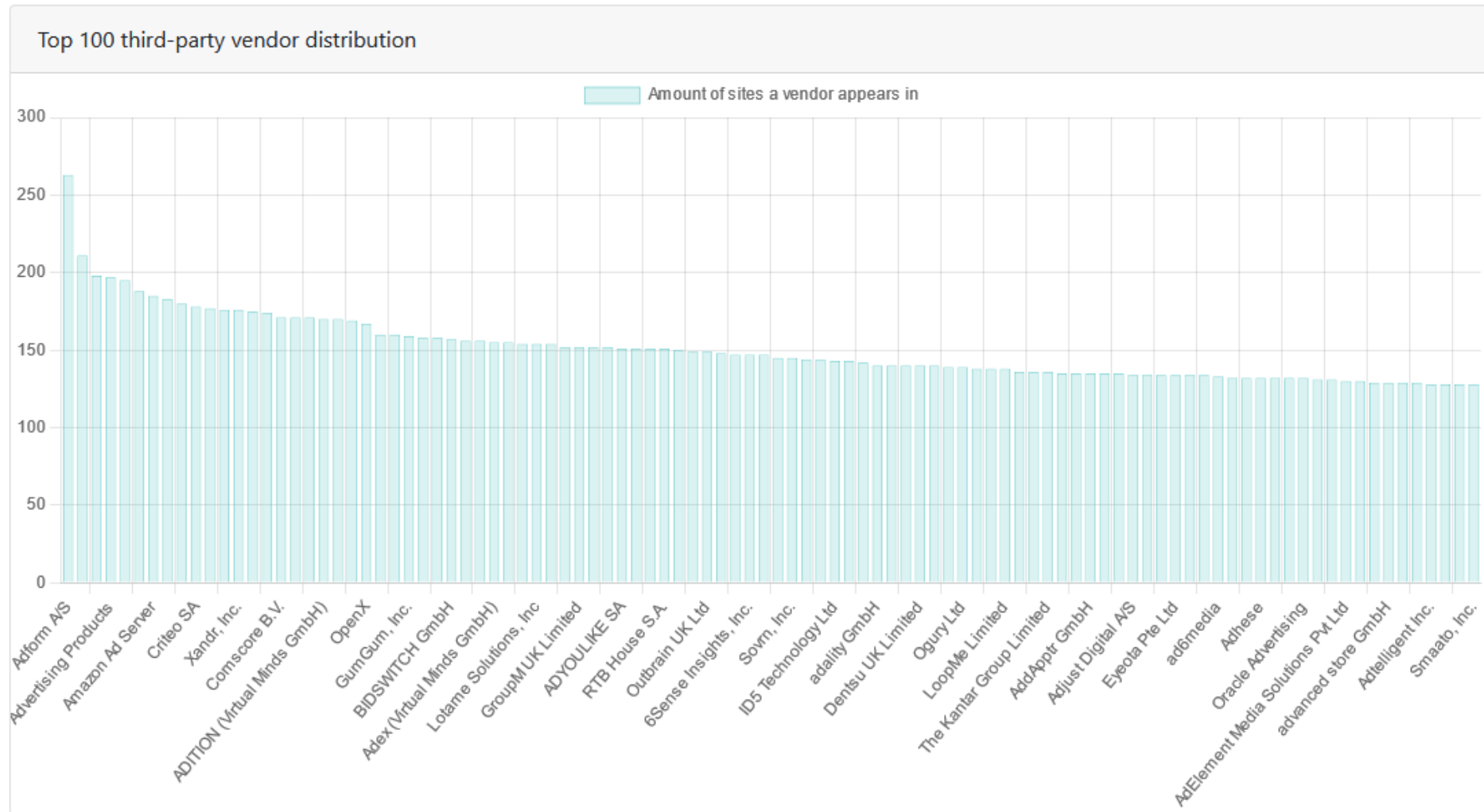
The bottom part of the screenshot shows the Selenium IDE test runner interface. The "Run" tab is active, displaying the following HTML code snippet:

```
</li><li>Crear perfiles para publicidad personalizada</li><li>Uso de datos limitados para seleccionar anuncios básicos</li></ul></div></div><div class="didomi-vendors-details-purposes-legit"><div class="didomi-component"><div class="didomi-retention-time"><span>Tiempo de retención</span><span>90</span><span>días</span></div></div></div><div class="didomi-retention-time"><span>Tiempo de retención</span><span>90</span><span>días</span></div></li></ul></div></div><div class="didomi-retention-time"><span>Tiempo de retención</span><span>183</span><span>días</span></div></li></ul></div></div><div class="didomi-
```

