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APIs and Your Privacy

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Executive Summary

Application programming interfaces, or APIs, have been the topic of much recent discussion. Newsworthy events, including those involving Facebook's API and Cambridge Analytica obtaining information about millions of Facebook users, have highlighted the technical capabilities of APIs for prominent websites and mobile applications. At the same time, media coverage of ways that APIs have been misused has sparked concern for potential privacy invasions and other issues of public policy. This paper seeks to educate consumers on how APIs work and how they are used within popular websites and mobile apps to gather, share, and utilize data.

APIs are used in mobile games, search engines, social media platforms, news and shopping websites, video and music streaming services, dating apps, and mobile payment systems. If a third-party company, like an app developer or advertiser, would like to gain access to your information through a website you visit or a mobile app or online service you use, what data might they obtain about you through APIs and how? This report analyzes 11 prominent online services to observe general trends and provide you an overview of the role APIs play in collecting and distributing information about consumers. For example, how might your data be gathered and shared when using your Facebook account login to sign up for Venmo or to access the Tinder dating app? How might advertisers use Pandora's API when you are streaming music?

After explaining what APIs are and how they work, this report categorizes and characterizes different kinds of APIs that companies offer to web and app developers. Services may offer content-focused APIs, feature APIs, unofficial APIs, and analytics APIs that developers of other apps and websites may access and use in different ways. Likewise, advertisers can use APIs to target a desired subset of a service's users and possibly extract user data. This report explains how websites and apps can create user profiles based on your online behavior and generate revenue from advertiser-access to their APIs. The report concludes with observations on how various companies and platforms connecting through APIs may be able to learn information about you and aggregate it with your personal data from other sources when you are browsing the internet or using different apps on your smartphone or tablet. While the paper does not make policy recommendations, it demonstrates the importance of approaching consumer privacy from a broad perspective that includes first parties and third parties, and that considers the integral role of APIs in today's online ecosystem.

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I. Introduction

The objective of this paper is to educate the public and policymakers on how application programming interfaces (APIs) are used within consumer-facing websites and mobile applications to gather, share, and utilize data. How are companies such as Facebook, Google, and Amazon using APIs to compile and share your data? APIs are, essentially, a specified way through which different online services, websites, and applications can exchange data and interact with one another. Thus, APIs are the common way for programmatically interconnecting two or more services. To make it easier for developers to utilize another service's API (for example, for a mobile app developer who wants to allow its users to log into its app with Facebook), access and use of APIs are made easier through programming code provided by the party offering the API¹ (e.g., Facebook for its Login API). Other developers can then directly integrate this programming code into their apps or websites. In addition to enabling the integration of functionality, however, APIs may also reveal certain information about a service's users.

Events involving APIs and personal information have recently made headline news. For example, Facebook's Open Graph API enabled the *thisisyourdigitallife* app to provide Cambridge Analytica third-party access to

troves of Facebook user data.² Although only 300,000 Facebook users consented, the API also enabled access to data of those users' "friends," affecting 87 million people.³ The U.K. Information Commissioner's Office levied its maximum fine of £500,000 against Facebook⁴ and the company faces numerous civil lawsuits⁵ following Cambridge Analytica's data access. On August 1, 2018, Facebook reportedly revoked access to its API for hundreds of thousands of apps that failed to submit to a new audit sparked by the Cambridge Analytica scandal and other scrutiny relating to its API.⁶

This recent spotlight on Facebook's API and its reported use in 2016 to affect the U.K. Brexit vote⁷ and the U.S. Presidential election⁸ caused other tech companies to move quickly to revisit and reform their policies for API access by third parties. For example, Twitter recently strengthened policies and procedures for vetting third-party developers seeking user data access through its API.⁹ Current events involving APIs of internet platforms have also fueled momentum toward enhanced privacy laws in the U.S.¹⁰ and globally, especially when increased public awareness of APIs and reports of improper data uses coincided with a new data protection regime already scheduled to become effective in the European Union in May 2018.¹¹ The EU's General Data Protection Regulation (GDPR) requires

¹ Those code pieces are often called third-party libraries.

² *You Are the Product': Targeted by Cambridge Analytica on Facebook*, N.Y. Times, April 8, 2018, <https://www.nytimes.com/2018/04/08/us/facebook-users-data-harvested-cambridge-analytica.html>.

³ Id.

⁴ *Facebook faces UK fine over Cambridge Analytica scandal*, CNET, July 10, 2018, <https://www.cnet.com/news/facebook-may-face-uk-fine-over-cambridge-analytica-scandal/>.

⁵ See, e.g., *Facebook hit with four lawsuits in one week over Cambridge Analytica scandal*, The Verge, March 23, 2018, <https://www.theverge.com/2018/3/23/17155754/facebook-cambridge-analytica-data-breach-scandal>.

⁶ *Facebook shuts off access to user data for hundreds of thousands of apps*, The Verge, July 31, 2018, <https://www.theverge.com/2018/7/31/17637244/facebook-apps-api-access-shut-off-missed-review-deadline>.

⁷ *Lawmakers publish evidence that Cambridge Analytica work helped Brexit group*, Reuters, April 16, 2018, <https://www.reuters.com/article/us-facebook-cambridge-analytica-britain/lawmakers-publish-evidence-that-cambridge-analytica-work-helped-brexit-group-idUSKBN1HN2H5>.

⁸ *How Trump Consultants Exploited the Facebook Data of Millions*, N.Y. Times, March 17, 2018, <https://www.nytimes.com/2018/03/17/us/politics/cambridge-analytica-trump-campaign.html>.

⁹ *Twitter to place new restrictions on its API to stop abuse*, The Next Web, July 24, 2018, <https://thenextweb.com/twitter/2018/07/24/twitter-to-place-new-restrictions-on-its-api-to-stop-abuse/>.

¹⁰ Notably, California passed its new Consumer Privacy Act (CaCPA) in June 2018, deemed "the nation's toughest data privacy law." *California just passed the nation's toughest data privacy law*, CNN, June 29, 2018, <https://money.cnn.com/2018/06/28/technology/california-consumer-privacy-act/index.html>.

¹¹ Regulation (EU) 2016/679 of the European Parliament and of the Council (General Data Protection Regulation), April 27, 2016, EU-LEX, <http://data.europa.eu/eli/reg/2016/679/oj>.

any company that collects or processes information in Europe to adhere to the GDPR's data protection requirements – regardless of where the company is located or incorporated. As a result, the GDPR has prompted entities of all sizes, both inside and outside of Europe, to evaluate data practices, strengthen privacy protections, and implement data governance models, creating a global ripple effect and corporate investment in privacy.¹²

This report describes how APIs function technologically and in practice and analyzes how APIs may generally be used by online services, also sometimes referred to as edge providers, to facilitate data sharing and use. If a third party, such as a web or app developer or advertiser, would like to gain access to your information through a website or mobile app you use, what data might they obtain about you through these APIs and how?

To answer these questions, we examined popular websites and apps that consumers use in their daily lives. APIs are a technical mechanism to interconnect services and they are used everywhere – for instance in mobile games; internet search engines; social media platforms; news, shopping, and sports sites; video and music streaming services; location-based search utilities; dating apps; and mobile payment systems. While many APIs serve technical purposes, an increasing number of services also provide APIs that give other third parties, such as app or website developers and advertisers, direct

or indirect access to data about a service's users. For this report, we researched one specific popular website or application in each of the foregoing categories to discover and report on what those services' APIs may reveal about you.

Based on a reasoned selection process,¹³ we examined 11 popular online services and mobile apps:

- Candy Crush Saga (mobile game)
- Google Search (online search engine)
- Facebook (social media website and app)
- CNN.com (online news)
- Netflix (video streaming)
- Pandora (music streaming)
- Amazon.com (online shopping)
- Google Maps (location-based service)
- Tinder (dating mobile app)
- ESPN.com (sports website)
- Venmo (mobile payment app)

We examined the APIs of each of these services or platforms to observe general trends, and to inform you as to how APIs in these platforms function either to potentially enable your data to be shared with third-parties, or enable these platforms to gather more information about you. While not exhaustive, this selection provides a representative overview of the role online services' APIs play in distributing information about consumers.

¹² See, e.g., *G.D.P.R., A New Privacy Law, Makes Europe World's Leading Tech Watchdog*, N.Y. Times, May 24, 2018, <https://www.nytimes.com/2018/05/24/technology/europe-gdpr-privacy.html> ("In Silicon Valley, Google, Facebook and other tech companies have been working for months to comply with the new rules...Brazil, Japan and South Korea are set to follow Europe's lead, with some having already passed similar data protection laws.")

¹³ See Section IV – Appendix: Selection Methodology.

II. Application Programming Interfaces and User Data Access

We examined how the information that companies have about you may be accessed through APIs in each of these popular offerings. Developers of websites, apps, and other platforms may access your data through APIs. Advertisers on these platforms may also access information about you from popular websites and apps. In addition, websites and apps may learn more information about you from those developers and advertisers utilizing their APIs.

