Submission to the Irish Data Protection Commission

Two years on from complaint to the Irish Data Protection Commission, the RTB data breach is the largest ever recorded, and appears to have worsened.

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September 2020 marks two years since my formal complaint to the Irish Data Protection Commission about the "Real-Time Bidding" (RTB) data breach. This submission demonstrates the consequences of two years of failure to enforce.

Key Insights

- Real-Time Bidding operates behind the scenes on websites and apps. It constantly broadcasts the private things we do and watch online, and where we are in the real-world, to countless companies. As a result, we are all an open book to data broker companies, and others, who can build intimate dossiers about each of us. **Google's RTB system sends this data to 968 companies (see Appendix F for a 27 page list of these companies).**

- A data broker company that uses RTB data to profile people **influenced the 2019 Polish Parliamentary Election** by **targeting LGBTQ+ people**. See page 5.

- Google's RTB system allows users to target 1,200 people in Ireland profiled in a "**Substance abuse**" category, based on a data broker profile built with RTB data. Other health condition profiles from the same data broker available via Google included "**Diabetes**", "**Chronic Pain**", and "**Sleep Disorders**". See page 6.

- The IAB's RTB system allows users to target 1,300 people in Ireland profiled in a "**AIDS & HIV**" category, based on a data broker profile build with RTB data. Other categories from the same data broker include "**Incest & Abuse Support**", "**Brain Tumor**", "**Incontinence**", and "**Depression**". See page 6.

- A data broker that gathers RTB data tracked **the movements of people in Italy** to see if they observed the **Covid-19 lockdown**. See page 11-12.

- A data broker that illicitly **profiled Black Lives Matters protesters** in the United States has also been allowed to gather **RTB data about Europeans**. See page 9.

- The industry template for profiles includes intimate personal characteristics such as "**Infertility**", "**STD**", and "**Conservative**" politics. See pages 13-15.

- RTB is the most massive data breach yet recorded, involving millions of websites and apps, and hundreds of billions of individual data leaks per day. Google's RTB system now **sends people's private data to more companies**, and **from more websites than when the DPC was notified two years ago**. A single ad exchange using the IAB RTB system now sends 120 billion RTB broadcasts in a day, an **increase of 140% over two years ago when the DPC was notified**. See pages 16-18.

List of Appendices

Acknowledgement

Thanks in particular to Wolfie Christl of Cracked Labs, who shared research on data broker use of RTB data for this report.

Data brokers and RTB

Two years ago, my formal complaint to the Irish Data Protection Commission highlighted the lack of control over highly intimate personal data when they are released in the RTB system, which operates behind the scenes on virtually every website and app. As one RTB company says on its website

> "The demand-side platform collects every available attribute that characterises ever user that sees your ads. This happens even in the case when you don't win the impression. What else does this mean? You get the obscenely large amount of data for free…"[1]

The GDPR strictly prohibits such data free-for-alls.[2] But today, two years after my complaint, RTB remains a vast, systematic data breach. Data brokers continue to use "bidstream" data from the RTB system to track our movements over time, and develop intimate profiles about us, our afflictions, and interests. These data are available for purchase today.

The following examples demonstrate the grievous consequences of the GDPR supervisory authorities' failure to act to end the massive RTB data breach.

Example: OnAudience.com

OnAudience, based in Poland, claims to have "a database that includes more than 27 billion of anonymous user profiles… from over 200 markets globally".[3] The company acknowledges that it collects RTB data from DSPs that receive RTB broadcasts: "We analyze more than several billion impressions daily working closely with DSP and DMP partners…"[4]

This allows OnAudience.com to profile people by "observing user activity based on websites visited, content consumed and history paths to find clear behavior patterns and proper level of intent".[5]

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[1] "5 reasons why white label DSP beats self-serve DSP hands down", Epom ad server, 16 September 2020 (URL: https://epom.com/blog/programmatic/5-key-differences-between-white-label-DSP-vs-self-serve-DSP, last accessed 16 September 2020).

[2] General Data Protection Regulation, Article 5(1)f.

[3] "Company", OnAudience.com (URL: https://www.onaudience.com/company, last accessed 14 September 2020).

[4] "OnAudience.com: a buyers guide", Oracle Data Cloud, p. 110.

[5] ibid.

Influencing an election in Europe

A case study published by OnAudience discusses how it profiled 1.4 million people in Poland to influence Poland's 2019 Parliamentary Elections. "The main goal of the campaign was to reach people open to LGBTQ+".

To do this, OnAudience "looked for profiles that … read watched or searched for content about LGBTQ+" and "built a segment that includes over 1.4 million Unique IDs…".[6]

See Appendix A.

The company claims that all data in its database are anonymous.[7] However, every person is identified by a unique identifier. This identifier can then be tied to unique identifiers held by OnAudience's business partners, such as Google, The Trade Desk, and Ad Form.