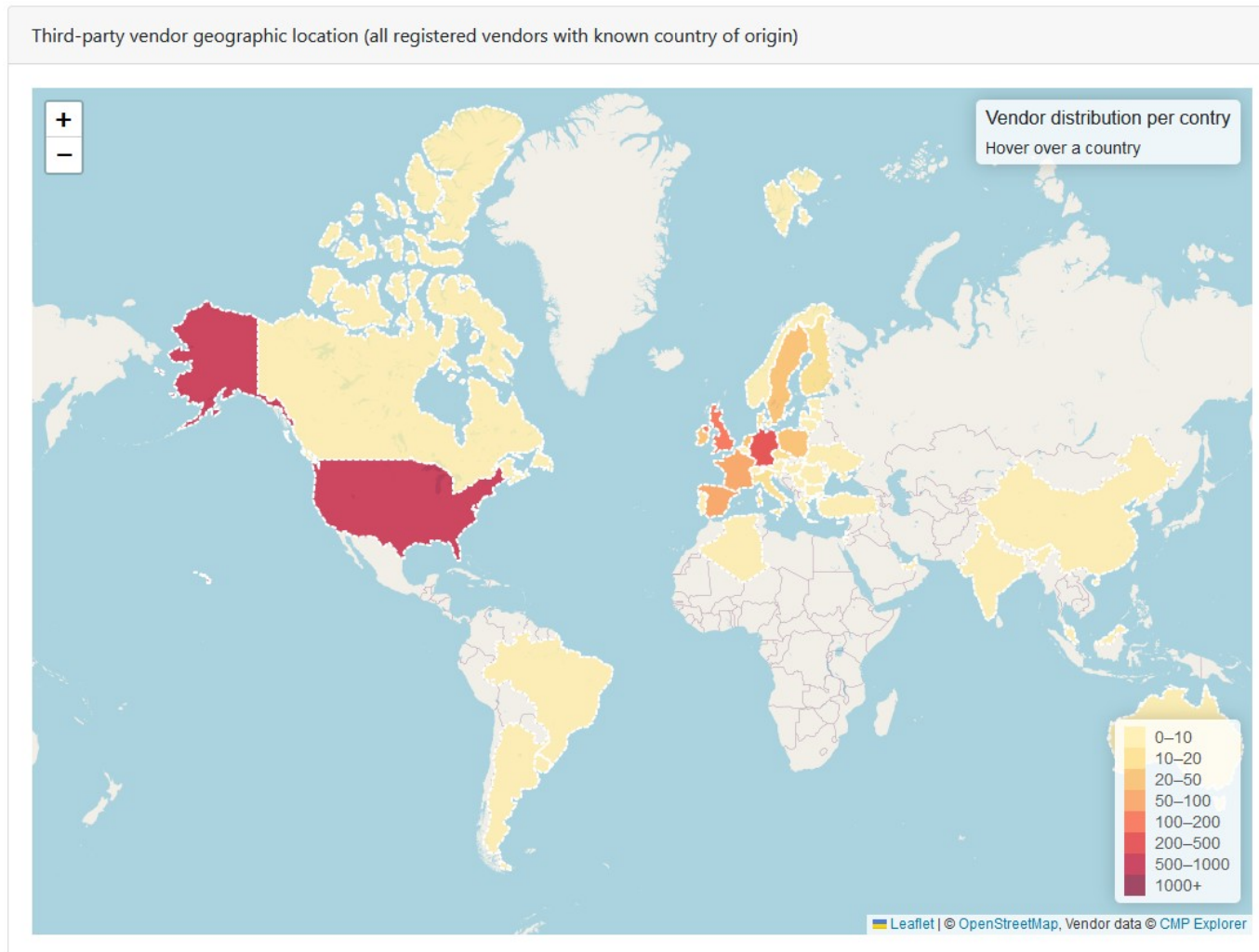
# CMP Explorer

- Validation:
  - Top 10K most popular webs
  - 55 Supported CMPs
  - 1762 scraped sites compliant with GDPR as per iab (400 completely scraped)
- Results
  - 4703 vendors found
  - 1536 vendors with known country of origin
  - Approximately 310 vendors per site