A. WHAT ARE APIS AND HOW DO THEY WORK?

An API, or application programming interface, is a predefined way for two services to interact with one another. A website may have a feature or tool it wants to make available to other websites or applications. The site can create a set of allowed interactions and a protocol for using its feature or tool, and other websites or applications can then use that protocol – the API – to use the service.

We use predefined protocols in a similar way in many parts of our lives. For example, if you want to send a letter with the U.S. Postal Service, you know that you should write the destination address on the front of the envelope, the return address in the top left corner, put the postage stamp in the top right corner, and deposit it in an authorized pickup location. In sending this letter, you are following the protocol that the USPS defined to send mail. Using their service is much easier than finding your own way to send letters or packages to your friends and family afar. If you make a mistake or neglect part of the protocol (like forgetting the stamp), the USPS may reject your letter and send it back to you to correct.

In the same way, an API can be used to interact with a service online. For instance, an online service might want to make its premier feature available to other relevant websites. Take, for example, a weather service that wants to enable a kayak rental website to use its data to display weather predictions for the kayak rental website's city. The weather company will enumerate a set of allowed interactions (*e.g.*, request temperature today for a certain city, request precipitation for a specified date), define a protocol for achieving them (*e.g.*, send weather company the city's zip code and date in order to receive temperature data for that location), and create a service address that can receive and handle requests (*e.g.*, the URL that receives and responds to the date and zip code sent by the kayak website). The weather website, to make integration easy, will probably also write some code that can be included on the kayak rental website that follows this protocol precisely. Here is how this might look:

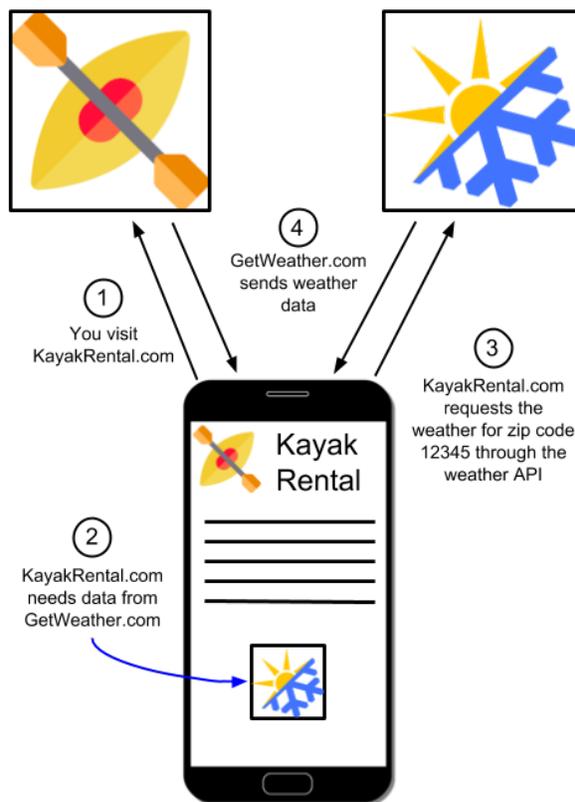


Figure 1: When you visit KayakRental.com, the kayak rental company's website includes a request to GetWeather.com's API to obtain the current weather. Your device will then also send and receive data from GetWeather.com, even though you did not visit GetWeather.com directly.

In this way, when you visit the kayak rental website, you are not only interacting with its code, but also code from the weather service. If you were to click on a button that displayed next week's weather instead of this week's, the request for that data could be seen by the kayak rental website but would also go to the weather service. This means that in addition to getting weather data requests from the kayak website, the weather service also gains some knowledge of who is visiting the kayak rental website, for which days they want to know the weather, and even a rough approximation of their current location, due to the fact that the request for data will come from your mobile phone or computer rather than from the kayak rental shop. It is exactly these types of additional data exposures that we hope to elucidate in this report.

B. WHO USES APIS

Two major users of APIs are developers and advertisers. In the following sections, we discuss how each of these types of users may utilize the APIs companies provide.

a. Developers

Many online services may wish to make their product or content available to the developers of other websites and applications to integrate and utilize their product in other products. These types of APIs are what enable features like using your Facebook account to log into other websites or watching a YouTube video embedded on Twitter, on a personal blog, or on a news website. In many ways, these APIs enrich our online experiences. But in the process of interacting with these online services, third-party developers and companies might have additional access to information about customers of the original service.

There are several different categories of APIs that services can provide to developers. Specifically, in the following subsections we discuss four different types of developer-oriented APIs:

- **Content-focused APIs** provide access to data published by the original service (e.g., news stories or weather reports).
- **Feature APIs** allow other websites or mobile apps to integrate another service's existing feature into their offering (e.g., using Google search on one's own website).
- **Unofficial APIs** are meant for internal use by the service but may also be used by third parties.
- **Analytics APIs** enable developers to gain information about the visitors to their websites.

Of the websites and apps we analyzed, Facebook and Google offer the most developer APIs by far, having multiple offerings in the content, feature, and analytics API categories. Other services, like Amazon and Venmo, offer feature APIs, which provide their service's functionality to other websites and apps. Further websites and apps, like CNN and ESPN, offer or have offered at some point only content-focused APIs that allow developers to access content they publish. Some websites and apps that we examine offer no official APIs, but have services that are unofficially available for developers to use, like Pandora and Tinder. Finally,

several services we analyze offer no APIs, like Netflix and Candy Crush Saga. These companies may simply want to ensure that their product and content is available to consumers only through their official website and app. However, this has little to do with whether the company itself monetizes user data; for example, Candy Crush Saga displays ads, and in the process may exchange data about users with advertising companies every time an ad is displayed to a user (*see* Section II(B)(b)).

We will discuss the specific developer APIs offered by the apps we analyzed in more detail in the rest of this section.

1. Content-Focused APIs

Other websites or applications may choose to expose only *content-focused APIs*. This means that a developer using the API only has access to data that the original service publishes, rather than data about the customers of the service. For example, a third-party website may want to display the most recent news stories about a particular topic. They could use the CNN NewsGraph API to fetch and display stories related to a term or by specific journalists on their website or app.¹⁴ This API, however, does not reveal to the third-party website or its developers information about who has read the article on CNN.com or shared it on social media—although CNN may have that data and use it internally, for example, to learn your interests based on the articles you read. However, by letting third-party developers use their NewsGraph API on their websites, CNN may be able to learn who reads the article on the third-party website, even if the visitor doesn't open the article on CNN.com.

ESPN also used to have a content-focused API for sports statistics and schedules, but the API has been deprecated, meaning it is no longer accessible to new developers.¹⁵ This is likely a move to draw more visitors to the ESPN website and mobile apps.

2. Feature APIs

Services may also offer APIs that allow other websites or mobile apps to integrate another service's existing feature into their offering. For example, among many other APIs, Facebook provides a Facebook Login API that developers can incorporate into their own website or app that lets users use their Facebook account to access the new service, without having to create a separate account for it.¹⁶ These *feature APIs* may enhance the experience of the user and provide high-quality features

¹⁴ NewsGraph Docs, CNN, <https://developer.cnn.com/docs/read/api> (accessed July 24, 2018).

¹⁵ Public API Retirement, ESPN Developer Center, <http://www.espn.com/static/apis/devcenter/blog/read/publicretirement.html> (accessed August 27, 2018).

¹⁶ Facebook Login & Account Kit, Facebook for Developers, <https://developers.facebook.com/products/account-creation> (last visited August 27, 2018).

to other websites for little effort. However, we should consider what data is being shared through this type of API.

In order for developers to incorporate Facebook Login into their website or app, they include some code in their website or app that asks whether a user would like to use their Facebook account to log into the service. If you choose to log in with Facebook, the service will gain access to your public Facebook profile and email address. Developers can request more information when you log in with Facebook, such as your Facebook friends, photos, likes, and groups, but the website or app first needs to be reviewed by Facebook, and you as the user need to grant permission on first login.¹⁷ However, this is a product of recent change; in spring of 2018, Facebook began restricting how data can be accessed by third-party developers. Now, these permissions require an app to go through Facebook's review process. Additionally, sensitive or protected information categories like religion, political views, relationship status, work history, video watching activity, and other similar data that once were accessible to third-party developers are no longer available through Facebook Login.¹⁸

Amazon also offers a feature API. Developers can incorporate Amazon payment in their mobile app that allows users to purchase virtual goods, like coins or enhancements in a game app.¹⁹ This means that if you buy Candy Crush Saga on an Amazon Fire tablet, you could use your Amazon account to buy additional lives in the game, extra moves, or hidden levels. In this case, the Amazon API will only tell the Candy Crush app your unique user ID and your "marketplace," which indicates your location and currency.²⁰ This is a relatively conservative amount of data for Amazon to share, and developers would not gain more information than they would through your regular use of the app. Amazon also requires that all apps using in-app purchases be reviewed before being submitted to the Amazon Appstore.²¹

This process includes a review of whether the app puts customer data at risk.

Google Search provides another example of a feature API that enhances user experience. A developer can use Google's Custom Search API to incorporate custom search onto their website, which allows users to search through that website's content with the quality of a Google search.²² Websites might also enable auto-completed search terms or monetize their search engine by displaying ads in their custom search results. For these APIs, Google does not share user data with the website incorporating custom search, but Google does learn what users are typing into the search bar, as that search term will be sent to Google to be processed and so the results can be returned.

