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The Powers That Be (Internet Edition): Google, Apple, Facebook, Amazon, and Microsoft

As of fall 2017, five U.S.-based technology firms—Google, Apple, Facebook, Amazon, and Microsoft—were collectively worth almost \$3.3 trillion, an increase of \$1.1 trillion over just two years.¹ What the New York Times deemed “the Frightful Five”² had come to dominate the U.S. Internet economy over the course of a few decades, and increasingly to wield enormous influence over the broader economy as a whole. The newest of the five, Facebook, had been founded just 13 years earlier. All five companies had arrived as pioneers in different sectors of the technology industry, benefiting from the rapid growth of the digital economy in the 21st century, and each continued to scale by continually branching into new areas, such as artificial intelligence (AI), self-driving vehicles, and cloud storage. Many miles away, three Chinese companies—Baidu, Alibaba, and Tencent (collectively known as BAT)—had grown on a parallel trajectory behind the so-called Great Firewall of China and similarly emerged as three of the biggest global players in technology. (See **Exhibit 1** for top global companies by market capitalization over time and **Exhibit 2** for 2018 market capitalization of the Five and BAT.)

By early 2018, the future of the Frightful Five had become slightly less certain. In March 2018, reports alleged that a political research firm, Cambridge Analytica, had collected data from tens of millions of Facebook users, primarily in the U.S., without those users’ consent, spurring a Federal Trade Commission (FTC) inquiry in the U.S. and driving calls from U.S. lawmakers and the public for heavier regulation of big Internet-based companies. Across the Atlantic, the European Union’s (EU) General Data Protection Regulation (GDPR)—a sweeping set of consumer data protection laws—was scheduled to come into effect in May 2018, raising questions about how the Five and other ad-tech and e-commerce companies would adjust their business models to ensure GDPR compliance. Beyond these pressing issues, the Five also faced myriad challenges associated with cybersecurity and net neutrality.^a

^a Net neutrality referred to the notion that Internet service providers (e.g., Comcast) had to treat all Internet content equally and could not block or slow down certain content. The absence of net neutrality could allow ISPs to disadvantage content from competitors (e.g., throttling a streaming site like Netflix might benefit Comcast’s cable business) or to prioritize content from companies willing to pay for preferential treatment. A net neutrality order was passed in 2015 under the Obama Administration but was repealed under the Trump Administration two years later. Source: Klint Finley, “The Wired Guide to Net Neutrality,” *Wired*, March 1, 2018, <https://www.wired.com/story/guide-net-neutrality/>, accessed April 2018.

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How would the Five respond to these concerns? What did the path to continued growth look like? Furthermore, in what areas would the Five compete, and in what areas would they cooperate?

Data in the Modern World

The Internet's origins could be traced as far back as 1969, to the launch of the Advanced Research Projects Agency Network, or ARPANET, an effort funded by the U.S. Department of Defense.³ In the 1970s, as networks connected to ARPANET proliferated, researchers developed TCP/IP,^b a set of protocols that enabled different networks to exchange information and become interoperable; beginning in 1983, all networks connecting to ARPANET were mandated to follow TCP/IP, giving rise to a far-reaching global network of networks now commonly known as the Internet.⁴ Most early users of the Internet worked in government or academia.⁵ That began to change with the introduction of the World Wide Web in 1991, which allowed users to create content using the HTML^c programming language and easily interconnect Web pages and sites using hyperlinks.⁶ The Internet was swiftly commercialized over the next few years. By 2018, the Internet had become an integral part of business and daily life.

With the rise of the Internet it became easier for companies to collect, or to acquire from third parties, vast amounts of consumer behavioral information. For example, companies might glean data using only a user's IP address and online connection, including their geographic location, their device type and Operating System (OS), their browser type, and their Internet access provider. They might also encourage users to register at sites or establish accounts that required them to provide personal contact information (e.g., email or physical address, phone number, credit card information, and demographics such as age and gender), and maintain a record of the items individuals purchased or the pages they viewed (or even moused over). Companies increasingly relied on data analytics to guide business processes, such as product development and personalized marketing campaigns. As data sets grew in scale, the term "big data" emerged to describe large collections of data, especially those that contained both structured and unstructured data.^d Data scientists could use analytics to establish relationships between correlated data points and train machine learning algorithms to predict future outcomes.

Companies increasingly used first-, second-, and third-party customer data to drive business decisions. First-party data was data that was observed and collected directly by a company, often on a website or via an email campaign.⁷ For example, Netflix collected first-party data on the shows its users watched, enabling it to train algorithms to recommend other shows they might like. Amazon and other online retailers collected first-party data on consumer purchases, in order to refine and deliver product recommendations and ad targeting.

Second-party data was purchased from, or shared by, the entity that collected it, often as part of partnerships in which two entities saw value in being able to access each other's data.⁸ Third-party data was purchased from third-party data vendors, and it was typically available to any company with the money to buy it.⁹ For example, companies could acquire data on consumer preferences and behaviors from syndicated research companies or data aggregators such as Nielsen, Experian, and Acxiom.

^b Transmission Control Protocol and Internet Protocol.

^c Hypertext markup language.

^d Structured data followed defined patterns (e.g., spreadsheets). Unstructured data did not follow defined patterns and could not be organized as easily as structured data (e.g., audio or text).

Apple, Inc.

Apple, Inc. (Apple) was founded in 1975 by Steve Jobs and Steve Wozniak, who built the Apple I computer using \$1,350 in startup capital.¹⁰ After selling just under 200 Apple I units, Jobs and Wozniak released the Apple II—one of the world's first personal computers (PCs)—in 1977 and sold more than 300,000 units in four years.^{11,12} Apple went public in 1980 at a \$100 million valuation, but its next few products (Apple III and Lisa) did not generate the same success as the Apple II.¹³ In 1983, Jobs recruited a new CEO, John Sculley, and in 1984, the company introduced the Apple Macintosh, or “Mac,” one of the first computers to use a pointing device, called a mouse.¹⁴ The Mac had a graphical user interface (GUI) based heavily on one Jobs had seen at the Xerox Palo Alto Research Center (PARC), which had developed many elements (icons, menus, etc.) that would come to be standard for GUIs.¹⁵ In 1985, after clashes with Sculley and Apple's board of directors, Jobs resigned under duress, sold his Apple shares, and founded a new computer company, NeXT.¹⁶ Wozniak also left Apple in 1985.