# CMP Explorer: Top third-parties

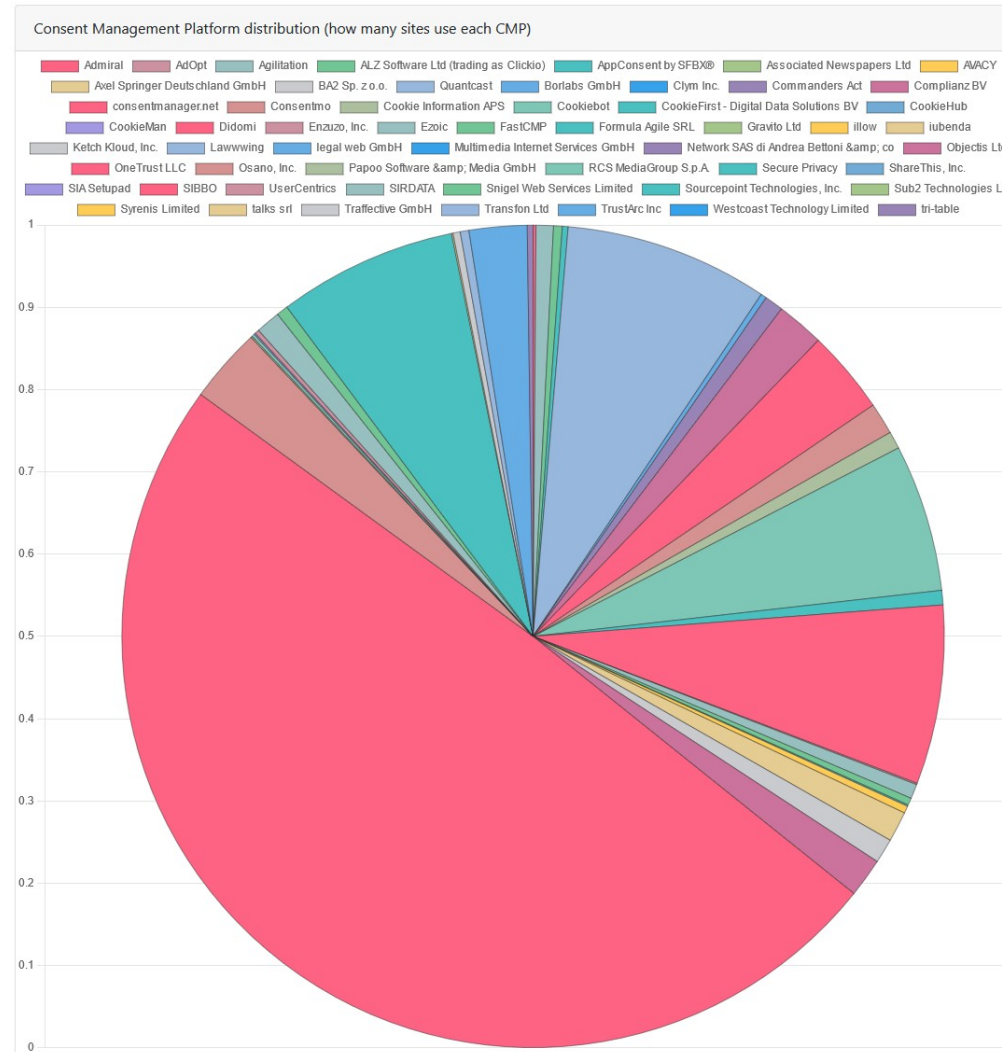


# CMP Explorer: Geographic location



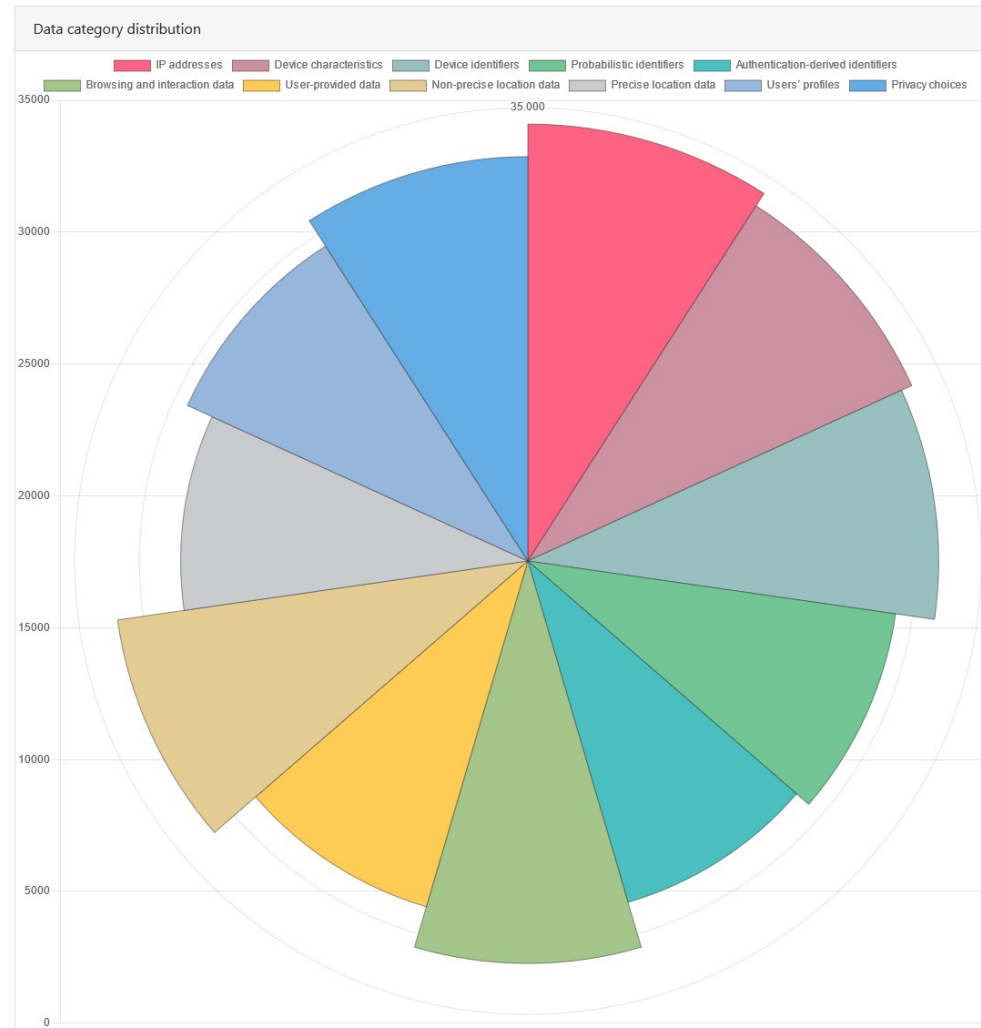
Country	Amount of third-party vendors
United States of America	523
Germany	393
United Kingdom	185
France	94
Spain	70
Netherlands	43
Poland	30
Ireland	24
Sweden	23
Finland	17