With feature APIs, the website or application using the API might learn some information about the user. But in all cases, the website offering the API learns which users come into contact with the API, often because you are already logged into your Facebook and Google accounts on the same device or web browser. Sometimes this won't be immediately obvious to a website visitor, like in the case of Google Custom Search, which may look like a normal search bar on the third-party website. Through the use of cookies²³ and other methods, Google and Facebook can consistently identify users even on external websites when their APIs are used. For example, if you do *not* use Facebook Login, instead opting to create a new username and password for the third-party website, Facebook may still know that you visited the website that offered Facebook Login if you are also logged into your Facebook account at the same time. The presence of the Facebook Login button means that Facebook code is included on the website and every time you visit such a website information about your visit gets sent to Facebook. The same holds true for Facebook Like buttons, the Facebook Comments feature or the other social media share buttons that many websites use to enable their visitors to quickly share an

¹⁷ Permissions Reference - Facebook Login, Facebook for Developers, <https://developers.facebook.com/docs/facebook-login/permissions> (accessed August 27, 2018).

¹⁸ API and Other Platform Product Changes, Ime Archibong, <https://developers.facebook.com/blog/post/2018/04/04/facebook-api-platform-product-changes> (accessed August 27, 2018).

¹⁹ In-App Purchasing Overview, Amazon Appstore, <https://developer.amazon.com/docs/in-app-purchasing/iap-overview.html> (accessed August 27, 2018).

²⁰ IAP FAQ, Amazon Appstore, <https://developer.amazon.com/docs/in-app-purchasing/iap-faqs.html> (accessed August 27, 2018).

²¹ Overview of the App Approval Process, Amazon Appstore, <https://developer.amazon.com/docs/app-submission/viewing-app-submission-status.html#overview-of-the-app-approval-process> (accessed August 27, 2018).

²² Overview, Google Custom Search, <https://developers.google.com/custom-search/docs/overview> (last visited August 27, 2018).

²³ A cookie is a small, unique piece of data that is stored on a user's device and sent to a website when a user interacts with the website that created the cookie. It allows websites to identify the same user across multiple visits.

article with their Facebook friends or on other social media services.

In this way, companies like Amazon, Facebook, and Google have huge insight into how you browse the web, even when you are visiting other websites and applications. It is likely that the majority of websites you visit day to day use a feature or other type of API from one of these large companies, giving those companies a near complete picture of your online life. In the case of feature APIs, users are typically gaining some feature or enhancement in their online experience. Thus, smaller companies are incentivized to incorporate features like Facebook Login and Google Custom Search because they are easy for developers to use and often improve customer experience. Most importantly, companies like Facebook, Amazon, and Google are incentivized to create these feature APIs because collecting data that enables a more complete view of each user's internet browsing habits and app usage may increase profits in the advertising space (*see* Section II(B)(b)).

While feature APIs make some actions more convenient for users, there is one additional concern with feature APIs like Facebook Login: a single service controlling account access for hundreds of websites means that there is a single point of failure for data leaks and hacks. We saw the unlikely but devastating effect of this in September 2018, when Facebook announced that it had experienced a security breach that allowed attackers to steal tokens for users' accounts that not only let them access users' Facebook accounts, but also accounts the users had created using Facebook Login.²⁴ When large companies offer services like Facebook Login, a feature API that allows Facebook to collect information about you across many other websites, we not only need to consider what Facebook, Google, or Amazon might do with the data, but also the sheer volume of data about you that is exposed if that company holding that data is compromised, or when a company is acquired by or merges with another company.

3. Unofficial APIs

Sometimes, APIs that are meant for internal purposes end up being used by third parties. These *unofficial*

APIs may be discovered and documented by developers who then build new applications using the API for an unintended purpose. This happens when a developer examines the way the legitimate app on their phone or computer (*e.g.*, the Tinder app or website) communicates with the remote website or app infrastructure (*e.g.*, Tinder's servers), and mimics that communication. For example, Tinder does not advertise any developer API, but the API that the official app uses to communicate with Tinder's servers can also be used by any developer who mimics the functionality of the official app in their unofficial one. When the username and password for a legitimate Tinder account is provided by the user, developers can interact with Tinder as though they are using the official application, *e.g.*, by swiping, chatting, or browsing. Indeed, developers have taken advantage of this API to build new applications that do things like automatically swipe right on all nearby users and advertise a new game to them,²⁵ implement a different interface that has additional features like the ability to hold your phone in landscape mode, automatically swipe right on nearby users, and save user profiles so you can look at them again later,²⁶ and even use facial recognition to swipe right on only certain users and automatically start a conversation with them.²⁷

Similarly, Pandora has an API that is used by the official app for its normal functioning and that was not documented publicly by Pandora. However, developers have examined the Pandora app and understood how the Pandora app communicates with Pandora's servers (*i.e.*, computers owned by Pandora that store all of Pandora's music). Using this knowledge, developers have built new unofficial Pandora applications, like PianoBar, a text-based Pandora app, that can be used with real Pandora accounts.²⁸ This allows users who use less common operating systems like Linux (instead of Windows or Mac OS) to use a Pandora application instead of the Pandora website, even though their operating system is not officially supported by Pandora.

While these unofficial APIs aren't intentionally being given any additional data by the original company, you should keep in mind that if you sign into your account using a third-party application, that application will have complete access to your account. In the case of Tinder,

²⁴ *The Massive Facebook Hack Might Have Affected Other Apps and Websites, Too*. Slate, September 28, 2018, <https://slate.com/technology/2018/09/facebook-hack-50-million-affected-apps-other-websites.html>.

²⁵ Tinderbot, alkawryk, <https://github.com/alkawryk/tinderbot> [software] (accessed August 27, 2018).

²⁶ Dinger, Jorge Antonio Díaz-Benito Soriano, <https://stoyicker.github.io/dinger> [software] (accessed August 27, 2018).

²⁷ *Automating Tinder with Eigenfaces*, Justin Long, <http://crockpotveggies.com/2015/02/09/automating-tinder-with-eigenfaces.html> (accessed August 27, 2018).

²⁸ *Console-based pandora.com player*, PromyLOPh, <https://github.com/PromyLOPh/pianobar> [software] (accessed August 27, 2018).

this would mean that the third-party application could access your full profile, matches, and messages. This is true even for authorized third-party applications.

Consider Venmo: If you connect your Venmo account to a budgeting tool like Mint or You Need A Budget, that third-party service has access to all the data and transactions in your Venmo account, including private transactions. Once an application has access to your data, nothing technically prevents it from storing your data on its own servers and/or analyzing your data with data mining and machine learning to learn facts about you and your behavior that might be useful to that company (*e.g.*, to target you with advertising or sell information about you to other companies).

Venmo also offers an open API of all public transactions.²⁹ Because transactions are public by default, which means anyone can view any transaction unless it is set to private, this provides public access to hundreds of thousands of transactions a day, with details like sender and receiver name and profile photo, date and time, and sender message.³⁰ Access to data that chronicles who pays whom and when via Venmo has led enterprising developers to build tools like Vicemo, a site that watches all public transactions for words that might be related to drugs, alcohol, or sex, and re-publishes the message, name, and photo of the users on its website.³¹ Other tools will take advantage of the public API to infer social behaviors of a user's friends by watching who is paying whom, what the messages are, and what time they're making transactions.³²

4. Analytics APIs

Finally, Facebook and Google offer third-party developers access to *analytics APIs*, which allow third-party services to gain information about the visitors to their website. These APIs often remain invisible to the

visitor. Of the websites and apps that we investigated, Google and Facebook are the two companies who offer analytics APIs.

As an example of how an analytics API works, a developer can include some code on their website that lets Facebook invisibly identify the visitor based on the Facebook account they are logged into. Facebook will then share aggregate statistics with the website about its visitors, like number of unique visitors over a period of time, their age, gender, and education level, all of which Facebook knows from your Facebook profile.³³ These details might be used to inform the website which group of users is more likely to buy their product than others.

Google has a similar analytics API. A developer can include a small piece of Google code on its website. While this code is invisible to you, every time you visit a website with Google Analytics code, that code communicates to Google who you are when you visit the website based on your Google account and other identifying factors.³⁴ A website that uses the Google Analytics API will be able to ask Google for demographic information like age, gender, and shopping interest about the users that visit the website,³⁵ similar to Facebook. Google offers information about individual users, too. A website developer can also see information about unique visitors like the amount of time they spent on the website, how many times they have visited, the total amount of money they spent on the website, what type of device they are using, and how they got to the website (*e.g.*, if they followed a Google search or clicked on a link from Facebook).³⁶

Google and Facebook analytics are both extremely common. In fact, these two companies are the most popular analytics companies on the internet. As of 2016, Google tracking services were being used by about 75%

²⁹ *Venmo: how the payment app exposes our private lives*, The Guardian, July 17, 2018, <https://www.theguardian.com/world/2018/jul/17/venmo-payments-app-default-privacy-settings-public-information>.