"Audiences" built with these identifiers can then be purchased on Google's RTB system,[8] and on The Trade Desk,[9] and Ad Form[10] implementations of the IAB RTB system.[11] This cross-referencing of identifiers, and purchasing of data, is a reoccurring theme in the online data and advertising market.[12]

[6] "Creating custom segments for "I vote for love" campaign", OnAudience.com (URL: https://www.onaudience.com/files/Case-Study-VMLYR-OnAudience.pdf, last accessed 15 September 2020), p. 1.

[7] "Reach the right people with accurate audience data", OnAudience.com (URL: https://www.onaudience.com/audience-data, last accessed 15 September 2020).

[8] For a step by step guide to how to do this, see "How to purchase OnAudience segments: DV360", OnAudience (URL: https://www.onaudience.com/files/OA_DSP_Tutorials_DV360.pdf,last accessed 16 September 2020).

[9] For a step by step guide to how to do this, see "How to purchase OnAudience segments: The Trade Desk", OnAudience (URL: https://www.onaudience.com/files/OA_DSP_Tutorials_TTD.pdf, last accessed 16 September 2020).

[10] For a step by step guide to how to do this, see "How to purchase OnAudience segments: AdForm", OnAudience (URL: https://www.onaudience.com/files/OA_DSP_Tutorial_Adform.pdf, last accessed 16 September 2020).

[11] ibid.

[12] See for example "Data Transparency Standard 1.0", IAB Tech Lab, 27 June 2019 (URL: https://iabtechlab.com/wp-content/uploads/2019/06/Data-Transparency-Standard-1.0-Final-June-2019.pdf, last accessed 16 September 2020).

Sensitive data about people in Ireland, examples

OnAudience's data about people in Ireland, for example, currently includes "users who regularly visit websites about…" the following highly sensitive health issues:[13]

AIDS & HIV
People available in Ireland, via Ad Form: 500 people
People available in Ireland, via The Trade Desk: 1,300 people

Chronic Pain
People available in Ireland, via Google: 2,300 people
People available in Ireland, via The Trade Desk: 1,900 people
People available in Ireland, via Ad Form: 700 people

Incest & Abuse Support
People available in Ireland, via The Trade Desk: 200 people

Diabetes
People available in Ireland, via Google: 1,400 people
People available in Ireland, via The Trade Desk: 1,400 people
People available in Ireland, via Ad Form: 700 people

Brain Tumor
People available in Ireland, via The Trade Desk: 100 people

Depression
People available in Ireland, via The Trade Desk: 100 people

Incontinence
People available in Ireland, via The Trade Desk: 200 people

Sleep disorders
People available in Ireland, via Google: 1,800 people
People available in Ireland, via The Trade Desk: 1,400 people
People available in Ireland, via Ad Form: 700 people

Substance abuse
People available in Ireland, via Google: 1,200 people

[13] "Audience taxonomy", OnAudience (URL: https://www.onaudience.com/taxonomy/ireland, last accessed 15 September 2020).

People available in Ireland, via The Trade Desk: 1,200 people
People available in Ireland, via Ad Form: 500 people

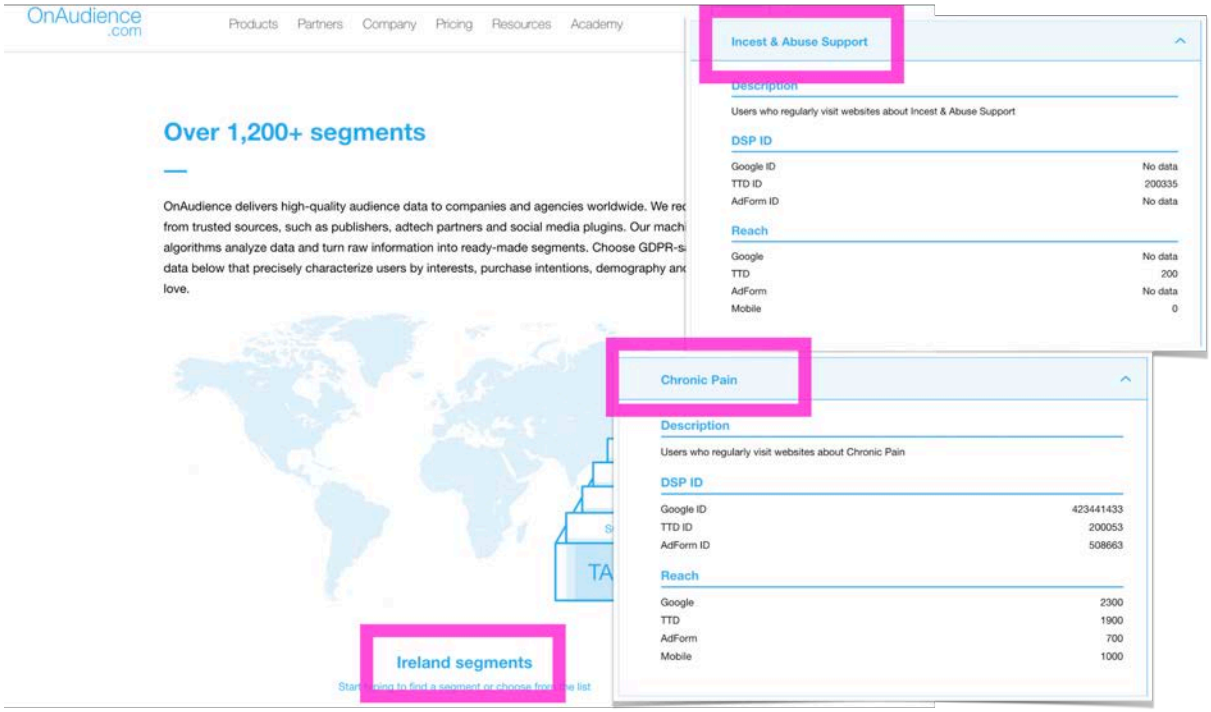

Image: samples from OnAudience's audience taxonomy.