Though NeXT had mixed success, Jobs had also delved into the entertainment industry. Pixar Animation Studios, which he acquired in 1986, went public in 1996 at a \$1.5 billion valuation.¹⁷ Apple, meanwhile, was struggling, holding just 5.3% of PC market share.¹⁸ In 1997, Apple purchased NeXT for \$400 million, bringing Jobs back into the fold.¹⁹ Jobs became Apple's interim CEO in 1997, then CEO in 2000.²⁰ Under Jobs, Apple's performance improved. In 1998, the company introduced the iMac desktop computer, which was sold in bright, eye-catching colors.²¹ The company reportedly spent \$100 million marketing the iMac, and it paid off;²² from 1997 to 1998, Apple went from a \$1 billion loss to a \$300 million profit.²³

By 2000, Apple had become a powerful brand, building a reputation that the company would continue to expand over the next decade. In 2001, as digital music was gaining popularity fueled by illegal file sharing websites like Napster and BitTorrent, Apple released iTunes, a digital music platform that allowed users to transfer tracks from physical CDs to Apple computers.²⁴ Later in 2001, Apple began selling the iPod, a digital music player with an innovative, touch-sensitive scroll wheel.²⁵ Other companies had already launched digital music players,^e but there was no legal source of content for these players, limiting their mass-market appeal. By contrast, in 2003 Apple launched a music store on iTunes that sold individual tracks for \$0.99 each; the integration of iTunes with iPods streamlined the experience—and made music file-sharing legal in a market that had previously been dominated by pirated downloads.²⁶ Supported by the three major record labels (e.g., SONY, Universal, and Warner), Apple's iTunes established a shared platform for the legitimate sale of nearly every commercial track and positioned Apple to dominate the digital music market. Various iterations of the iPod—the compact iPod Mini, the ultra-thin iPod Nano, and the stripped-down iPod Shuffle—followed over the next few years. By 2008, Apple controlled 70% of the digital music player market and was the largest U.S. music retailer, while iTunes also sold movies and TV show episodes.²⁷

In early 2007, Apple announced the launch of the iPhone, a “smartphone” with a high-resolution color touchscreen, as well as the iPod Touch, a similar device, minus the ability to make and receive calls. Both devices featured Apple's new mobile operating system, iOS. The iPhone was a success: between its June 2007 release and Labor Day, Apple sold a million units.²⁸ One reviewer suggested that the iPhone “for the most part, lives up to its inflated expectations” and described the iOS interface as “not only functional [but] a blast to use.”²⁹ In 2008, Apple introduced the App Store, which enabled third-party developers to build mobile applications (apps) for iPhone and iPod Touch users. In the

^e The first commercial MP3 players were Saehan Information Systems' MPMan F10 and Diamond Multimedia's Rio PMP300, both released in 1998. Source: Tony Smith, “Ten years old: the world's first MP3 player,” *The Register*, March 10, 2008, https://www.theregister.co.uk/2008/03/10/ft_first_mp3_player/, accessed May 2018.

fourth quarter of 2010 (ending in September), Apple's revenue totaled \$20.34 billion, up from \$12.21 billion in the prior year; iPhone unit sales were up 91% compared to the same quarter in the prior year and totaled 14.1 million units.³⁰

In 2010, Apple acquired Siri, the creator of an eponymous voice-based virtual personal assistant, for an estimated \$150 to \$200 million.³¹ Siri relied on artificial intelligence (AI) to recognize natural speech patterns and respond intelligently to users with spoken words. Apple integrated Siri into iPhones the following year, from which she performed basic tasks, such as information retrieval and scheduling.³² Later in 2010, Apple introduced the iPad, a tablet computer with a larger touchscreen that enabled users to perform more complex tasks than on an iPhone. Apple sold 19 million iPads in the first 12 months following the release.³³ Customers had come to trust Apple as a maker of high-quality tech products, as one writer explained in 2010: "Apple has built up its brand consistency over time with a series of products that reinforce the company's central identity – sleek, elegant products that push the boundaries of innovation. And Apple wants you to feel sleek and elegant too: That's why you don't see the Apple logo on pay-as-you-go cell phones or shoddy cassette players."³⁴

Jobs, meanwhile, was struggling with serious health issues, having been diagnosed with pancreatic cancer in 2003.³⁵ After undergoing a liver transplant in early 2011, Jobs resigned in August of that year and passed away in October.³⁶ Tim Cook became Apple's new CEO, leaving some to wonder whether "[Cook] and his colleagues can keep coming up with products as disruptive as the iPod, iPhone, and iPad."³⁷ Under Cook's leadership, in fall 2011, Apple introduced iCloud, a new set of cloud storage services that synced users' personal data across multiple devices; it was hosted on third-party cloud platforms such as Amazon's AWS and, later, Google.³⁸ The company also continued to release new versions of iPhone and iPad, launched a mobile payment app, Apple Pay, in 2014, and began working on the Apple Watch, a "smartwatch" with functionality similar to that of the iPhone.³⁹ The Watch was released in April 2015 to mixed reviews. While one observer asserted, "[T]his is a power you can't live without,"⁴⁰ another noted, "[S]martwatches are a solution in need of a problem. . . . You don't need one, and neither do I."⁴¹ In summer 2015, Apple released Apple Music, a monthly subscription-based music streaming service to compete with Spotify and Pandora.⁴²

In 2016, Apple was ordered by the European Commission to pay \$14.5 billion in back taxes to Ireland, where Apple had been operating for decades in exchange for a significantly reduced tax rate, which in some years was as low as 0.005%.⁴³ Both Apple and Ireland appealed the decision, but Apple began paying the fine in April 2018.⁴⁴

Apple continued to cater to customers who desired high-end, professional-grade products, introducing the iMac Pro and iPad Pro in 2017.⁴⁵ The company also released two new iPhone models, the iPhone 8 and the iPhone X, the latter of which had a \$1,000 price and a FaceID feature that allowed individuals to use facial recognition to unlock their phones.⁴⁶ Though demand for the iPhone X was tepid as compared with previous iPhone releases, it was still a robust seller and highly profitable, accounting for 35% of smartphone market share profits in the fourth quarter of 2018, while the iPhone 8 and iPhone 8 Plus accounted for 19% and 15%, respectively.⁴⁷ (See **Exhibit 3** for worldwide smartphone shipments in 2017.)

In early 2018, Apple released HomePod, a voice-activated speaker that used Siri's voice-AI.⁴⁸ However, some wondered whether Apple was prepared to compete in the next technological frontier, with one observer suggesting, "I'm sure [HomePod] will be beautiful and have excellent sound quality, but that's not what these gadgets are about. . . . Apple gets this, but it's not up to the task."⁴⁹ In the first quarter of 2018, Apple's revenue totaled \$88.3 billion, up 13% year over year.⁵⁰ As of May 2018, analysts predicted Apple would become the first company to reach \$1 trillion in market capitalization.⁵¹ (See

Exhibit 4 for selected financial metrics for the Five and **Exhibit 5** for a graph of the Five's share prices over time.)

Amazon.com, Inc.