³⁰ *Public by Default*, Hang Do Thi Duc, <https://publicbydefault.fyi> (last visited August 27, 2018).

³¹ Vicemo, Lacher, M., Baker, C., <http://www.vicemo.com> (last visited August 27, 2018).

³² Money Trail, arankhanna25, <https://chrome.google.com/webstore/detail/money-trail/pfapinkogbekmajdmmmdiifcmnkeflm> [software] (last visited August 27, 2018).

³³ Facebook Analytics, Facebook for Developers, <https://developers.facebook.com/docs/analytics> (accessed August 27, 2018).

³⁴ There are other ways companies can persistently identify users across the web even if they are not logged into any accounts, like the type of device they use, which browser they are in, which browser extensions they have installed, and so forth. All of these details in combination do a good job of making you uniquely identifiable. To see how identifiable you are, you can visit <https://panopticlck.eff.org>.

³⁵ About Demographics and Interests, Analytics Help, <https://support.google.com/analytics/answer/2799357> (accessed August 27, 2018).

³⁶ User Explorer, Analytics Help, <https://support.google.com/analytics/answer/6339208> (accessed August 27, 2018).

of the one million most popular websites, and Facebook tracking services appeared on 25% of those websites.³⁷ This means that the vast majority of websites you visit will contain some code from Google or Facebook or both, allowing these companies to develop extremely complex and detailed profiles of you as an internet user. For example, if you are visiting different websites to look at paint samples, to learn how to put up drywall, and recommendations for electricians in your area, Google will very likely learn what products you are interested in and might be able to infer that you are doing construction on your home, even if you never used a Google website like Google Search or YouTube in the course of your research. This information can then be used to inform their advertising ecosystem so, for example, you may be offered ads for sandpaper and power tools.

b. Advertisers

Traditionally, to reach their intended audience, TV and radio advertisers had limited tools. For example, a company aiming to increase sales of a certain car model or alcoholic beverage could try advertising its product during a popular sports broadcast. Mass advertising, however, can be very expensive. Companies with a limited budget wishing to focus on consumers most likely to purchase their product could, alternatively, air their ads around the same time as a show known to be popular with potential customers. For example, a toy company could air commercials on weekends with morning cartoons.

Today, the ability to collect, store, and share information about internet users has revolutionized the field of advertising by allowing marketers to more-effectively target products and services to specific audiences.

There are two major benefits to doing so: decreasing users' negative perceptions of advertising, and lowering advertising costs while increasing revenue streams for advertisers and the online websites, services, and apps they partner with.³⁸

While some people dislike ads altogether, studies show that most online consumers are receptive to ads they find relevant.³⁹ Reasons many users may like ads include exposure to new products, ads for products they are interested in, and ads that keep apps and content free.⁴⁰ For example, a well-placed advertisement on Amazon.com by a toy company can help parents looking for educational toys find just what they were looking for in a matter of seconds. Thus, by advertising online instead of during weekend cartoon time, a toy company can increase sales and increase customer satisfaction. However, research also suggests that consumers tend to feel uncomfortable when ads are too personalized, which has the effect of lowering purchasing interest.⁴¹

It follows that there is a fine line between helpful and privacy-invasive advertising, and APIs play a critical role in defining advertiser-consumer relationships.

To purchase ad space on websites or in mobile apps, advertisers typically rely on online auctions hosted by private (in-house) or third-party exchanges. Big platforms, like Facebook and Google, usually operate their own marketplaces while relatively smaller companies typically rely on third-party exchanges such as OpenX and Smaato. There are many types of ads one can buy online. Pandora, as might be expected with a leading music platform, is big on audio ads. Its offerings don't stop there – display, video, and brand station advertising solutions are also available. Similarly, companies renowned for keyword searches like Amazon.

³⁷ Online tracking: A 1-million-site measurement and analysis, Princeton Web Census, <https://webtransparency.cs.princeton.edu/webcensus> (accessed August 27, 2018).

³⁸ Programming Sponsored Content: How APIs Have Transformed Advertising, Kristopher Sandoval, Nordic APIS, October 21, 2015, <https://nordicapis.com/programming-sponsored-content-how-apis-have-transformed-advertising/>.

³⁹ A 2016 study from HubSpot found that “83% of respondents agree that not all ads are bad, but they want to filter out the really obnoxious ones. 77% agree that they would prefer to ad filter rather than completely ad block.” *Why People Block Ads (And What It Means for Marketers and Advertisers)*, Mimi An, HubSpot, July 13, 2016, <https://research.hubspot.com/why-people-block-ads-and-what-it-means-for-marketers-and-advertisers>. More recent studies support such findings, see e.g., *10 data-driven numbers to help you plan your year*, choozle, February 7, 2018, <https://choozle.com/10-data-driven-numbers-to-help-you-plan-your-year/>; and *Consumers Don't Like and Don't Trust Digital Advertising (Infographic)*, Kimberlee Morrison, May 5, 2017, <https://www.adweek.com/digital/consumers-dont-like-and-dont-trust-digital-advertising-infographic/>.

⁴⁰ *Consumers Don't Like and Don't Trust Digital Advertising (Infographic)*, Kimberlee Morrison, May 5, 2017, <https://www.adweek.com/digital/consumers-dont-like-and-dont-trust-digital-advertising-infographic/>.

⁴¹ Two data gathering techniques in particular were highlighted as producing discomfort: “obtaining information outside the website on which an ad appears, which is akin to talking behind someone's back;” and “deducing information about someone from analytics, which is akin to inferring information.” *Ads That Don't Overstep*, Leslie K. John, Tami Kim, and Kate Barasz, Harvard Business Review, Jan.-Feb. 2018, <https://hbr.org/2018/01/ads-that-dont-overstep>.

com and Google also offer a wide array of options to advertisers. Some platforms price ads per “impression” (*i.e.*, number of views), while others charge per customer click. Additionally, and most importantly for advertisers, platforms offer targeting options that enable advertisers to select audiences strategically and receive feedback to evaluate their success.

All of these interactions are controlled by advertising APIs. For example, if our toy company uses Facebook’s Marketing API, it will be able to manage its audience, buy ads, and create analytics tools all from one place. So, users who have been identified as parents and as potential purchasers of toys for toddlers may see ads for the toy company’s educational toys for toddlers, while other Facebook users will see ads for various other items from different merchants.

The level of access advertisers have to user data and audience selection will be delineated by the platform’s advertisement API. The degree of access is usually influenced by (a) how much user data the platform already knows and collects, and (b) company policy. For example, Venmo currently chooses not to engage in advertising or marketing on its platform.⁴² Comcast Spotlight’s API, on the other hand, allows advertisers on CNN.com to select their audience based on gender, household income, education, home ownership, age, presence of children, and marital status.⁴³ This does

not mean that the advertiser will be able to identify consumers individually, but means that they will be able to target categories of users. In some cases, targeting can be quite narrow. For example, Pandora and Facebook offer very refined audience selection tools. This is in contrast to Amazon.com, which offers limited audience selection tools. This is partially due to the nature of Amazon’s business as an online retailer, where limiting targeting to product-related keywords makes sense. Nonetheless, Amazon still provides advertisers with additional insights through its powerful analytics tool, Amazon Pinpoint.⁴⁴ In our toy company example, this means that the toy maker will only have to worry about bidding for keywords and providing Amazon with an ad conforming to the platform’s guidelines.⁴⁵ In essence, Amazon provides the advantage of selecting an advertiser’s target audience for the advertiser; whereas, an advertiser on, say CNN.com or Facebook, would need to determine its intended audience beforehand.

Therefore, there are several functionalities APIs can adopt to help platforms, websites, and apps make money and advertisers reach their desired consumer base and extract user data. **API monetization** derives financial value from APIs. **Marketing APIs** define how ad-related information exchanges will happen; their unique specifications result in different levels of consumer data access for advertisers.⁴⁶

⁴² General Business & Partnership Inquiries, <https://help.venmo.com/hc/en-us/articles/226001687-General-Business-Partnership-Inquiries> (accessed August 29, 2018).

⁴³ Find your audience, Comcast Spotlight, <https://www.comcastspotlight.com/find-your-audience?zip=10128> (accessed August 29, 2018).

⁴⁴ Amazon Pinpoint, Amazon.com, <https://aws.amazon.com/pinpoint/> (accessed August 29, 2018).

⁴⁵ Advertise your products on Amazon.com, Amazon.com, https://services.amazon.com/advertising/overview.htm?ref=scus_sp_login_b_lm&ld=SCSPStriplogin (accessed August 29, 2018).

⁴⁶ In our research of advertising and Tinder’s APIs, advertising specifications are not publicly available. However, in an inquiry to Tinder parent Match Media Group, we confirmed that audience selection includes age, gender, and geography. Email from Match Media Group to Fordham CLIP (August 28, 2018, 11:06 a.m. EST) (on file with authors).