# CMP Explorer: CMP distribution





# CMP Explorer: Data distribution



# CMP Explorer: Website statistics

Results for [lavanguardia.com](http://lavanguardia.com) Clear search

CMP used	Third-party vendors	Purposes leveraged	Collected data
Didomi	943 vendors	15 purposes	11 types

**List of employed purposes**

- Store and/or access information on a device.
- Use limited data to select advertising.
- Create profiles for personalised advertising.
- Use profiles to select personalised advertising.
- Create profiles to personalise content.
- Use profiles to select personalised content.
- Measure advertising performance.
- Measure content performance.
- Understand audiences through statistics or combinations of data from different sources.
- Develop and improve services.
- Use limited data to select content.
- Ensure security, prevent and detect fraud, and fix errors.
- Deliver and present advertising and content.
- Ensure security, prevent and detect fraud, and fix errors.
- Deliver and present advertising and content.

**List of data categories**

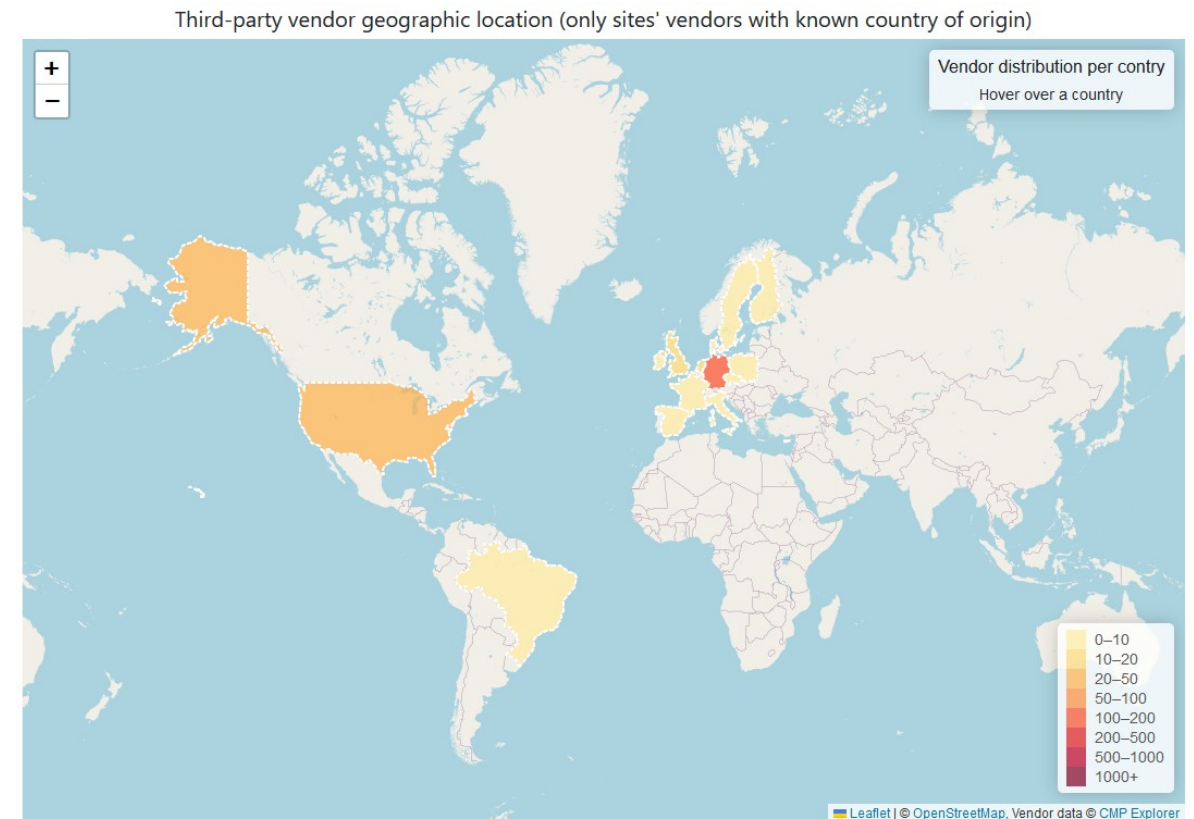
- IP addresses.
- Device characteristics.
- Device identifiers.
- Probabilistic identifiers.
- Authentication-derived identifiers.
- Browsing and interaction data.
- User-provided data.
- Non-precise location data.
- Precise location data.
- Users' profiles.
- Privacy choices.