See Appendix B for a longer sample of OnAudience's categories.

Example: Mobilewalla

Mobilewalla claims to have 4 years of data about the people who use 1.6+ billion devices in 35 countries.[14] Its documentation acknowledges that its "sources of mobile signal collection are … exchange supply signals."[15] The company's CEO wrote about the convenience of RTB broadcasts as a source for profiling:

> "Ad requests are not only information-rich, but are also relatively easy to interpret, given the structure imposed on them by standards bodies (such as the OpenRTB organization). … Bid Requests (BRQs) … represent a key source of data helpful in modelling…"[16]

[14] According to the first screen of the company's website (URL: https://www.mobilewalla.com/, last accessed 15 September 2020).

[15] "Mobilewalla", Adobe Audience Finder (URL: https://www.adobe-audience-finder.com/data_partner/mobilewalla/)

[16] Anindya Datta, "A largely ignored but critical dimension to incorporate in understanding consumers on mobile", The Data Source, Oracle, Fall 2016 (https://cdn2.hubspot.net/hubfs/4309344/the-data-source-magazine-fall-2016.pdf), p. 22.

An engineer who worked at the company between 2014 and 2019 notes in his resume that he built on "a data segmentation product … on top of collected mobile bid stream data".[17] According to the same document, this was applied to "tens of terabytes of data a day".

The company use RTB data to build a profile of people's locations over time. It collects device IDs, GPS coordinates, whether the location is work or home or "other", app in use, number of times seen at this location and/or using this app, timestamps, specific device details.[18] Its CEO writes that "two years of stored history is adequate to perform a vast majority of persistence analysis".[19] See Appendix C for Mobilewalla's "data directory" and "aggregated data directory" documents.

Mobilewalla uses these data to categorise people as, for example, "expectant families, diet & weight loss, low income".[20] The company's CEO published an article in which demonstrated how Mobilewalla can use these data to identify people by their religious faith, and target them at their church.[21]

> "Note that the data elements that enable behavioral persistence identification are already embedded in ad requests—timestamps and location. … To identify regular churchgoers, we must figure out which devices have appeared in churches weekly over a period of six months".[22]

Black Lives Matter protestors

In July of this year, United States Senators and Members of Congress urged the FTC to examine Mobilewalla's use of "illicitly gained" RTB data to profile Black Lives Matters protests: "Mobilewalla, a data broker and a buyer of bidstream data, used location and inferred race data to profile participants in recent Black Lives Matter

[17] Resume of Jiang HaoYuan, GitHub (URL: https://haoyuan90.github.io/Resume/).
[18] See the full list in "Mobilewalla Aggregated Data Dictionary", Mobilewalla, 2020 (URL: https://cdn2.hubspot.net/hubfs/4309344/Content%20Offers/Mobilewalla%20Data%20Dictionary_Aggregated_FEB2020.pdf, last accessed 12 September 2020).
[19] Anindya Datta, "A largely ignored but critical dimension to incorporate in understanding consumers on mobile", The Data Source, Oracle, Fall 2016 (https://cdn2.hubspot.net/hubfs/4309344/the-data-source-magazine-fall-2016.pdf), p. 23; see also "Time: A critical dimension of understanding mobile consumers", presentation hosted at AdSquare.com, March 2017 (URL: https://www.adsquare.com/wp-content/uploads/2017/03/08_AIM_Mobilewalla.pdf).
[20] "Time: A critical dimension of understanding mobile consumers", presentation hosted at AdSquare.com, March 2017 (URL: https://www.adsquare.com/wp-content/uploads/2017/03/08_AIM_Mobilewalla.pdf).
[21] Anindya Datta, "A largely ignored but critical dimension to incorporate in understanding consumers on mobile", The Data Source, Oracle, Fall 2016 (https://cdn2.hubspot.net/hubfs/4309344/the-data-source-magazine-fall-2016.pdf), p. 23.
[22] ibid.

protests".[23] They rightly note that "the identity of the companies that are selling bidstream data to Mobilewalla and countless other data brokers remains unknown."