1. Monetization APIs

Platforms with large numbers of users have a strong financial incentive to monetize their user base. Monetization APIs help achieve this by enabling platforms to categorize consumer interactions, create user profiles, and facilitate advertiser interaction. For example, when you use Google.com to look up products online, Google will collect and store various data points related to your searches and create a user profile. The next time you use the search engine, Google will be able to identify you and keep building up your profile by remembering unique identifying information with tracking tools like cookies. If you like searching for cars online, Google⁴⁷ will remember this and allow car advertisers to target you with their ads in exchange for payment. The more your interactions on a platform are varied, the more types of information it will be able to collect and use towards advertising.

Platforms retain control over monetization APIs by establishing *how* to access them, *when* to activate their functionality, and *who* pays for them. This means that advertiser access to consumer data is defined by the parameters set by the platform's API. For example, Pandora will only make its ad space available to advertisers who have already paid to do so, and only then will it allow them to target its users. Because Pandora has developed very precise ad targeting tools, permitting advertisers to select over 1,300 different filtered audience segments or categories of users,⁴⁸

advertisers have a strong incentive to use its platform. These categories include ethnicity, family status, device type, and lifestyle,⁴⁹ and as put by the company, “[w] hether you want to reach fitness-driven moms in Atlanta or mobile Gen Z in Sioux Falls, Pandora’s targeting platform allows us to zero in on your audience.”⁵⁰ Similarly, Google and Facebook collect vast amounts of personal information through their different products and services, as well as the feature and analytics APIs they offer to other developers, allowing them to offer ad targeting based on demographics, personal interests, location, and online behavior.⁵¹ In other words, what you do or “like” online leaves a digital trace that apps and websites use to create user profiles, from which analytic and predictive tools can extract value. There are two principal monetization strategies: internal and external.

Internal Monetization

The internal monetization model includes revenue-sharing strategies where payment for an ad is distributed between host and content creator using the host's platform. For example, on YouTube, advertisers can pay for banner ads, as well as promotional videos. If they choose to run a promotional video before the start of a popular video, the price paid will be split between the video producer and Google, YouTube's corporate parent.⁵² This is revenue-sharing. As a video sharing service under the Google umbrella, YouTube benefits from being able to offer advertisers similarly focused targeting categories as Google.⁵³

⁴⁷ This is big business for parent company Alphabet, which reported over \$31 billion in revenue for the second quarter of 2018. *Google beats expectations again with \$31.15B in revenue*, Matthew Lynley, TechCrunch, April 23, 2018, <https://techcrunch.com/2018/04/23/google-beats-expectations-again-with-31-15b-in-revenue/>.

⁴⁸ Targeting, Pandora Media, Inc., <http://pandoraforbrands.com/data-driven/targeting/> (accessed August 29, 2018).

⁴⁹ The Pandora Programmatic Buying Guide, Pandora Media, Inc., http://brands.pandora.com/WF-2018-08-ID-Programmatic-BuyingGuide_Landing-Page.html?leadattribute=BL-2018-08-1466-ProgrammaticAudio (accessed August 29, 2018).

⁵⁰ Targeting, Pandora Media, Inc., <http://pandoraforbrands.com/data-driven/targeting/> (accessed August 29, 2018).

⁵¹ Targeting your ads, Google <https://support.google.com/google-ads/answer/1704368?hl=en> ; Choose your audience, Facebook <https://www.facebook.com/business/products/ads/ad-targeting> (accessed August 29, 2018).

⁵² A list—from A to Z—of all the companies, brands Google's Alphabet currently owns, Alejandro Alba, Daily News, <http://www.nydailynews.com/news/world/z-list-brands-companies-google-alphabet-owns-article-1.2321981> (accessed August 29, 2018).

⁵³ Choose people based on location, age, interests and more, Youtube Advertising, <https://www.youtube.com/yt/advertise/running-a-video-ad/#want-to-reach> (accessed August 29, 2018).

External Monetization

External monetization seeks to monetize services and products by placing a price on their usage similar to a rental fee. These include add-on, indirect, and direct monetization strategies.⁵⁴ Add-on strategies usually take the form of a premium service only available to subscribers. For example, Pandora offers three tiers of service: Pandora, Pandora Plus, and Pandora Premium.⁵⁵ Pandora Plus and Premium are only accessible to paying subscribers, offering features like no advertising and higher quality audio.

External monetization can be indirect or direct. Indirect monetization occurs where the use of the service is free to the consumer, but the platform is extracting a benefit from its use. For example, Amazon.com customers don't need to pay for using its app or website, just for the services and products purchased and any taxes or shipment fees. However, online sellers benefitting from the use of Amazon's platform to advertise and sell their goods must pay a fee to do so.⁵⁶

Direct monetization refers to charging advertisers based on general service usage. The more people use an app, the higher the potential value from advertising on it. This enables apps which dominate their field, like Google Maps, to attract much more advertising and be able to demand higher prices. Thus, by integrating services like YouTube, Google Maps, and Google Search, Google is able to offer extremely precise location mapping, consumer preferences, and potential interests consolidated in rich profiles which advertisers are willing to pay to interact with. In fact, Google and Alphabet do not break down YouTube, Google Maps, and Google Search's revenue separately, but it already boasted over \$19 billion in overall revenue in 2016.⁵⁷

2. Marketing APIs

Marketing APIs, in contrast to monetization APIs and strategies, focus on creating user profiles based on your behavioral data for advertisers to use. Facebook's Marketing API, for instance, allows advertisers to (a) customize their audience, (b) create an ad management tool, and (c) build a custom analytics tool.⁵⁸ This API allows advertisers to generate useful campaign-related insights⁵⁹ and collect consumer data through its Audience Management tool. This last feature enables advertisers not only to expand their current target pool on Facebook, but to re-engage specific sets of people they have already interacted with on or off Facebook through the use of identifying information like "mail address, Facebook UIDs, phone numbers, names, date of birth, gender, locations, app user IDs, Apple's Advertising Identifier (IDFA), [and] Android's advertising ID."⁶⁰ This means that an advertiser using Facebook's Marketing API could potentially know your name, age, where you live, what you look like, which phone or computers you use, and any other personal information you voluntarily offered or was inferred by Facebook.

3. Advertiser Access

As discussed, advertiser access to your data is limited to that which an app or website advertising API allows. Some apps and websites are more restrictive while others offer up consumer information with relative ease. Additionally, many platforms partner directly with advertisers using their APIs and allow the advertisers to use other third-parties to assist in ad development and functionality. Amazon, for instance, makes room for advertisers to work with third parties to assist them in advertisement placement and ad-derived data collection.⁶¹ For example, this could mean that Amazon's API would allow Ford to advertise on Amazon's platform and, using an approved third-party ad service like DoubleClick, Ford may then utilize DoubleClick to collect data from Ford's advertisements.

⁵⁴ Monetization: Unlock More Value for Your APIs, apigee, <https://apigee.com/about/tags/api-monetization> (accessed August 29, 2018).

⁵⁵ Homepage, Pandora Media, Inc., <https://www.pandora.com/> (accessed August 29, 2018).

⁵⁶ Choose Your Selling Plan, Amazon.com, <https://services.amazon.com/selling/pricing.html> (accessed August 29, 2018).

⁵⁷ *Here's how Google Maps could grow to be a \$5 billion business by 2020*, Avery Hartmans, Business Insider, November 7, 2016, <https://www.businessinsider.com/google-maps-could-be-a-5-billion-business-by-2020>.

⁵⁸ Facebook Marketing Developers, Facebook, <https://www.facebook.com/marketingdevelopers/videos/772240782890323/> (accessed August 29, 2018).

⁵⁹ Insights, Facebook, <https://developers.facebook.com/docs/marketing-api/insights> (accessed August 29, 2018).

⁶⁰ Custom Audience, Facebook, <https://developers.facebook.com/docs/marketing-api/reference/custom-audience> (accessed August 29, 2018).

⁶¹ Approved third party ad servers and technology providers, Amazon.com, <https://advertising.amazon.com/ad-specs/en/policy/approved-3p-ad-servers> (accessed August 29, 2018).

Such policies add *layers* to the data an advertiser can collect about you to include not only ad-related consumer interactions, but data collected by analytic tools used with the advertisements. This is known as cookie syncing. How it works is, when you visit a webpage with an advertisement that is linked to a cookie, the cookie makes itself visible to other advertisers, which enables them to match and merge advertising profiles about you. By joining forces, they have the ability to exchange specific user data collected separately between their services and figure out information like your phone number and your laptop IP address, enabling them to create a highly accurate profile about you without your knowledge.⁶² The result is that, where advertiser access to consumer data is more generous, advertisers can amass detailed

personal information by placing tracking tools in their advertisements which can follow users around the web, studying and collecting their information.

Alternatively, platforms that have not developed analytic tools of their own may contract third parties to do so. For instance, through the use of Comcast Spotlight, a subsidiary of Comcast Corporation’s Xfinity, CNN.com enables advertisers to pick a desired audience based on the type of service or product marketed as well as demographics – including gender, household income, education, home ownership, age, presence of children, and marital status, as identified by Comcast Spotlight.⁶³ ESPN.com equally utilizes Comcast Spotlight for digital advertising, offering the same level of audience targeting.⁶⁴

What Kind of Business Are You?

Tell us about yourself (optional).