**Quick thought:** Out of **401** sites registered, for the page you have searched ([lavanguardia.com](http://lavanguardia.com)), the third party vendor named **'Adform A/S'** is the one that appears in most sites. It is present in **263** sites, roughly a **66%** of the registered sites.

**And what does this mean?**  
This vendor could potentially know at least a **66%** of your browsing history (you would have to visit the other sites where the vendor is present, but you get the idea).

**List of vendors**  
(marked as Low presence / Medium presence / High presence)

152 Media LLC IAB TCF <span>in 131 more sites</span>	1plusX AG IAB TCF <span>in 32 more sites</span>	2KDirect, Inc. (dba iPromote) IAB TCF <span>in 32 more sites</span>
33Across IAB TCF <span>in 33 more sites</span>	3Q GmbH IAB TCF <span>in 28 more sites</span>	6Sense Insights, Inc. IAB TCF <span>in 32 more sites</span>
: Tappix IAB TCF <span>in 34 more sites</span>	A Million Ads IAB TCF <span>in 32 more sites</span>	A.Mobi IAB TCF <span>in 33 more sites</span>
AA INTERNET-MEDIA Ltd IAB TCF <span>in 27 more sites</span>	Aarki, Inc. IAB TCF <span>in 32 more sites</span>	ABCS INSIGHTS IAB TCF <span>in 21 more sites</span>
Accengage <span>in 0 more sites</span>	Accorp Sp. z o.o. IAB TCF <span>in 28 more sites</span>	AccountInsight Ltd IAB TCF <span>in 26 more sites</span>
Accurat IAB TCF <span>in 22 more sites</span>	Active Agent (Virtual Minds GmbH) IAB TCF <span>in 31 more sites</span>	ACTV8, Inc. IAB TCF <span>in 27 more sites</span>
Aditya Ads, Inc. IAB TCF <span>in 33 more sites</span>	Ad Alliance GmbH IAB TCF <span>in 33 more sites</span>	Ad.com Interactive Media, Inc. IAB TCF



# Conclusions

- Summary
  - CMP Explorer can help to collect web privacy information by looking at CMPs
  - It discovers hidden data brokers collecting data in multiple non-related websites (browsing history trackers)
- Future work
  - Improve data collection to detect not only iab-compliant CMPs
  - Integrate into browser plugin
- What do we need?
  - It has proven very hard to find funding for this project...
  - We could only develop it as a side project 📌