A Mobilewalla presentation claims that its data in Europe covers 117 million unique devices, tracks the users of 61 billion devices a month.[24] These figures are from 2017, and the situation is likely to be significantly more acute now. The company's current documentation confirms that it continues to collect and sell RTB data about people in Europe (see Appendix C).[25]

Example: Adsquare

Adsquare, which is headquartered in Berlin (and is the recipient of investment from the European Commission), claims it has 450 million+ user profiles.[26] A company presentation acknowledges that it receives data through "bid-stream data collection via ad exchanges/SSPs. Location data is transferred with each ad request."[27]

It provides software for its business partners for "providing bid-stream data" to it. Adsquare says "providing bid-stream data is primarily used by Supply Side Platforms (SSPs) to transmit bid requests in a very efficient way to adsquare".[28] The data are then used "to build audience segments…" among other things.

[23] Ron Wyden, Maria Cantwell, Elizabeth Warren, et. al. to the Hon. Joseph J. Simmons, Chairman, Federal Trade Commission, 31 July 2020 (URL: https://www.wyden.senate.gov/imo/media/doc/073120%20Wyden%20Cassidy%20Led%20FTC%20Investigation%20letter.pdf, last accessed 12 September 2020).

[24] "Time: A critical dimension of understanding mobile consumers", presentation hosted at AdSquare.com, March 2017 (URL: https://www.adsquare.com/wp-content/uploads/2017/03/08_AIM_Mobilewalla.pdf).

[25] "Mobilewalla data directory 2020", Mobilewalla (URL: https://cdn2.hubspot.net/hubfs/4309344/Mobilewalla%20Data%20Dictionary%20(1)%20(1).pdf, last accessed 15 September 2020), p. 2.

[26] On the first page of the Adsquare website (URL: https://adsquare.com, last accessed 15 September 2020).

[27] "Data quality: turning the challenge into an opportunity", AdSquare, 14 June 218 (URL: https://www.adzine.de/uploads/AdTrader_Data_Quality_adsquare_Luise_Weiss_freigegeben.compressed.pdf).

[28] "Welcome to the adsquare data-delivery library", AdSquare, 9 November 2017 (URL: https://github.com/adsquare/data-delivery/blob/master/README.md, last accessed 12 September 2020).

The software includes a sample list of 200 bid requests, sent by an iPhone app called "subway surfers", and including location and device information about the individuals concerned.[29]

(Adsquare also receives data from Mobilewalla and OnAudience.[30])

Example: UberMedia

UberMedia claims to have over 1 billion records,[31] and is active in Europe.[32] Its documentation acknowledges that it receives profiling data from the RTB system.

> "Bid Stream Data: UberMedia is a marketing demand side platform and participates in ad exchanges, thus collecting data in the process of displaying banner and video ads in over 100,000 apps (~68% of data by volume). This data is also known as RTB data and is collected from an SDK installed by app publishers."[33]

Another company documentation shows the RTB data that it can provide, including device details, identifier, IP address, etc.[34] See Appendix D.

Elsewhere, the company says that bid stream data are accurate to "under 10 feet", observes that this is "mostly low quality, but significant amount of high quality due to scale".[35]

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[29] "Sample_bid_requests.txt", AdSquare, 9 November 2017 (URL: https://github.com/adsquare/data-delivery/blob/master/example-ssp/src/test/resources/sample_bid_requests.txt, last accessed 12 September 2020).

[30] "Mobile programmatic & data: how to reach your audience, drive foot traffic, and attribute store visits", Adsquare and Tabmo, 23 March 2018 (URL: https://www.adsquare.com/wp-content/uploads/2018/04/OMR_Masterclass_TabMo_adsquare_2018.pdf), p. 55.

[31] "Location data sources", UberMedia (URL: https://ubermedia.com/wp-content/uploads/2019/03/Location_Data_Sources_One_Sheet-UberMedia.pdf, last accessed 11 September 2020) p. 1; see also remarks by UberMedia CMO to MarTech in "UberMedia buys Cintric to blend first and third party data for 'always-on' location", MarTech, 31 July 2017 (URL: https://martechtoday.com/ubermedia-buys-cintric-blend-first-third-party-data-always-location-201667, last accessed 11 September 2020).

[32] "Consumer Privacy Choices: Privacy notice: European Union, UK, and Switzerland", UberMedia, 1 January 2020 (URL: https://ubermedia.com/consumer-privacy-choices/#1489503959261-4697954d-1d49, last accessed 12 September 2020).

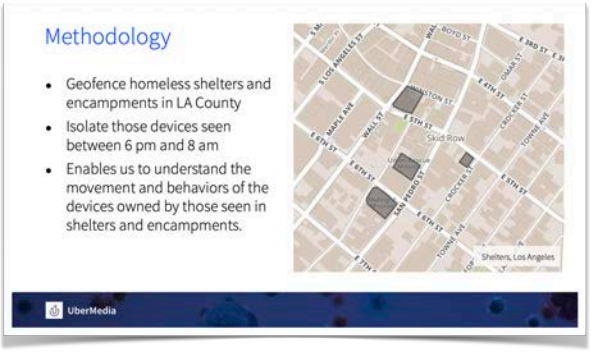
[33] "SDK Data Impact to the Vista API", UberMedia (URL: https://ubermedia.com/wp-content/uploads/2019/03/SDK_Data_Impact_to_the_Vista_API-UberMedia.pdf, last accessed 11 September 2020), p. 2.