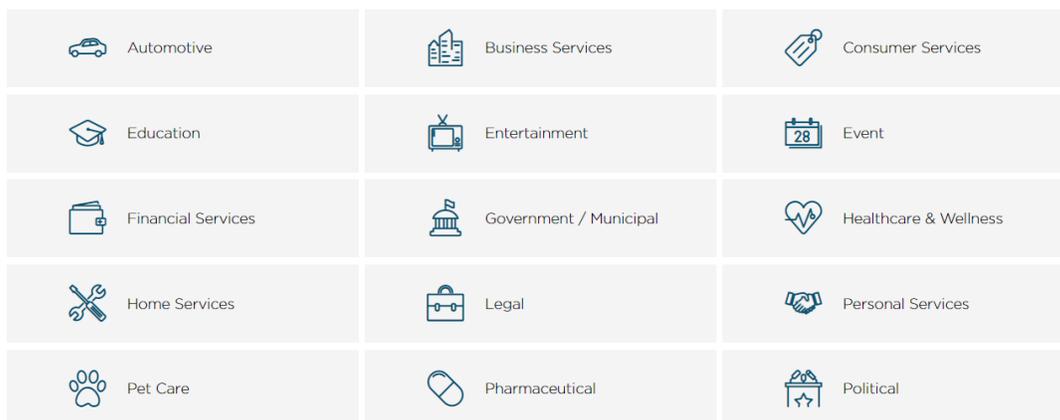


Figure 2: Industry-specific targeting options for CNN.com and ESPN.com.⁶⁵

⁶² *The Truth About Data Mining: How Online Trackers Gather Your Info and What They See*, Arthur Baxter, Observer, July 21, 2016, <http://observer.com/2016/07/the-truth-about-data-mining-how-online-trackers-gather-your-info-and-what-they-see/>.

⁶³ Advertise on CNN, Comcast Spotlight, <https://www.comcastspotlight.com/content/cnn> (accessed August 29, 2018).

⁶⁴ Advertise on ESPN, Comcast Spotlight, <https://www.comcastspotlight.com/content/espn> (accessed August 29, 2018).

⁶⁵ Find Your Audience, Comcast Spotlight, <https://www.comcastspotlight.com/find-your-audience> (accessed August 29, 2018).

Who Are Your Customers?

Let's build a profile (optional). Select all that apply.

 Gender Male Female	 Age 18-34 18-49 25-54 35-64 35+ 50+	 Household Income Less than \$25,000 \$25,000 - \$49,999 \$50,000 - \$74,999 \$75,000 - \$99,999 \$100,000 - \$149,999 \$150,000+
 Household Composition Single Married Children: Yes Children: No Child Age Older than 5 in Household	 Homeowner Yes No	 Education No High School Diploma High School Graduate College Intender College Graduate Post Graduate Degree

Figure 3: Audience-specific targeting options for CNN.com and ESPN.com.⁶⁶

In sum, advertisers can partner with platforms in using their APIs, and platforms can supplement their audience management and analytic offerings by partnering with data management firms. Advertisement APIs will control

advertiser, platform, and consumer interactions and define the types and amounts of data advertisers have access to. The result of such interactions and API-driven exchanges is a worldwide data marketplace.⁶⁷

⁶⁶ Find Your Audience, Comcast Spotlight, <https://www.comcastspotlight.com/find-your-audience> (accessed August 29, 2018).

⁶⁷ *6 Predictions For The \$203 Billion Big Data Analytics Market*, Gil Press, Forbes, January 20, 2017, <https://www.forbes.com/sites/gilpress/2017/01/20/6-predictions-for-the-203-billion-big-data-analytics-market/#742310c52083>.

III: Observations and Conclusions

APIs are essential for the combination and integration of online services. APIs enable the rich and interactive websites and mobile apps of today. At the same time, APIs can be used by developers and advertisers to collect large amounts of your personal information when you use popular websites and apps. Vice versa, APIs can enable sites and apps to gain access to information that platform developers and advertisers have about you. If a developer incorporates Facebook Login into its mobile app, Facebook may receive your location data when you use Facebook to log into the app. When you are listening to music on Pandora in a Ford car, both Pandora and Ford may have access to data collected about you from the car. When you connect one of your accounts to another service, like using Mint with Venmo, that service could have access to your entire account. Be cautious and use only services that you trust. In addition, there are intermediaries, like advertising placement networks, that may have access to your personal data through APIs.

APIs enable enhanced tracking of you as you go from website to website, app to app, or website to app to website, and all of this data can be aggregated together, both by online services, such as Google and Facebook, as well as advertisers. (And, most popular services have both web and mobile offerings.) Large companies with popular platforms will be able to collect more data and enjoy more discretion when choosing what advertisement services to offer. Some, like Pandora, Facebook, and Google, choose to offer advertisers thousands of filters for audience selection. Other companies, like Amazon, prefer to handle audience management themselves, limiting advertiser choice to keywords. The size of these companies permits them to make such calculated and independent choices.

Additionally, companies with large affiliate structures, many different offerings, and numerous types of APIs can compile all of the data they collect from and about you in one place. For example, Google's APIs for Search and Maps, when integrated into websites and apps by developers, increase advertising value of your data for Google with enhanced ability to track you across the websites and apps using various types of Google APIs.

Likewise, advertisers and data brokers may compile large amounts of personal data from many different sources, including those companies you interact with who are willing to share the data with them, all without the advertiser or data broker ever contacting you. It is possible you may then be profiled or labeled based upon large amounts of information about you aggregated from many sources. Sometimes a developer or advertiser directly utilizing a website's or app's API may also be compiling your personal information and profiling you for purposes of selling this information to others. Cambridge Analytica, for example, was a web developer, profiler, and seller of information it collected through the Facebook API. The point is that these technologies are complex and the companies using APIs may play several different roles.

In conclusion, while APIs are an inherent part of how the online ecosystem works, their privacy implications deserve closer scrutiny – for APIs made available to both developers and advertisers. Driven by exploitations of their APIs, companies like Facebook and Twitter have started to more-tightly control access to their APIs or limit what information is available through APIs. Yet, for many websites and mobile apps, including those companies, monetizing information about their users remains at the core of their business model. As a consumer, you should consider what companies might learn about you because of the information you provide directly to them or through information they might be gathering about you implicitly. Many online services, including Google, Facebook, and other services we analyzed, provide privacy settings that allow you to limit at least to some extent how the company can use and share data it collects about you. However, most of those privacy choices are opt-outs – meaning they require you to become active and deliberately change the privacy settings to, for example, limit what information is provided to advertisers.

Appendix: Selection Methodology

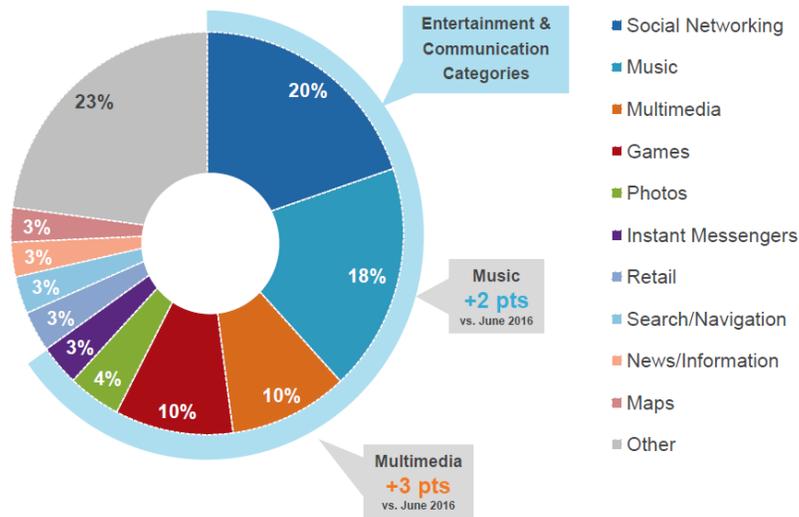
This study focuses on APIs in mobile applications and websites familiar to and popular among consumers. Several metrics were used when selecting our sample of websites and platforms to be studied. Applications and websites were first selected in various categories to survey a diverse set of platform types. Google Play and the Apple Store provide the most application offerings and downloads worldwide,⁶⁸ so our initial step was to turn to these to find the most popular categories of apps and websites consumers rely on. Popularity can

be measured in several ways, including number of downloads, number of apps available per category, and time spent or frequency of usage. Because this report seeks to focus on apps and websites impacting Americans the most in their daily lives, the amount of time people spend on these virtual offerings is most persuasive. According to comScore, categories under the “Entertainment & Communication” umbrella were responsible for nearly two thirds of time spent on apps in 2017.⁶⁹

Figure 1:

Share of Mobile App Time Spent by Content Category

Source: comScore Mobile Metrix, U.S., Age 18+, June 2017



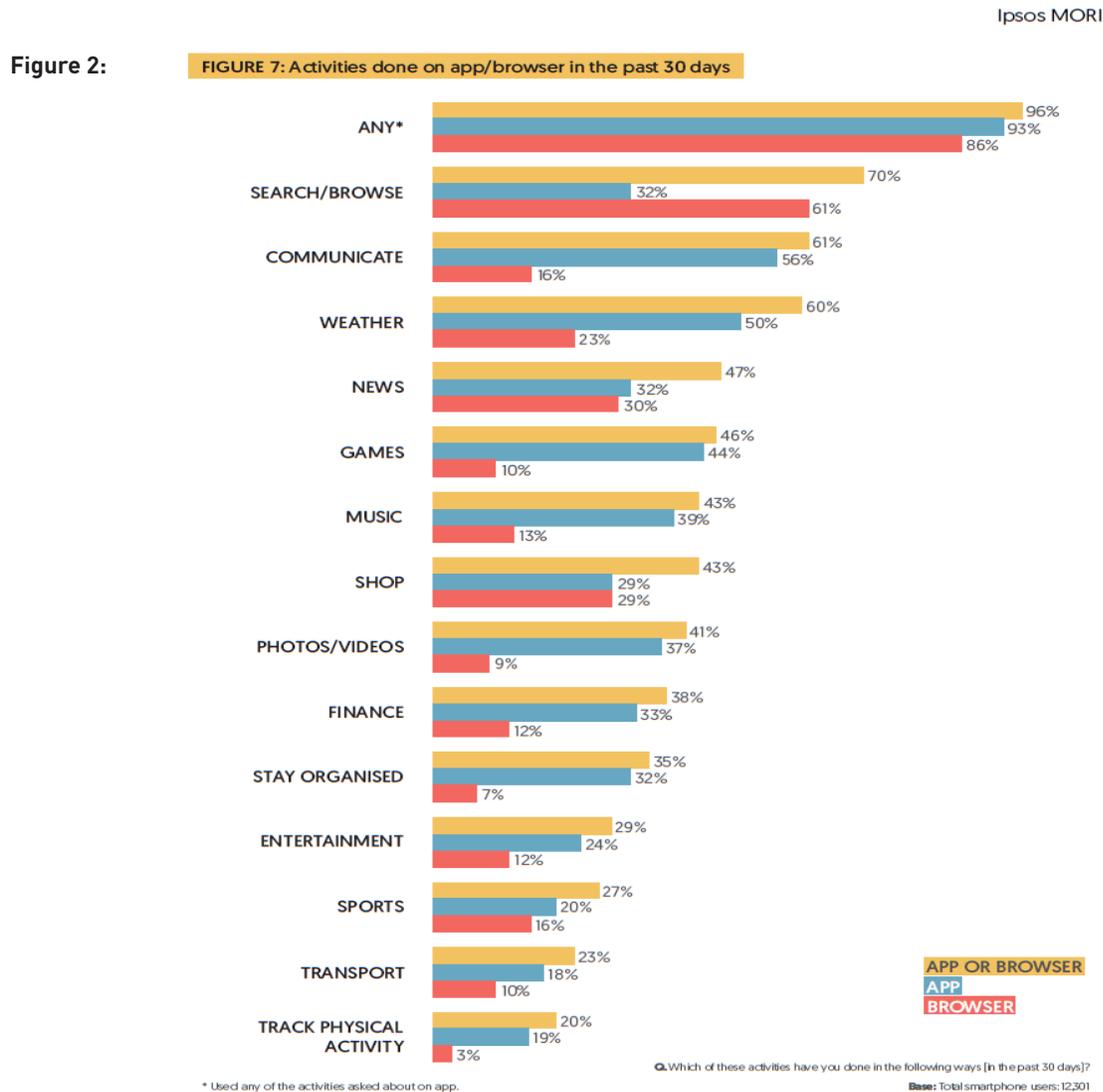
© comScore, Inc. Proprietary.

⁶⁸ Business of Apps, <http://www.businessofapps.com/data/app-statistics/>, May 25, 2018.

⁶⁹ comScore, *The 2017 US Mobile App Report*, <https://www.comscore.com/Insights/Presentations-and-Whitepapers/2017/The-2017-US-Mobile-App-Report>, August 24, 2017, at p. 46.

Whereas slight divergences between app and browser category usage ranking exist, a study from Ipsos MORI reveals that most category types themselves remain virtually the same (see Figure 2).⁷⁰ Early 2018 studies

show that the prevalence of these categories is likely to persist as they continue to lead in total number of apps or share of available apps in the Apple Store and Google Play.⁷¹



⁷⁰ Ipsos MORI, *Something For Everyone, Why the growth of mobile apps is good news for brands*, July 2017, <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=14&cad=rja&uact=8&ved=0ahUKewimgrWgKHcAhUHExoKH-fRkC98QFgiRATAN&url=https%3A%2F%2Fwww.ipsos.com%2Fsites%2Fdefault%2Ffiles%2F2017-08%2FGoogle-mobile-apps-report-2017.pdf&usg=AOvVaw32O8XfZ2ooE-BCoXZncNKJ>.

⁷¹ App category ranking by share of App Store offerings: Statista, *Most popular Apple App Store categories in May 2018, by share of available apps*, <https://www.statista.com/statistics/270291/popular-categories-in-the-app-store/>; App category ranking by number of apps available for each category on Google Play store: App Brain, *Most popular Google Play categories*, <https://www.appbrain.com/stats/android-market-app-categories>, July 14, 2018.

As for websites, data updated monthly by Alexa Internet and competing internet data companies show that the

prevalence of these categories persists on traditional desktops.

Figure 3:

Top Sites in the United States in July 2018 ⁷²		
RANK	SITE	CATEGORY
1	Google.com	Search
2	Youtube.com	Video/Multimedia
3	Facebook.com	Social
4	Amazon.com	Shopping
5	Reddit.com	News/Multimedia
6	Wikipedia.org	Education
7	Twitter.com	Social/News
8	Yahoo.com	News/Multimedia
9	Instagram.com	Multimedia
10	Ebay.com	Shopping
11	Linkedin.com	Social
12	Netflix.com	Video/Multimedia

The most notable exception is games, which find their greatest popularity in app form, demonstrated by their 24.93% share of all available apps on the Apple App Store.⁷³ While the audience for games is not as large as for other categories, their usage is more frequent. Gaming apps are used with similar frequency to dating apps which, while limited in audience capture, boast strong use and consumer loyalty. Similarly, increasingly popular mobile payment applications⁷⁴ are not reflected in these rankings. The main reason for this is that mobile payment apps create value for consumers by enabling them to pay for goods and services just using their

smartphone. This requires a certain degree of integration between phone and payment service necessitating installation of an app program. Online offerings and shopping are booming, and so are internet-connected payment solutions; thus we added mobile payments as an additional category.

Our second metric is app or website popularity within the category. To assess popularity, we looked at both frequency of use and reach within the consumer base. Reach is measured as a percentage of mobile users accessing an app. This led to the results shown in Figure 4.

⁷² Alexa Internet, Inc., <https://www.alexa.com/topsites/countries/US>, July 6, 2018. Alexa ranks these sites by weighing the daily time spent on them, daily pageviews per visitor, percentage of traffic from search, and total sites linking in.

⁷³ Statista, *Most popular Apple App Store categories in May 2018, by share of available apps*, <https://www.statista.com/statistics/270291/popular-categories-in-the-app-store/>.

⁷⁴ Jill Cornfield, *Instant payment apps grow up. They're not just for millennials anymore*, CNBC, July 14, 2018, <https://www.cnbc.com/2018/07/12/instant-payment-is-growing-up-its-not-just-for-millennials-anymore.html>.

Figure 4:

Leading Websites & Apps in April 2018 ⁷⁵				
RANK	UNIQUE MONTHLY VIEWS	CATEGORY	APP REACH	CATEGORY
1	Google Sites	Search	Facebook	Social
2	Oath [includes AOL and Yahoo! brands]	News/Multimedia	YouTube	Multimedia
3	Microsoft Sites	News/Multimedia	Google Search	Search
4	Facebook	Social	Google Maps	Utility
5	Amazon Sites	Shopping	Messenger	Social
6	Comcast NBC Universal	News/Multimedia	Snapchat	Multimedia
7	CBS Interactive	News/Multimedia	Gmail	Utility
8	Twitter	Social	Google Play	Search
9	The Walt Disney Company	Multimedia	Instagram	Multimedia
10	Apple Inc.	Multimedia	Amazon	Shopping
11	Meredith Digital	News/Multimedia	Google Drive	Utility
12	Turner Digital	News/Multimedia	Pandora	Multimedia

More time is spent on apps than on websites.⁷⁶ Approximately 34% of time spent on virtual platforms is dedicated to desktop browsing versus 50% to mobile apps. Mindful of this difference, this study sampled a total of eleven services, of which four are primarily web-based and seven primarily app-based. However, we note that a hard distinction between websites and mobile apps is less significant when most services have both web and mobile offerings.

Third, this study filtered its sample set based on corporate ownership, aiming to cover a greater company diversity where popularity rankings alone would have dictated a pronounced dependence on services offered by Alphabet and Facebook.⁷⁷ Thus, in order to examine popular apps and websites for a diverse set of companies and in different categories, the following chart shows the apps and websites selected for research in this study along with each alternative considered:

⁷⁵ See Statista, <https://www.statista.com/statistics/281605/reach-of-leading-us-smartphone-apps/>, April 2018. Reach is defined as the percentage of mobile audience accessing the respective app via smartphone.