# Discovering databrokers

Bringing to light hidden companies

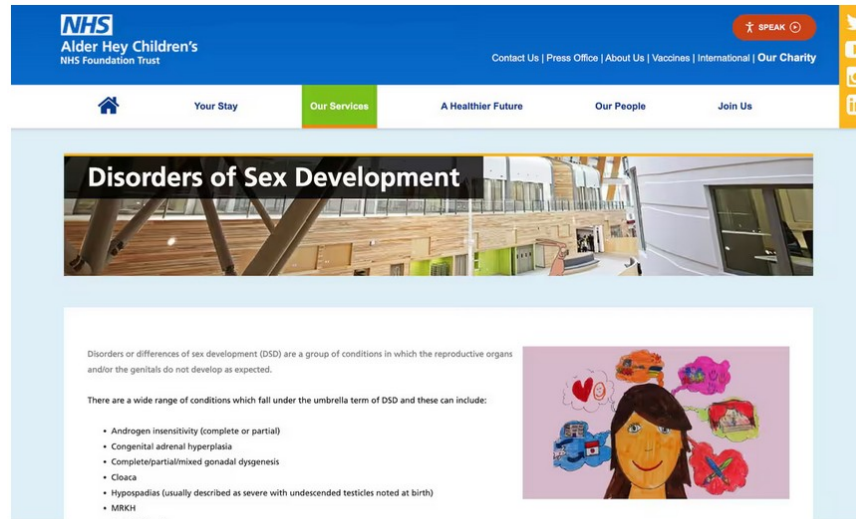
**Ismael Castell & Pere Barlet**  
Universitat Politècnica de Catalunya (UPC)

ESNOG 32 – 25 Oct. 2024

# Backup slides

# Third-party trackers

## NHS data breach: trusts shared patient details with Facebook without consent



📷 A page about sexual development disorders on Alder Hey Children's Hospital's website, which shared details of the browsing with Facebook via the Meta Pixel.

### Observer investigation reveals Meta Pixel tool passed on private details of web browsing on medical sites

NHS trusts are sharing intimate details about patients' medical conditions, appointments and treatments with [Facebook](#) without consent and despite promising never to do so.

An *Observer* investigation has uncovered a covert tracking tool in the websites of 20 [NHS](#) trusts which has for years collected browsing information and shared it with the tech giant in a major breach of privacy.

The data includes granular details of pages viewed, buttons clicked and keywords searched. It is matched to the user's IP address - an identifier linked to an individual or household - and in many cases details of their Facebook account.

Information extracted by [Meta Pixel](#) can be used by Facebook's parent company, Meta, for its own business purposes - including improving its targeted advertising services.

Records of information sent to the firm by NHS websites reveal it includes data which - when linked to an individual - could reveal personal medical details.

It was collected from patients who visited hundreds of NHS webpages about HIV, self-harm, gender identity services, sexual health, cancer, children's treatment and more.

It also includes details of when web users clicked buttons to book an appointment, order a repeat prescription, request a referral or to complete an online counselling course. Millions of patients are potentially affected.

# Top third-parties

Company	Sites with presence	Presence rate
Adform A/S	219 sites	64.79%
Adobe Advertising Cloud	175 sites	51.77%
Adobe Audience Manager, Adobe Experience Platform	164 sites	48.52%
Google Advertising Products	159 sites	47.04%
Amazon Advertising	154 sites	45.56%
33Across	149 sites	44.08%
Index Exchange Inc.	147 sites	43.49%
Amazon Ad Server	144 sites	42.6%
Criteo SA	141 sites	41.71%
Magnite, Inc.	141 sites	41.71%