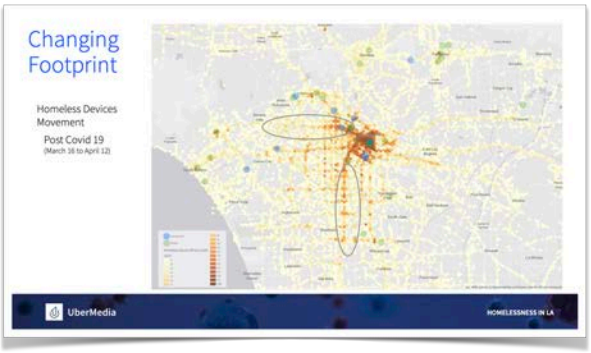
[34] "Data directory: available fields in data feeds", UberMedia (URL: https://ubermedia.com/wp-content/uploads/2019/03/Data-Dictionary-UberMedia.pdf, last accessed 11 September 2020).

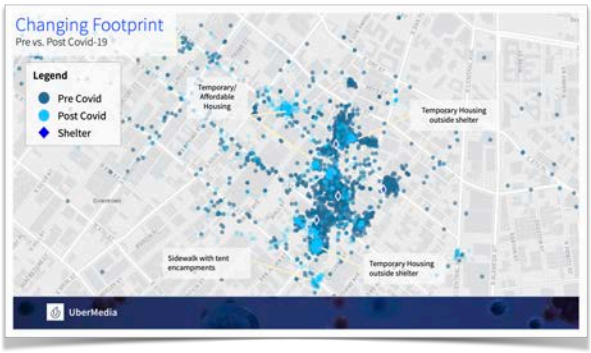
[35] "Location data sources", UberMedia (URL: https://ubermedia.com/wp-content/uploads/2019/03/Location_Data_Sources_One_Sheet-UberMedia.pdf, last accessed 11

Tracking homeless people in San Francisco, and people in Milan during the lockdown

As an example of the concerns this raises, note that the company has performed analysis of the movements of homeless people in the United States.[36]





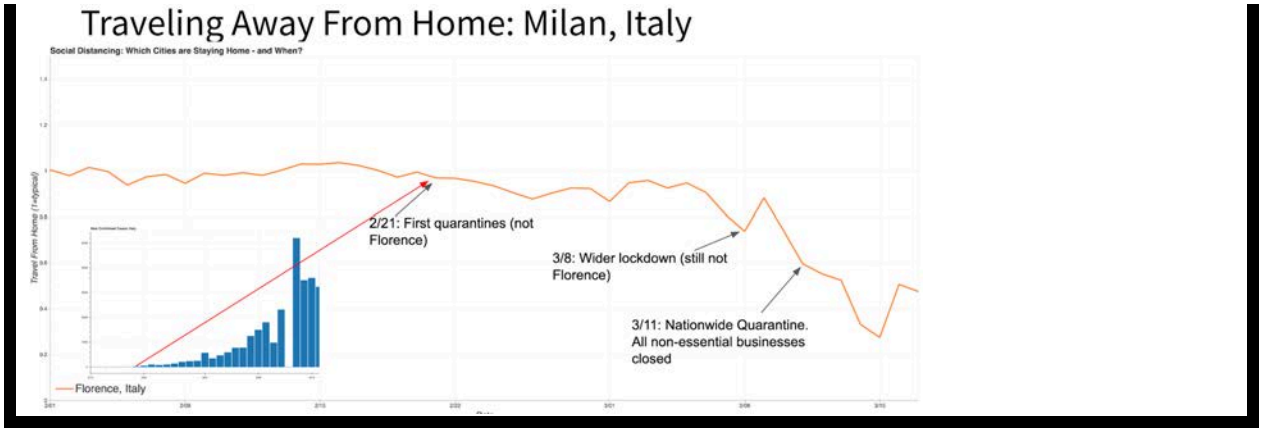


Similarly, UberMedia tracked the movements of individuals in Milan during Covid-19 lockdown.[37] The chart below shows the results of this analysis.

September 2020) p. 1; see also remarks by UberMedia CMO to MarTech in "UberMedia buys Cintric to blend first and third party data for 'always-on' location", MarTech, 31 July 2017 (URL: https://martechtoday.com/ubermedia-buys-cintric-blend-first-third-party-data-always-location-201667, last accessed 11 September 2020).

[36] "COVID-19: Identifying homeless encampments for pandemic resource allocation", UberMedia, 16 April 2020 (URL: https://covid19.ubermedia.com/blog/covid-19-identifying-homeless-encampments-for-pandemic-resource-allocation/, last accessed 11 September 2020), slides 15-18.

[37] "COVID-19: Distance Traveled from Home as a Metric for Social Distancing", UberMedia, 27 March 2020 (URL: https://covid19.ubermedia.com/blog/covid-19-distance-traveled-from-home-as-a-metric-for-social-distancing/, last accessed 11 September 2020).