⁷⁶ See comScore, *The 2017 US Mobile Report*, at p. 6

⁷⁷ A study abiding strictly to rankings would be dominated by Alphabet Inc., Facebook, Inc., and Amazon.com, Inc., companies which took 9 out of 12 slots in the Google Play Store most popular rankings and 6 out of 12 in the Apple App Store in July 2018. Sources: Google Play active usage: SimilarWeb, <https://www.similarweb.com/apps/top/google/app-index/us/all/top-free>, July 10, 2018; App Store active usage: <https://www.similarweb.com/apps/top/apple/store-rank/us/all/top-free/iPhone>, July 10, 2018. The same companies also dominated a website-based ranking by monthly views: Alexa Internet, Inc., <https://www.alexa.com/topsites/countries/US>, July 6, 2018.

Figure 5:

RANK	CATEGORY	PRODUCT	PLATFORM	CORPORATE PARENT	ALTERNATIVE	PLATFORM	CORPORATE PARENT
1	Games	Candy Crush Saga	Application	King Digital Entertainment Ltd.	Subway Surfers	Application	KILOO and SYBO games
2	Search	Google	Website	Alphabet Inc.	Bing	Website	Microsoft Corporation
3	Social	Facebook	Application	Facebook, Inc.	WhatsApp	Application	Facebook, Inc.
4	News/ Business	CNN	Website	AT&T Inc.	NBC	Website	Comcast Corporation
5	Video	Netflix	Application	Netflix, Inc.	YouTube	Application	Alphabet Inc.
6	Music	Pandora	Application	Pandora Radio	Spotify	Application	Spotify Technology SA
7	Shopping	Amazon	Website	Amazon.com, Inc.	eBay	Website	eBay Inc.
8	Utilities	Google Maps	Application	Alphabet Inc.	Clean Master	Application	Cheetah Mobile Inc.
9	Dating	Tinder	Application	MatchGroup, Inc.	Bumble	Application	Badoo*
10	Sports	ESPN	Website	The Walt Disney Company & Hearst Communications	Yahoo! Sports	Website	Verizon Communications Inc.
11	Mobile Payment	Venmo	Application	PayPal Holdings, Inc.	Starbucks	Application	Starbucks Corporation

*In talks to sell ownership

Our thought process for selection was as follows:

- **Games:** Candy Crush Saga is synonymous with app-based video gaming.⁷⁸ Whereas Subway Surfers has surpassed Candy Crush Saga in number of downloads, having reached one billion,⁷⁹ Candy Crush reached over five hundred million in 2013, has remained highly popular since then, and is widely considered to have shaped the mobile gaming field.⁸⁰
- **Search:** Google.com controls approximately 87% of search engine market share in the United States.⁸¹ Internet search alternatives exist like Bing and Yahoo; however, these remain significantly behind Google in popularity and prevalence.⁸²
- **Social:** With over 2.2 billion active users, Facebook is 500 million users ahead of YouTube and WhatsApp.⁸³ Facebook Messenger is fourth. Also, YouTube is owned by Alphabet, already analyzed under the Search category, and WhatsApp is owned by Facebook, Inc.
- **News/Business:** Making a successful transition from cable television to the internet, CNN is regularly ranked in the top five most popular news websites.⁸⁴ Although NBC has strong viewership, its more diverse portfolio of entertainment content is less focused on news than CNN.

⁷⁸ Tiffany Hsu, *Video Game Addiction Tries to Move From Basement to Doctor's Office*, The New York Times, June 17, 2018, <https://www.nytimes.com/2018/06/17/business/video-game-addiction.html> ("I have patients who come in suffering from an addiction to Candy Crush Saga, and they're substantially similar to people who come in with a cocaine disorder," Dr. Levounis has said to the Times).

⁷⁹ Wikipedia, *Free applications with one billion or more downloads*, https://en.wikipedia.org/wiki/List_of_most_downloaded_Google_Play_applications.

⁸⁰ Emma Brockes, *The Never-Ending Candy Crush Saga*, February 15, 2014, <https://www.nytimes.com/2014/02/16/opinion/sunday/the-never-ending-candy-crush-saga.html>.

⁸¹ Statcounter, *Search Engine Market Share United States of America, June 2018*, <http://gs.statcounter.com/search-engine-market-share/all/united-states-of-america>.

⁸² Statista, *Share of search queries handled by leading U.S. search engine providers as of April 2018*, <https://www.statista.com/statistics/267161/market-share-of-search-engines-in-the-united-states/>.

⁸³ Statista, *Most famous social network sites 2018, by active users, April 2018*, <https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/>

⁸⁴ Alexa Internet, Inc., *Top Sites/News, July 15, 2018*, <https://www.alexa.com/topsites/category/News>; and eBiz, *Top 15 Most Popular News Websites | May 2018*, <http://www.ebizmba.com/articles/news-websites>.

- **Video:** YouTube leads in number of unique visitors⁸⁵ and Alexa ranking⁸⁶. However, since YouTube is owned by Alphabet, we chose to examine Netflix for corporate diversity. Netflix itself is not far behind YouTube, second behind it in estimated monthly visitors according to eBIZ⁸⁷ and 12th according to Alexa.⁸⁸
- **Music:** Pandora and Spotify reach a combined 95 million unique monthly visitors.⁸⁹ Pandora is the more popular of the two⁹⁰ and, founded in 2000, Pandora Radio was one of the early pioneers on internet-based music services. Thus, we selected Pandora for this study.
- **Shopping:** Synonymous with online retail, Amazon.com dominates its market in the United States.⁹¹
- **Utilities:** With over a billion downloads and regularly used on both Apple iOS and Android platforms,⁹² Google Maps is one of the most successful tools available. Its ability to show and locate nearby businesses or points of interest, many of which pay to be featured, adds an extra layer of interest regarding data sharing. Clean Master, while close in popularity of late, is much more prevalent in the iOS platform, making it less relatable to the Android system user.
- **Dating:** Tinder and Bumble are two dating app leaders experiencing steady growth since inception. Tinder, however, is the earlier and better-known dating app and has been the source of many articles and studies analyzing how it has changed the nature of dating.⁹³
- **Sports:** ESPN is the leading website in the sports category.⁹⁴
- **Mobile Payments:** Starbucks' payment app grabbed headlines in May 2018, when eMarketer released a study showing that the app remains the most popular in the U.S., ahead of Apple Pay.⁹⁵ However, the utility of this app is inherently tied to a specific brand. Venmo offers a more-general payment-by-text service which does not bind the user to an ecosystem – Android, iPhone, or otherwise. It is also often cited as one of the best and most popular mobile payment apps.⁹⁶

⁸⁵ eBiz, Top 15 Most Popular Video Websites | May 2018, <http://www.ebizmba.com/articles/video-websites>.

⁸⁶ Alexa Internet, Inc., Top Sites in United States, on July 15, 2018, <https://www.alexa.com/topsites/countries/US>.

⁸⁷ Biz, Top 15 Most Popular Video Websites | May 2018, <http://www.ebizmba.com/articles/video-websites>.

⁸⁸ Alexa Internet, Inc., Top Sites in United States, on August 8, 2018, <https://www.alexa.com/topsites/countries/US>.

⁸⁹ eBiz, Top 15 Most Popular Music Websites | May 2018, <http://www.ebizmba.com/articles/music-websites>.

⁹⁰ eBiz, Top 15 Most Popular Music Websites | May 2018, <http://www.ebizmba.com/articles/music-websites>.

⁹¹ Alexa Internet, Inc., The top 500 sites on the web, on July 15, 2018, <https://www.alexa.com/topsites/category/Top/Shopping>.

⁹² SimilarWeb, *Mobile App Ranking*, on August 27, 2018, <https://www.similarweb.com/apps/top/google/app-index/us/all/top-free>.

⁹³ See e.g., Kevin W., Thrive Global, *How Has Tinder Changed Dating and Relationships?*, November 15, 2017, <https://www.thriveglobal.com/stories/16600-how-has-tinder-changed-dating-and-relationships>; and see MIT Technology Review, *First Evidence That Online Dating Is Changing the Nature of Society*, October 10, 2017, <https://www.technologyreview.com/s/609091/first-evidence-that-online-dating-is-changing-the-nature-of-society/>.

⁹⁴ Alexa Internet, Inc., The top 500 sites on the web, on July 15, 2018, <https://www.alexa.com/topsites/category/Top/Sports>.

⁹⁵ eMarketer, *Starbucks App Leads Mobile Payment Competitors*, May 21, 2018, <https://retail.emarketer.com/article/starbucks-app-leads-mobile-payment-competitors/5b02fc5aebd40003a0c246b1>.

⁹⁶ Michael Muchmore, PCmag Digital Group, *The Best Mobile Payment Apps of 2018*, April 2, 2018, <https://www.pcmag.com/roundup/358553/the-best-mobile-payment-apps>.