In 1994, Jeff Bezos quit his well-paid Wall Street job at hedge fund DE Shaw and drove west with his wife to Seattle. He had noted the Internet's blazing growth, and he was convinced that many products would soon be sold online. After considering a number of retail categories, Bezos settled on the idea of selling books. He knew that an e-commerce platform could showcase a larger selection of books than any brick-and-mortar store, and that consumers were likely to become comfortable buying books without seeing them in person. He named his new site Amazon.com (Amazon).⁵²

Amazon entered the market as a bookseller, but Bezos' ambitions were more expansive. In 1998, Amazon expanded into CDs and DVDs. In 2000, Amazon Marketplace opened up the site to third-party sellers in exchange for a sales commission,⁵³ which was set at 15% on most products.⁵⁴ Amazon continued to expand its breadth of retail categories. In its 2003 annual report, Amazon listed 20 different categories, including "consumer electronics" and "babycare products," and signaled its intent to keep growing its product breadth.⁵⁵

As it grew, Amazon invested heavily in technology and infrastructure. In 2002, Amazon launched Amazon Web Services (AWS), which began as a collection of software programs that outside developers could run remotely on Amazon's servers. AWS was integral to the start of the cloud computing industry.⁵⁶ In 2006, AWS began to allow outside companies to rent the basic building-blocks of computing—storage and computing power—remotely from AWS.⁵⁷

Much of Amazon's technology development was focused on gathering and profiting from customer information. Based on previous customer clicks, purchases, reviews, and other behaviors, Amazon personalized its site and product suggestions for each user.⁵⁸ By 2011, each product page on the site called upon 200 to 300 proprietary algorithms and systems to assemble a "personalized experience" for each individual shopper.⁵⁹

Amazon also innovated in its business model. In February 2005, Bezos announced the launch of Prime—a service that gave customers unlimited two-day shipping for an annual fee of \$79.⁶⁰ Prime improved the economics of Amazon's business, because Prime members tended to shop more on the site once they had paid the annual fee.⁶¹ According to Amazon insiders, shoppers that switched to Prime increased average order value by 150%, tended to explore more new product categories, and shopped less on competing sites.⁶² In 2006, Amazon also began selling logistics services such as warehousing and shipping to its Amazon Marketplace merchants with a program called "Fulfillment by Amazon" (FBA).⁶³ FBA sellers paid Amazon fees for fulfillment and storage services.^g Amazon encouraged sellers to join FBA by giving participants better placement on the site. In 2015, Amazon would fulfill over one billion orders through FBA.⁶⁴

^f In 2014, Amazon raised the price of Prime to \$99 per year. Source: Greg Bensinger, "Amazon Raises Prime Subscription Price To \$99 A Year," *The Wall Street Journal*, March 13, 2014, <https://www.wsj.com/articles/amazon-raises-prime-subscription-price-to-99-a-year-1394714165>, accessed April 2018.

^g In 2018, fulfillment fees ranged from \$2.41 to \$137.32 per item, depending on weight. Storage fees ranged from \$0.48 to \$2.40 per cubic foot, based on whether or not an item was considered oversized and on the time of year. Source: Amazon, "Fees and rate structure," <https://services.amazon.com/fulfillment-by-amazon/pricing.html>, accessed May 2018.

Amazon also invested in logistics, acquiring Kiva Systems—a warehouse robotics company—for \$775 million in 2012.⁶⁵ By 2018, Amazon had an estimated 100,000 robots working in logistics worldwide, in addition to the estimated 125,000 hourly associates working in the U.S. distribution centers alone.⁶⁶ One observer noted that this investment in logistics was expensive, but provided an advantage in time to delivery that other online retailers could not easily match.⁶⁷ In 2017, Amazon extended this advantage by purchasing Whole Foods for \$13.7 billion, providing the online retailer with 460 brick-and-mortar grocery stores known for natural and organic products in major urban areas.⁶⁸ With its increasing physical presence, Amazon was able to offer same-day delivery on more than a million items in over 8,000 cities.⁶⁹

As Amazon continued to grow, Bezos re-invested earnings into growth through technical innovation and expansion into new industries. The company pursued research in drones and cashless convenience stores.⁷⁰ Amazon also launched Alexa, a voice-AI initially integrated into an Amazon-built home speaker (called the Echo) launched in 2014.⁷¹ By 2017, over 20 million Alexa devices had been sold (see **Exhibit 6** for 2017 voice-enabled speaker market share).⁷² Amazon also expanded into new industries. It built its own film and video production studio, Amazon Studios, to develop content for television and video streaming along with traditional Hollywood-style films.⁷³ It launched a grocery delivery service (Amazon Fresh), a book publishing service (Amazon Publishing), and an app store (Amazon App Store), and it announced twin expansions into shipping services (Amazon Maritime, Shipping with Amazon).⁷⁴

In 2018, Amazon was a major force in the world economy. It ranked as the world's third-largest retailer by sales.⁷⁵ The company brought in \$177 billion in 2017 revenue,^{h,76} and it offered over 500 million products ranging from video games to wine.^{i,77} Amazon Prime had over 100 million worldwide customers.⁷⁸ AWS had more market share than its next five largest competitors combined.⁷⁹ Almost half of every online dollar spent by U.S. households was spent on Amazon, and nearly half of U.S. online shoppers went directly to the site for product search, bypassing other search engines.⁸⁰ Amazon's leadership remained ambitious for speed and growth. Bezos signed off his 2018 letter to shareholders by saying that, for Amazon, "it remains Day 1."⁸¹ (See **Exhibit 7** for top retailers' online sales in 2017 and **Exhibit 8** for the Five's monthly average users and average time spent by consumers.)

Alphabet's Google Inc.

In the fall of 1996, the Stanford University Internet connection was regularly crashing. Two graduate students, Larry Page and Sergey Brin, were running a computer science PhD project that kept increasing in size. Their project would grow to become Google Inc.⁸²

In the early days of the web, users struggled to find relevant and trustworthy content. Page and Brin's research project eased Internet navigation by analyzing the links between websites to surface the most useful pages for any given search term. The system, called PageRank, outperformed the largest

^h Figure is inclusive of Whole Foods revenue as of acquisition date.

ⁱ These product offerings are inclusive of marketplace sellers. The scrapehero methodology tracks the number of individual product pages on Amazon and so may count even slight variations in the same offering. Another analytics group, 360pi, estimated that Amazon carried 12.2 million of its own products and offered a further 350 million through the marketplace as of June 2016 (excludes: books, media, wine, and services). Source: 360pi, "How Many Products Does Amazon Actually Carry? And in What Categories?" press release, June 14, 2016, Business Wire, <https://www.businesswire.com/news/home/20160614006063/en/Products-Amazon-Carry-Categories>, accessed April 2018.

commercial search engines at the time. Its popularity grew, and it eventually became too large to be run as an academic research endeavor on Stanford's network infrastructure.⁸³