Traveling Away From Home: Milan, Italy
Social Distancing: Which Cities are Staying Home - and When?
2/21: First quarantines (not Florence)
3/8: Wider lockdown (still not Florence)
3/11: Nationwide Quarantine. All non-essential businesses closed
Florence, Italy

People's intimate characteristics

The taxonomies used by data brokers such as OnAudience, are an example of the industry standard. OnAudience uses "IAB standards" for "predefined segments".[38]

Topics such as "depression" and "substance abuse" are drawn from the IAB context taxonomy, about which I notified the DPC of in evidence on 28 January 2019, but which nonetheless remain in use today.[39] A recent update to the IAB content taxonomy adds the letters "SCD" to some, but not all, items that reveal special category data. According to my correspondence with the IAB, "the SCD flag is a marker that those categories should be treated with special consideration".[40] But there remains no restriction on whether these items are broadcast in the RTB system, or whether the full URL of what a person is viewing can be broadcast along with other data that could single them out.

The IAB Audience Taxonomy categorises people by their individual intimate characteristics, and provides a further illustration of the nature of the data being used in the industry.

The IAB Audience Taxonomy allows RTB and data broker companies to signal the personal characteristics of individual people. There are 1,679 personal characteristics in the taxonomy.[41]

The following is a brief sample:

- Personal affluence, for example "very low net worth" (IAB code: 193)
- Household, for example "rural" (IAB code: 147)
- Personal debt (IAB code: 537)
- Monthly mortgage payments (IAB codes: 114-130)
- Interest in buying "bail bonds" (IAB code: 1495)
- Political views, for example "conservative" (IAB code: 199)
- Interests, for example "vaccines" (IAB code: 404)
- Health related interests and purchases, for example "weight loss" (IAB code: 414)
- Interest in buying relevant to "law enforcement" (IAB code: 891)
- Matzoh food (IAB code: 1097)

[38] "OnAudience.com: a buyers guide", Oracle Data Cloud, p. 110.
[39] See evidence linked at https://brave.com/update-rtb-ad-auction-gdpr/.
[40] E-mail from Benjamin Dick to Johnny Ryan, 27 August 2020.
[41] "Audience taxonomy", IAB Tech Lab, April 2020 (URL: https://iabtechlab.com/standards/audience-taxonomy/, last accessed 12 September 2020).

The IAB Audience Taxonomy also includes various medical conditions:[42]

553	Allergy
554	Ear, Nose and Throat
555	Endocrine and Metabolic
556	Eye
557	Foot
558	Heart and Cardiovascular
559	Infectious Disease
560	First Aid Supplies
561	Lung and Respiratory
562	Mental Health
563	Infertility
564	Blood Disorder
565	STD
566	Skin Condition
567	Sleep
568	Substance Abuse
569	Pain
570	Bone and Joint
571	Nervous System
572	Cancer
573	Cold and Flu
574	Diabetes
575	Digestive Disorder
576	Contraceptive Products/Condoms
577	Dietary Supplements
578	Testosterone Boosters
579	Weight Reduction and Control
580	Medical Devices

And religious belief

596	Agnosticism
597	Astrology
598	Atheism
599	Buddhism
600	Christianity
601	Hinduism
602	Islam

[42] "Audience taxonomy 1", IAB Tech Lab (URL: https://iabtechlab.com/wp-content/uploads/2019/06/IABTL-Audience-Taxonomy-1.0-5.16.19-Final.xlsx, last accessed 12 September 2020).

603	Judaism
604	Sikhism
605	Spirituality

See the complete taxonomy in Appendix E.

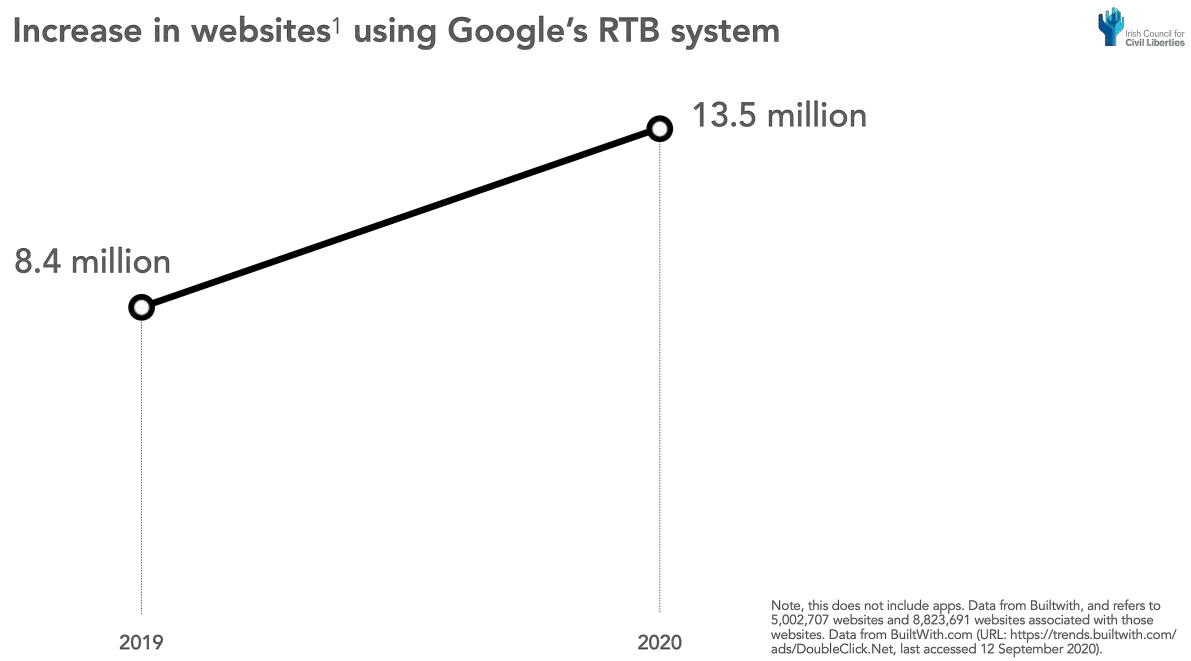
An updated version of the IAB Audience Taxonomy has been recently released, and excludes most religious and health characteristics.[43] But the previous version remains the one in general use, as OnAudience's taxonomy (Appendix D) illustrates.