# Dependency between CMP and vendors

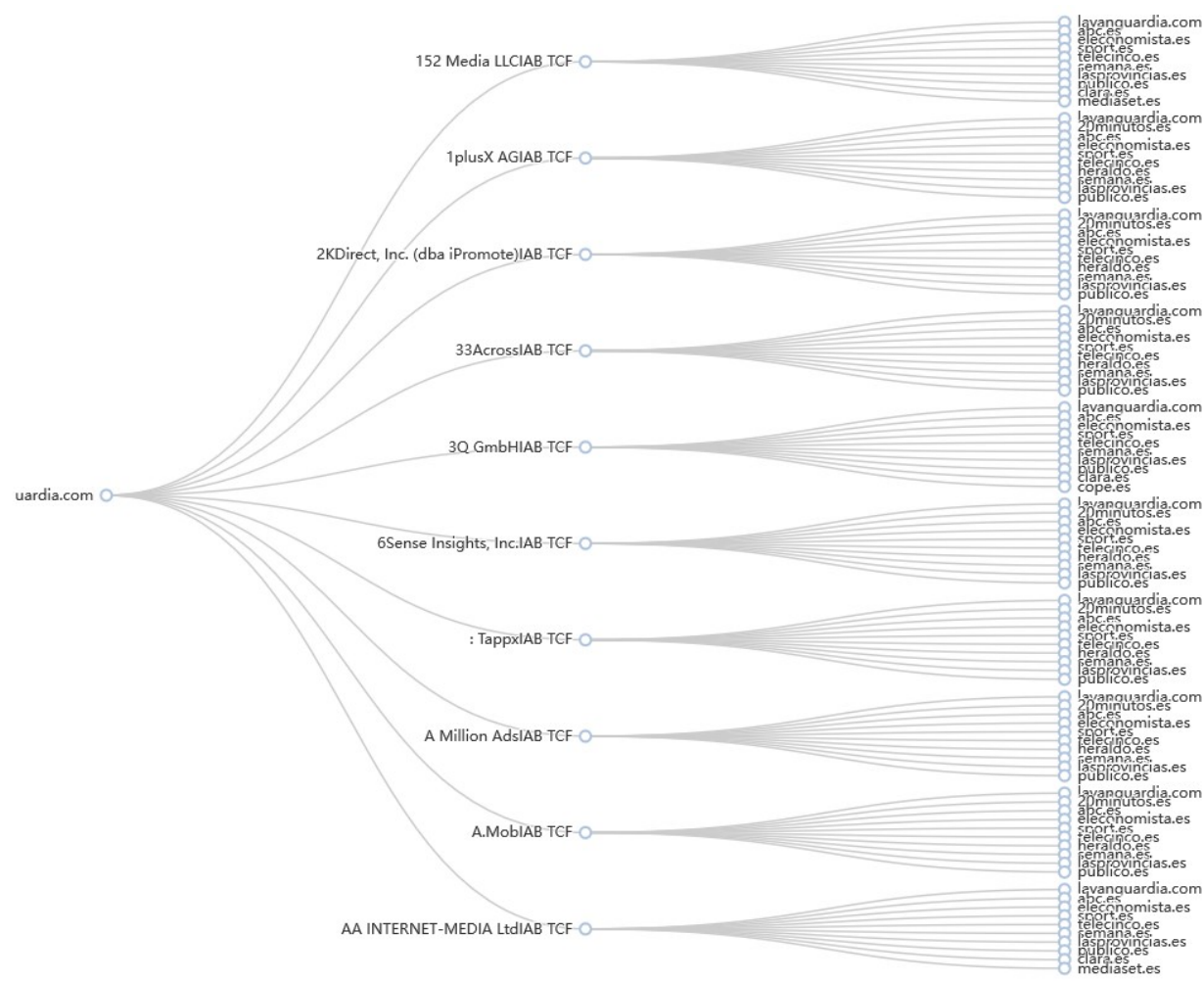
Site	Consent Management Platform	Amount of third-party vendors
marvel.com	OneTrust LLC	1438
indiewire.com	OneTrust LLC	1438
tvline.com	OneTrust LLC	1438
hunker.com	OneTrust LLC	1438
espncricinfo.com	OneTrust LLC	1437
investing.com	OneTrust LLC	1437
gameswfu.net	Ezoic	842
euro-muenzen.tv	Ezoic	842
gamesradar.com	Sourcepoint Technologies, Inc.	192
techradar.com	Sourcepoint Technologies, Inc.	192
laptopmag.com	Sourcepoint Technologies, Inc.	192
whathifi.com	Sourcepoint Technologies, Inc.	192



# Vendors per most used CMPs

Consent Management Platform	Amount of related third-party vendors
OneTrust LLC	523
Sourcepoint Technologies, Inc.	1255
Didomi	1100
tri-table	849
Ezoic	842
Quantcast	378
Cookiebot	297
SIRDATA	221
Osano, Inc.	216
Traffactive GmbH	174

# Connection between websites



Other sites using same CMP

Results limit: 10