Google incorporated in 1998 and later won contracts to provide search services to major web portals, including Yahoo! (in 2000) and AOL (in 2002). The search volume from these contracts enabled Google to train and improve its web search algorithms.⁸⁴ While Google collected technology licensing fees for these partnerships, its primary source of revenue increasingly became advertising on Google's own site.⁸⁵ In 2000, Google launched AdWords, a search advertising product that allowed marketers to pay for listings alongside Google's search results.⁸⁶ Advertisers could enter the paid search auction by bidding a dollar amount they were willing to pay for each click on their ads, and each bid was also adjusted by an estimate of the advertiser's relevance to searchers.⁸⁷ (These were second price auctions, meaning that the highest bidder won but then paid the next highest bid price.) Marketers found AdWords powerful, because ads could be targeted with precision based on a user's search intent.⁸⁸ In 2003, Google launched AdSense, which allowed advertisers to place display ads on third-party sites using Google's analysis of a site's relevance.⁸⁹ AdSense remitted 68% of the revenue from desktop display ads to the site publisher and Google kept the rest.⁹⁰ Google then augmented AdSense by acquiring DoubleClick in 2007, a sprawling advertising technology (or ad-tech) platform.⁹¹ Google's own site became the most popular search site in the U.S. in 2003.⁹² Yahoo! subsequently saw Google as a competitor and ceased using the company as a backend search provider, but Google continued to expand. By 2007, Google had 62% of global search volume and continued to gain share.⁹³

As Google grew, it expanded beyond its core activities of search and display ads. The company developed new online services internally. Google launched a free email service, Gmail, in 2004, and a free translation service, Google Translate, in 2006.⁹⁴ Google also expanded its services through acquisitions. It acquired a start-up that helped the company develop an online maps service, Google Maps, in 2004, and it acquired a video-streaming site, YouTube, in 2006.⁹⁵ It also invested in digitizing the content of every book ever published (Google Print), promoting a photo sharing platform (Picasa), and launching an e-commerce service (Froogle).⁹⁶ Many of these free services became wildly popular. By 2011, YouTube users were streaming three billion videos a day.⁹⁷ Maps reached one billion monthly active users by 2012,⁹⁸ and Gmail had one billion monthly active users by 2015.⁹⁹ Some of these services were directly monetized by Google. For example, YouTube was able to host video ads, and searches on Google Maps could host local ads with geographic targeting.

Among Google's most important initiatives were products that built a "moat" around the search business. Users could only navigate to Google's search site through other tools, such as web browsers, smartphones, and other distribution partners. In 2007, Google paid the Mozilla Foundation \$66 million to make Google the default search engine in its browser.¹⁰⁰ Page and Brin were worried that Microsoft, which held 85% share of the browser market in 2007, might create its own search engine to use as the default in its popular browser.¹⁰¹ As mobile became a more important internet gateway, Google's CEO Eric Schmidt said, "We're going to make sure Google is on those phones."¹⁰² To ensure prominent placement with users, Google acquired the Android smartphone operating system in 2005, and developed its own Google Chrome browser in 2008.¹⁰³

Google developed Android into a low-cost, open-source OS for smartphones, which it then provided free of charge to mobile handset manufacturers.¹⁰⁴ By 2011, Android had become the leading OS by smartphone shipments worldwide.¹⁰⁵ Google did not profit directly on Android OS; rather, it profited by leveraging smartphone distribution in its existing businesses, which started by making Google search the default for phones running Android. One expert wrote, "Android would be a Trojan horse for Google's consumer apps, chief among them mobile search."¹⁰⁶ The Chrome browser also gained traction and became the leading Internet browser by global market share in 2012.¹⁰⁷ Google

used these free products to collect data on users' behavior, such as browsing habits via Chrome or location data via mobile devices. Google used the data to improve its ad targeting and ad operations.¹⁰⁸

Google invested in some high-profile failures along the way. Google launched a social network called Orkut in 2002, which was used sparsely except in Brazil and India, in which markets it became the dominant social platform until Facebook arrived and overtook Orkut in popularity in 2010.¹⁰⁹ By 2010, the rise of Facebook presented a potential existential threat to the company, because Facebook commanded user attention to a degree that far outstripped Google. In response, Google launched a second social network, Google+, which failed to gain traction.¹¹⁰ In another miscalculated effort, the hype for Google Glass, which were augmented reality eyeglasses announced in 2012, outpaced its technical development. Tech reviewers found Glass had limited functionality and short battery life. One reviewer called it "the worst product of all time."¹¹¹ By 2014, Google had deferred commercialization of Glass indefinitely.¹¹²

In 2015, Google announced its reorganization into a conglomerate named Alphabet. This new structure separated the profitable ad-based businesses from the company's smaller speculative investments.¹¹³ The core business retained the name "Google" and included Search, AdWords, AdSense, Maps, and the ad-tech platform. The smaller subsidiaries were R&D-led initiatives. In 2018, these included Waymo (developer of self-driving cars), Verily (life science research), and X (R&D company pursuing "moonshot" projects with a low probability of success, but a high potential impact, such as "Project Loon" that researched internet delivery to the world's lowest income people via high-altitude balloons).¹¹⁴

By 2018, Google services were spread across the world and deeply embedded in consumers' lives. Google had seven products with more than one billion users (Gmail, Chrome, Maps, Search, YouTube, Google Play Store, and Android).¹¹⁵ Google Chrome held a 57% share of the Internet browser market,¹¹⁶ and Android made up nearly 90% of smartphone sales worldwide.¹¹⁷ By 2017, users were watching over one billion hours of YouTube videos per day.¹¹⁸ And Google's core product, search, was handling trillions of searches per year.¹¹⁹ (See **Exhibit 9** for 2016-2017 search engine market share and **Exhibit 10** for a summary of the display ad market from 2016-2020.) Despite Google's massive presence, its leadership remained ambitious for further growth. Larry Page publicly outlined his goals: "I want to push the envelope for what's possible for an innovative company with large resources."¹²⁰

Facebook

In 2004, Mark Zuckerberg launched the social media site Facebook as an undergraduate at Harvard University. Originally limited to Harvard, and soon after to students at other colleges and universities, by 2006 the site was available to the world and gained traction quickly.¹²¹ By 2007, Facebook had 30 million registered users and had introduced an app platform that enabled third-party developers to create apps for the site's users.¹²²

In 2007, Facebook experienced its first of many crises related to user privacy after introducing an advertising product called Beacon, which monitored users' purchasing behavior outside of Facebook and notified users' Facebook friends about purchases they made on third-party sites.¹²³ A group of Facebook users filed a class-action lawsuit, claiming Beacon represented a violation of privacy, and Facebook terminated the offering in 2009.¹²⁴ In this timeframe, Zuckerberg was also embroiled in litigation with former Harvard classmates Tyler and Cameron Winklevoss, who claimed that Zuckerberg had stolen the idea for Facebook from them; in 2008, the parties reached a settlement that awarded the Winklevoss twins \$20 million in cash and \$45 million in Facebook shares.¹²⁵

Meanwhile, Facebook continued to gain momentum. In 2008, the company introduced the first version of its iPhone mobile app, which offered a basic, stripped-down version of the website for use on a mobile platform.¹²⁶ Facebook's user base continued to grow, from 100 million in August 2008 to 200 million in March 2009.¹²⁷ From 2008 to 2009, the market share of rival social media company MySpace dropped from 66% to 30%.¹²⁸