[43] "Audience taxonomy 1.1", IAB Tech Lab (URL: https://iabtechlab.com/wp-content/uploads/2020/07/IABTL-Audience-Taxonomy-1.1-Final.xlsx, last accessed 12 September 2020).

Growth of the data breach

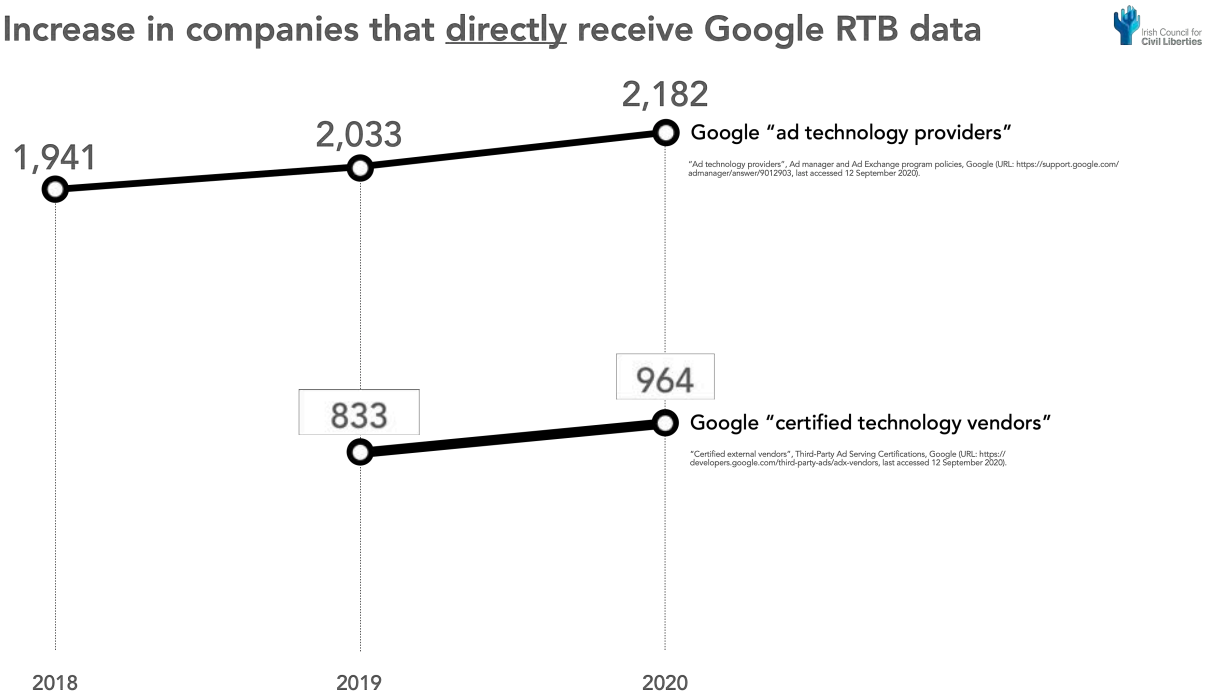
The ongoing Real-Time Bidding data breach is the most massive data breach ever recorded. The scale of that breach has continued to grow in the two years since the DPC was formally notified about this.

More websites broadcast data to more companies in Google's RTB system than before the DPC was alerted about the RTB data breach. The scale of the IAB RTB system appears to have grown too.



The number of websites using Google's RTB system has increased by 61% in the last year.[44] In addition, the number of companies receiving data directly from Google in its RTB system has also grown significantly over the last year.

[44] Doubleclick.net detected on 5,002,707 websites and 8,823,691 further websites associated with those websites. Data from BuiltWith.com (URL: https://trends.builtwith.com/ads/DoubleClick.Net, last accessed 11 September 2020).