In late 2011, Facebook introduced Timeline, a feature that allowed users to easily browse through their own and others' activity by year and month. In April 2012, Facebook purchased social media photo-sharing startup Instagram, which had 13 employees and 30 million users, for \$1 billion.¹²⁹ Just six weeks after the acquisition, Facebook went public at a share price of \$38 and a valuation of \$104 billion; the IPO was marred by technical issues (Wall Street traders termed it "Faceplant"), along with concerns that the company was overvalued.¹³⁰ By September 2012, the share price had dropped by half to \$17.55.¹³¹

Facebook continued to push forward after its rocky IPO. By late 2012, use of Facebook's mobile platform exceeded use of its desktop platform.¹³² In 2014, Facebook bought mobile messaging platform WhatsApp – which had 450 million active users and only 55 employees – for \$19 billion.¹³³ That same year, Facebook announced the Connectivity Lab team, consisting of aerospace technology experts, as part of a larger effort to improve Internet access around the world through the use of high-altitude long-endurance (HALE) aircraft.¹³⁴ As use of its mobile platform increased, a greater share of Facebook's advertising revenue came from mobile advertisements, with share from mobile growing from 3% to 87% from 2012 to the first quarter of 2017.¹³⁵

After the 2016 U.S. presidential election, Facebook faced criticism when it was revealed that Russian entities purchased \$100,000 in ads through the site in order to spread politically charged messages and fake news stories with the goal of influencing the election's outcome.¹³⁶ Although he initially dismissed the claims, Zuckerberg later suggested that Facebook would be able to flag inaccurate or offensive content using AI, but skeptics suggested that it would be five to ten years before AI could achieve the job, and some questioned whether even that estimate might be too optimistic.¹³⁷

Criticism of Facebook intensified in early 2018, when Facebook revealed that Cambridge Analytica, a political data company working on behalf of Donald Trump's presidential campaign, had collected data from up to 87 million users, the majority of whom had not given their consent.¹³⁸ That spring, Zuckerberg testified for four hours in front of a U.S. Senate committee, and the Federal Trade Commission opened an investigation into Facebook's treatment of user privacy.¹³⁹ In April 2018, a group of plaintiffs filed a class action lawsuit against Facebook for violating an Illinois law preventing Facebook from sharing users' biometric information without consent.¹⁴⁰ That same month, the results of one survey indicated that 60% of respondents believed that "Facebook should be regulated by new laws aimed at user privacy and security."¹⁴¹

Even as Facebook struggled with an increasingly negative public image, its business remained strong; the company reported quarterly net income of almost \$5 billion in the first quarter of 2018, up from approximately \$3 billion in the same quarter the year earlier.¹⁴² Despite a "#deletefacebook" campaign that gained momentum in the wake of the Cambridge Analytica news, Facebook had 2.2 billion users as of April 2018, an increase of about 70 million since the end of 2017.¹⁴³ Nearly 1.5 billion of its users visited the site each day during the first quarter of 2018.¹⁴⁴

^j Myspace, which had been acquired for \$580 million in 2005, was resold for \$35 million in 2011. Source: Dominic Rushe, "Myspace sold for \$35m in spectacular fall from \$12bn heyday," *The Guardian*, June 30, 2011, <https://www.theguardian.com/technology/2011/jun/30/myspace-sold-35-million-news>, accessed April 2018.

Microsoft

As a Harvard undergraduate, Bill Gates teamed up with his former high school classmate Paul Allen to write a programming language for the Altair 8800, the first microcomputer or PC.¹⁴⁵ Shortly thereafter, Gates dropped out of college, and, in 1975, the pair founded Microsoft with the aim of developing software and selling it to computer companies.¹⁴⁶ Microsoft's big break came in 1979, when the company licensed its Microsoft Disk Operating System (MS-DOS) to IBM, which was then embroiled in antitrust litigation with the U.S. Department of Justice over its dominance of the computer industry.¹⁴⁷ Many PC companies—with the notable exception of Apple—began licensing MS-DOS rather than develop an OS of their own.¹⁴⁸ By 1981, Microsoft's sales totaled \$16 million.¹⁴⁹ Two years later, Allen resigned from the company after being diagnosed with Hodgkin's disease, while Gates stayed on as CEO.¹⁵⁰

Microsoft released its Windows operating system in 1985 and went public in 1986, at the closing price of \$27.75 a share, the company had a market cap of \$685.4 million.^{151,k} Though the IPO was a success, Microsoft faced legal challenges. Apple had recently sued it, claiming that Windows OS copied elements of Apple's Macintosh OS; Microsoft ultimately prevailed.¹⁵² In the meantime, Microsoft remained focused on improving its OS with subsequent releases. By 1993, one estimate suggested that Windows was used on almost 85% of PCs around the world.¹⁵³ In 1995, Microsoft released the first version of its Microsoft CE operating system, which was made available on the first handheld PC devices in 1996.¹⁵⁴

In 1995, responding to the rise of the Internet, Microsoft released its Internet Explorer web browser, challenging the dominant Netscape Navigator, which had come out a year earlier and held a 90% share of the browser market.¹⁵⁵ At the time, installing a new application or browser typically involved the purchase of a CD-ROM containing the software, which a user would then copy onto a hard drive of a PC. To gain market share, Microsoft did something different: it put pressure on PC makers to preinstall Internet Explorer on Windows computers, and, by 1998, Microsoft had clawed its way to 48.3% of the browser market, reducing Netscape's share to 41.5%.¹⁵⁶ By 2000, Explorer's market share was 95%.¹⁵⁷ Microsoft's newfound dominance did not go unnoticed. In 1998, the U.S. Justice Department filed an antitrust lawsuit against Microsoft based on complaints from Windows users that Microsoft had made it difficult to switch web browsers.¹⁵⁸ In 1999, when Microsoft's annual revenue reached \$19.7 billion, the court found that Microsoft had established a monopoly position in PC software and had engaged in anticompetitive behavior.¹⁵⁹ Rather than force Microsoft to split itself up, the Justice Department required it instead to allow competitors to more easily integrate their software with Windows.¹⁶⁰ However, the damage been done. Netscape's once high-flying IPO story had been demolished, and, after it was acquired by AOL in 1998 for \$4.2 billion, the company was disbanded in 2003.¹⁶¹

In 2000, Gates stepped down as Microsoft's CEO and was succeeded by his longtime colleague and Harvard classmate, Steve Ballmer.¹⁶² Over the next few years, Microsoft continued to release updated operating systems: Windows XP, Windows Vista, and Windows 7, and the company rebranded Windows CE as Windows Mobile. The company also moved into gaming with the 2001 release of the Xbox gaming console, which sold a million units in its first three weeks, due in part to an exclusivity agreement with the creator of the highly anticipated *Halo* game.¹⁶³ In 2005, Microsoft released a new console, Xbox 360, followed in 2009 by Kinect, a motion sensor gaming accessory that allowed people to interact with certain Xbox 360 games by using the movement of their bodies.¹⁶⁴

^k Equivalent to approximately \$1.51 billion in 2015 dollars.

In 2009, Microsoft launched the Bing search engine, which began powering Yahoo! Search in late 2010; by 2011, one study indicated that Bing controlled 27% of the search market, compared to Google's 69%.¹⁶⁵ As with Google AdWords, Bing sold ad space on its results pages for message targeting linked to certain keywords. In 2010, Microsoft also released Microsoft Azure, a cloud computing platform. Also that year, the company launched a new mobile operating system, Windows Phone, to replace Windows Mobile; it was available on devices from Samsung, Dell, HTC, LG, and Nokia.¹⁶⁶ In 2011, Microsoft acquired the video chat company Skype for \$8.56 billion, its biggest acquisition to date; at the time, Skype had about 124 million monthly active users.¹⁶⁷

In early 2013, Microsoft released Outlook.com, a free webmail service comparable to its earlier Hotmail service, which it had built on a mid-1990s acquisition.¹⁶⁸ That year, Microsoft announced its latest console, Xbox One, which it initially sold packaged with Kinect, an idea that proved unpopular; Microsoft reversed the decision in 2014.¹⁶⁹ Also in 2013, Ballmer stepped down as CEO and was replaced by longtime Microsoft executive Satya Nadella, who had been largely responsible for building the Azure business.¹⁷⁰ The following year, Microsoft introduced Cortana AI, named for a character in the *Halo* video game franchise.¹⁷¹ Originally built into the Windows Phone OS, Cortana was a voice-AI like Siri that could help users find information or schedule meetings.¹⁷²

Microsoft acquired mobile phone maker Nokia's device business in early 2014 for \$7.2 billion—though reports claimed that former CEO Ballmer, who orchestrated the deal before leaving Microsoft, had wanted to purchase Nokia's entire business, including its mapping software, but received pushback from Microsoft's board.¹⁷³ Later that same year, Microsoft acquired Mojang, creator of the popular video game *Minecraft*, for \$2.5 billion; by that point, Mojang had sold more than 50 million copies of *Minecraft*.¹⁷⁴

In 2015, Microsoft introduced Windows 10 OS, quickly triggering concerns around user privacy when it was revealed that the operating system gave Microsoft the ability to collect data on practically everything users did on their computers.¹⁷⁵ (See **Exhibit 11** for desktop operating system market share.) Windows 10 integrated Cortana and was accompanied by the Microsoft Edge browser, a replacement for Internet Explorer.¹⁷⁶ Compared to Internet Explorer, Microsoft Edge had a sleeker design and was integrated with Cortana and Bing. Under Edge's default privacy settings, all of a user's browsing and search history was streamed to Microsoft to "find and fix problems and improve our products and services for all users."¹⁷⁷ In late 2016, Microsoft made its largest acquisition ever, purchasing social networking giant LinkedIn for \$26.2 billion.¹⁷⁸

While Windows Phone was generally well received, Microsoft was struggling to attract third-party app developers, and Google notably blocked the development of a Windows Phone YouTube app.¹⁷⁹ In mid-2015, Microsoft wrote off \$7.6 billion and cut 7,800 jobs related to its Nokia acquisition.¹⁸⁰ In late 2017, Microsoft announced that it would no longer be introducing new features for Windows Phone, effectively ending its effort to break into the smartphone market.¹⁸¹

From the time Nadella became CEO to October 2017, Microsoft's market cap had increased by \$250 billion, due in part to the company's new focus on its cloud computing division.¹⁸² In late 2017, Microsoft made Cortana available on a smart wireless speaker, the Harman Kardon Invoke.¹⁸³ In early 2018, Microsoft announced that Cortana would be integrated into additional third-party smart home speakers.¹⁸⁴ In the first quarter of fiscal 2018 (ended September 30, 2017), Microsoft's revenue was \$24.5 billion, up 12% from the year prior.¹⁸⁵

Baidu, Alibaba, and Tencent

China's digital ecosystem was dominated by three large players—Baidu, Alibaba, and Tencent. These companies were shielded from foreign competition by Chinese government policy. The Chinese “Great Firewall” blocked sites that did not comply with censoring, keeping Google, Facebook, Twitter, and YouTube, along with media companies like *The New York Times* and Bloomberg, out of the market.¹⁸⁶ Many foreign tech companies were allowed access to Chinese markets only if they agreed to create joint ventures with domestic partners that often included the transfer of intellectual property.¹⁸⁷ Critics of China's digital ecosystem argued that its scaled players were mere clones of U.S. companies, profiting from China's 800 million Internet users without the threat of foreign competition.¹⁸⁸ However, insiders considered this critique to be a “misunderstanding.”¹⁸⁹ Even U.S. writers argued that the Chinese companies offered a different mix of products and features than their U.S. counterparts, and were more tailored to the Chinese market and in some ways more innovative.¹⁹⁰

Baidu

Baidu was a search engine founded in 2000 by Robin Li and Eric Xu that specialized in Chinese language online search. Like Google in the U.S., Baidu initially provided search as a service to popular Internet portals as a way to gain traction on its own site.¹⁹¹ By 2009, Baidu had 60% of the Chinese search market, surpassing Google's 33%.¹⁹² Over the 2000s, the Chinese government grew a web censorship program that actively blocked politically undesirable sites and pushed companies to self-censor online content.¹⁹³ In 2010, Google withdrew from the Chinese search market rather than censor search results, which government regulations required.¹⁹⁴ Baidu agreed to censor its search results, thus securing government favor, and it fended off other domestic competitors and continued to dominate the Chinese search market. Baidu monetized its services by hosting ads alongside search results, in a manner similar to Google's AdWords.¹⁹⁵

By 2017, Baidu earned \$11 billion in revenue and controlled three-quarters of the Chinese search market.¹⁹⁶ The company made additional investments in online video, local travel booking, maps, and marketing local services.¹⁹⁷ Baidu's advertising offerings made up 23% of online ad revenue in China, and its maps service had half of the Chinese market.¹⁹⁸ To improve its products, Baidu invested heavily in AI research that could enhance and personalize user experience.¹⁹⁹

Alibaba

Alibaba Group was founded in 1999 by a team led by Jack Ma.²⁰⁰ Alibaba initially provided an Internet portal that English-language buyers could use to place orders with Chinese wholesalers. Alibaba expanded to domestic wholesale postings later that year.²⁰¹ In 2003, Alibaba launched a new service, Taobao, a marketplace for consumer-to-consumer and small business-to-consumer sales.²⁰² To facilitate these sales, Alibaba launched a messaging service, Aliwangwang, and a digital payments platform, AliPay.²⁰³ The development of AliPay was particularly important for Alibaba's growth, because credit card penetration in China at the time was low, and Chinese consumers did not trust online sellers.²⁰⁴ AliPay gave consumers the ability to make digital purchases and settle only after product delivery, improving buyer trust.²⁰⁵ Alibaba continued to expand its services to include online courses (2006), an e-commerce site for large brands to sell to Chinese consumers (launched in 2008, rebranded as Tmall in 2011), and a cloud computing infrastructure group (2009), among other new ventures.²⁰⁶