Google now sends data from its RTB system to 964 companies.[45] See Appendix F for a complete list of these companies. (A further 1,218 companies are listed on Google's "certified external vendors", which are presumably only in direct receipt of data from Google outside the European Economic Area.[46])

Since there are no technical measures of restrict the further transmission of data by these hundreds of companies once they receive RTB data from Google, it is likely that the totality of data leakage has also grown.

A sample of large RTB ad exchanges in the IAB system indicates that the problem has grown there too. The chart below shows the increase in bid requests per day over the last year on three significant RTB ad exchanges.[47]

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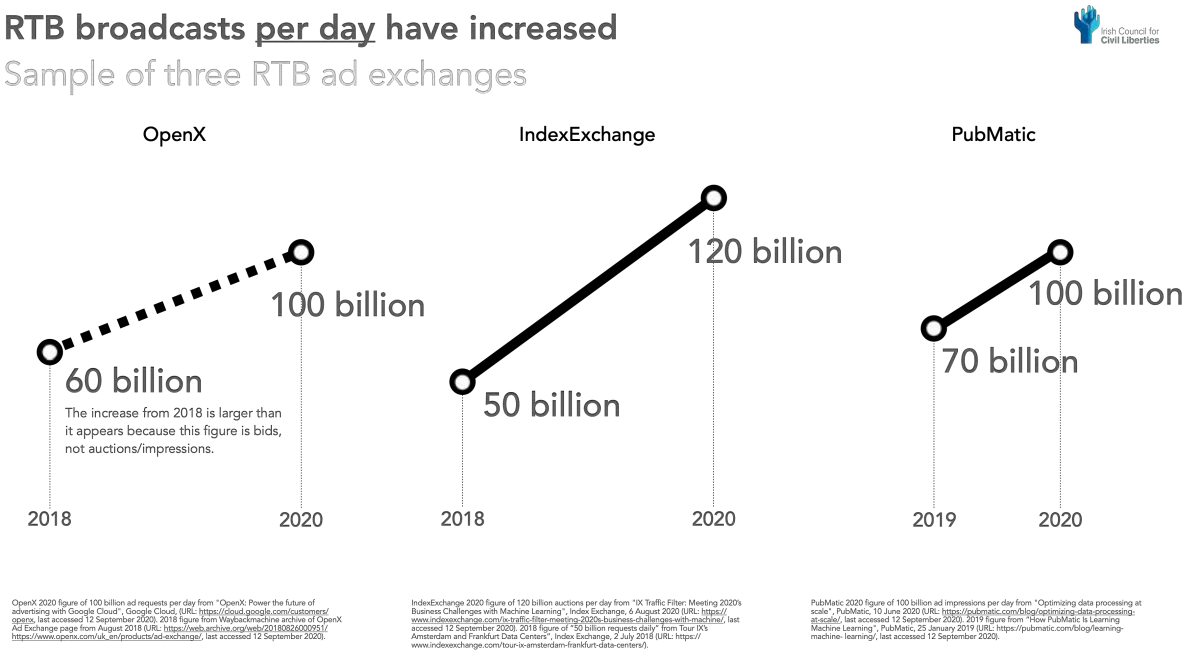
[45] "Ad technology providers", Ad manager and Ad Exchange program policies, Google (URL: https://support.google.com/admanager/answer/9012903, last accessed 12 September 2020).

[46] "Certified external vendors", Third-Party Ad Serving Certifications, Google (URL: https://developers.google.com/third-party-ads/adx-vendors, last accessed 12 September 2020).

[47] IndexExchange 2020 figure of 120 billion auctions per day from "IX Traffic Filter: Meeting 2020's Business Challenges with Machine Learning", Index Exchange, 6 August 2020 (URL: https://www.indexexchange.com/ix-traffic-filter-meeting-2020s-business-challenges-with-machine/, last accessed 12 September 2020). 2018 figure of "50 billion requests daily" from Tour IX's Amsterdam and Frankfurt Data Centers", Index Exchange, 2 July 2018 (URL: https://www.indexexchange.com/tour-ix-amsterdam-frankfurt-data-centers/, last accessed 12 September 2020). PubMatic 2020 figure of 100 billion ad impressions per day from "Optimizing data processing at scale", PubMatic, 10 June 2020 (URL: https://pubmatic.com/blog/optimizing-data-processing-at-scale/, last accessed 12 September 2020). 2019 figure from "How PubMatic Is Learning Machine Learning", PubMatic, 25 January 2019 (URL: https://pubmatic.com/blog/learning-machine-learning/, last accessed 12 September 2020) OpenX 2020 figure of 100 billion ad requests per day



Just these three ad exchanges alone made approximately 113.9 trillion RTB broadcasts in the last year.

from "OpenX: Power the future of advertising with Google Cloud", Google Cloud, (URL: https://cloud.google.com/customers/openx, last accessed 12 September 2020). 2018 figure from Waybackmachine archive of OpenX Ad Exchange page from August 2018 (URL: https://web.archive.org/web/20180826000951/https://www.openx.com/uk_en/products/ad-exchange/, last accessed 12 September 2020).