As of 2017, Alibaba's Tmall alone controlled 51% of Chinese e-commerce,¹ giving the company a dominant presence in China as well as a solid base from which to expand into other countries.²⁰⁷ In 2017, Alibaba invested in using better data to work more efficiently with its logistics partners.²⁰⁸ As of 2016, AliPay (then part of Ant Financial)^m held a 55% market share for mobile payments in China. Given the low penetration of credit cards there, mobile payments gained greater penetration in China than in developed markets, accounting for \$9 trillion in payments in 2016 compared to just \$112 billion in the U.S.²⁰⁹ Each digital transaction gave Ant Financial the opportunity to earn a commission and to track consumer buying behavior.²¹⁰ Ant Financial also expanded into other financial services, including wealth management (\$760 billion assets under management in 2016), small business loans (3 million users by 2016), and insurance (380 million users in 2016).²¹¹

Tencent

Tencent was founded in 1998 by Ma Huateng (known colloquially as Pony Ma) and several friends. Tencent created a clone of an Israeli messaging service called iQ, adapting it for Chinese users and branding it "QQ." Tencent grew quickly but was mostly focused on copying products and services conceived by others.²¹² The founder of Sina, one of China's early Internet portals, called Ma the "plagiarism king."²¹³ To this charge, Ma responded, "Imitation is the most reliable form of innovation."²¹⁴

In 2011, Tencent developed and released WeChat, a social network designed for smartphones.²¹⁵ WeChat's popularity grew along with the popularity of smartphones, reaching 100 million users by 2012 and 200 million by 2013.²¹⁶ In 2017, WeChat had nearly a billion active users, and users collectively spent 1.7 billion hours a day on Tencent apps, more than all other Chinese apps combined.²¹⁷ WeChat became a ubiquitous part of Chinese life, a conduit through which Chinese users interacted with each other, major brands, and local services. One venture capitalist explained, "its goal is to address every aspect of its users' lives, including non-social ones," and it is more like "a mobile operating system—complete with its own proprietary app store" than a simple "messaging app."²¹⁸ Tencent also launched a payment service, WeChat Pay, which in 2017 had a 40% share of the mobile payments market.²¹⁹ Unlike U.S. social networks, Tencent did not rely heavily on advertising, which made up only 18% of revenues in 2016, and instead monetized through value-added services, such as games and subscriptions.²²⁰ Given WeChat's strong hold on distribution to, and data about, consumers, many companies, particularly gaming companies, offered Tencent investment stakes at favorable terms.²²¹ Tencent continued to grow as a tech conglomerate, investing in AI, a smart speaker (with voice AI) product, a WeChat search engine, and expansion beyond China.²²²

¹ Market share excluded consumer-to-consumer commerce and travel.

^m In 2011, Alibaba had spun-out AliPay as Ant Financial while maintaining an ongoing partnership. Source: Louise Lucas and Don Weinland, "Alibaba's \$60bn payments arm stalls planned IPO," *Financial Times*, May 15, 2017, <https://www.ft.com/content/25780a7c-3702-11e7-bce4-9023f8c0fd2e>, accessed May 2018.

The Future of the Frightful Five

By early 2018, the U.S.'s Frightful Five and China's BAT had become some of the largest and most influential companies in the world. However, given the pace of technological change and the regulatory uncertainty surrounding privacy and security, it was unclear which players would continue to dominate Internet markets going forward. In spite of the technological advances the Five had delivered, the public were increasingly ambivalent about the power they wielded. When asked whether big technology firms were good for the world, 61% responded "yes" for Amazon, 57% for Google, 56% for Microsoft, 45% for Apple, and 40% for Facebook.²²³

Under the EU's GDPR, technology companies would need to seek explicit consent from consumers before using their personal data; the regulation would also give consumers a way to reverse such consent, including a "right to be forgotten," or to download all of the data collected from them.²²⁴ Fines for violations could be as high as \$20 million, or 4% of a company's global revenues, whichever was larger.²²⁵ By early 2018, many large technology companies had begun working to comply with these regulations. Facebook, for example, began developing a user privacy center to allow users to more easily adjust their privacy settings, while Amazon announced efforts to improve its data encryption.²²⁶ It was open question whether GDPR would become a legal and regulatory standard for the EU only, or a *de facto* standard for the world. (See **Exhibit 12** for a summary of GDPR compliance considerations.)

It was also possible that similar consumer privacy regulation would be enacted in the U.S. In early 2012, the Obama Administration had begun work on a Consumer Privacy Bill of Rights, which would "give Americans the ability to exercise control over what personal details companies collected from them and how the data was used."²²⁷ The legislation eventually stalled. However, it was possible that Facebook's Cambridge Analytica scandal, as well as the implementation of GDPR in Europe, might spur similar regulatory changes in the U.S. In one 2018 survey, 83% of respondents said that data privacy breaches should be subjected to "tougher regulations and penalties," and 53% supported federally regulating big technology companies similarly to banks.²²⁸ Some individuals, such as U.K. politician Vince Cable, had even called for big technology firms to be broken up.²²⁹

Looking ahead, how would these massively scaled Internet platforms compete? How would the rest of the global economy react? What responsibilities did these companies have regarding customer data? Which would continue to thrive, and which would be displaced by fierce competition, advancing technology, and increasing regulation? Finally, when and where would the Five from the U.S. and BAT in China begin to compete—and how might such a battle play out?

Exhibit 1 Top 10 Companies by Market Capitalization, 1996–2015 (U.S. \$, millions)

	1996	2000	2005	2010	2015
1	Nippon Telegraph & Telephone (Japan)	Microsoft (U.S.)	General Electric (U.S.)	PetroChina (China)	Apple (U.S.)
2	General Electric (U.S.)	General Electric (U.S.)	Exxon Mobil (U.S.)	Exxon Mobil (U.S.)	Exxon Mobil (U.S.)
3	Royal Dutch/Shell (Nth/U.K.)	NTT Mobile Communications (Japan)	Microsoft (U.S.)	Microsoft (U.S.)	Berkshire Hathaway (U.S.)
4	AT&T (U.S.)	Cisco Systems (U.S.)	Citigroup (U.S.)	Industrial & Commercial Bank of China (China)	Google (U.S.)
5	Exxon (U.S.)	Wal-Mart Stores (U.S.)	BP (U.K.)	Apple (U.S.)	Microsoft (U.S.)
6	Coca-Cola (U.S.)	Intel (U.S.)	Wal-Mart (U.S.)	BHP Billiton (Australia/U.K.)	PetroChina (China)
7	Merck (U.S.)	NTT (Japan)	Royal Dutch-Shell (Nth/U.K.)	Wal-Mart Stores (U.S.)	Wells Fargo (U.S.)
8	Philip Morris (U.S.)	Exxon Mobil (U.S.)	Johnson & Johnson (U.S.)	Berkshire Hathaway (U.S.)	Johnson & Johnson (U.S.)
9	Toyota Motor (Japan)	Lucent Technologies (U.S.)	Pfizer (U.S.)	General Electric (U.S.)	Industrial & Commercial Bank of China (China)
10	Industrial Bank of Japan (Japan)	Deutsche Telekom (Germany)	Bank of America (U.S.)	China Mobile (Hong Kong)	Novartis (Switzerland)

Source: Casewriters, compiled from *Financial Times*, Global 500 (1996, 2000, 2005, and 2010), via Financial Times Historical Archive (1888–2010); and *Financial Times*, “FT 500 2015,” June 19, 2015, <https://www.ft.com/ft500>; all accessed May 2018.

Note: Market capitalization is as of March 31.

Exhibit 2 Market Capitalization, 2008–2018 (U.S. \$, millions)

March 31,	2018	2016	2014	2012	2010	2008
Apple Inc.	851,317.9	604,303.8	479,069.4	559,002.4	213,096.7	126,118.7
Alphabet Inc.	719,249.2	518,916.8	344,098.9	208,490.4	180,578.3	138,034.0
Microsoft Corporation	702,760.1	436,830.8	340,246.7	270,644.3	256,864.9	264,132.1
Amazon.com, Inc.	700,667.7	279,510.7	154,480.7	92,155.8	60,356.0	29,719.1
Tencent Holdings Limited	491,988.0	187,894.7	126,786.9	50,284.7	35,985.5	10,069.5
Alibaba Group Holding Limited	471,601.9	198,557.1	N/A	N/A	N/A	N/A
Facebook, Inc.	464,190.1	334,694.2	154,449.2	N/A	N/A	N/A
Baidu, Inc.	77,706.4	66,056.8	53,350.0	50,894.3	20,747.7	8,179.3

Source: Casewriters, adapted from Company Comparable Analysis (Amazon.com, Inc., Microsoft Corporation, Apple Inc., Alphabet Inc., Facebook, Inc., Alibaba Group Holding Limited, Baidu, Inc., and Tencent Holdings Limited), Capital IQ, Inc., a division of Standard & Poor's.

Exhibit 3 Smartphone Shipments Worldwide, by OS, 2017 and 2022 (U.S. \$, millions)

	2017	% of total	2022	% of total	CAGR
Android	1,244.0	85.1%	1,435.8	85.5%	2.9%
iOS	215.8	14.8%	242.4	14.4%	2.4%
Other	2.2	0.1%	0.7	0.0%	-21.1%
Total	1,462.0	100.0%	1,678.9	100.0%	2.8%

Source: From "Smartphone Shipments Worldwide, by OS, 2017 & 2022," eMarketer (from International Data Corporation, "Worldwide Quarterly Mobile Phone Tracker"), accessed May 2018.

Note: Numbers may not add up to 100% due to rounding.

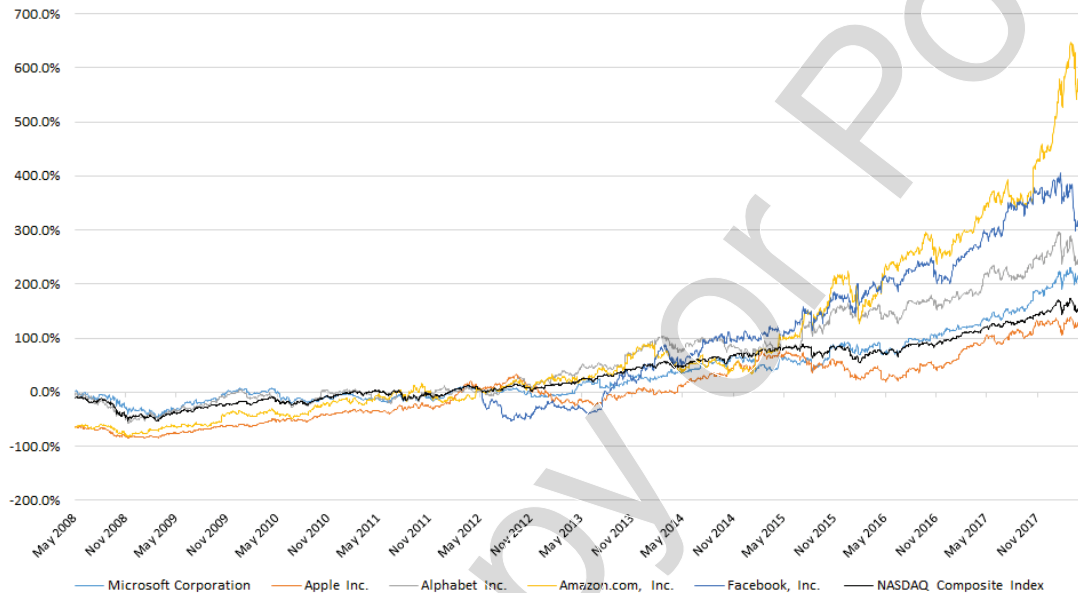
Exhibit 4 Selected Financial Metrics for Apple, Amazon, Microsoft, Alphabet (Google), and Facebook, 2018

	Market Cap (\$ millions)	Revenue (\$ millions)	Gross Margin (%)	EBITDA (\$ millions)	EBITDA Margin (%)
Apple Inc.	838,531.4	247,417.0	38.3%	76,378.0	30.9%
Amazon.com, Inc.	759,928.4	193,194.0	37.8%	17,233.0	8.9%
Microsoft Corporation	718,532.6	99,259.0	62.7%	35,078.0	35.3%
Alphabet Inc.	707,017.3	117,251.0	58.0%	36,707.0	31.3%
Facebook, Inc.	497,876.0	44,587.0	86.0%	25,628.0	57.5%

Source: Casewriters, adapted from Company Comparable Analysis (Amazon.com, Inc., Microsoft Corporation, Apple Inc., Alphabet Inc., and Facebook, Inc.), Capital IQ, Inc., a division of Standard & Poor's.

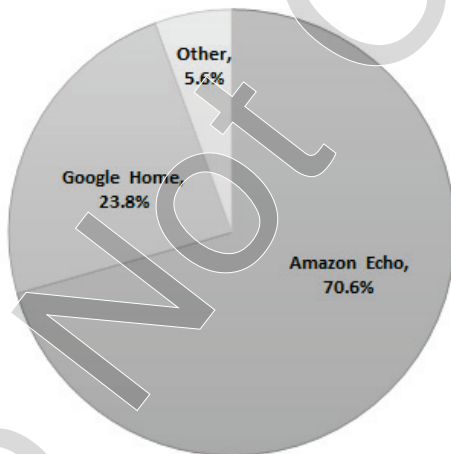
Note: Market capitalization is as of April 30, 2018. Total revenue, gross margin, EBITDA, and EBITDA margin are for the 12 months ended May 30, 2018.

Exhibit 5 Frightful Five Share Prices Over Time



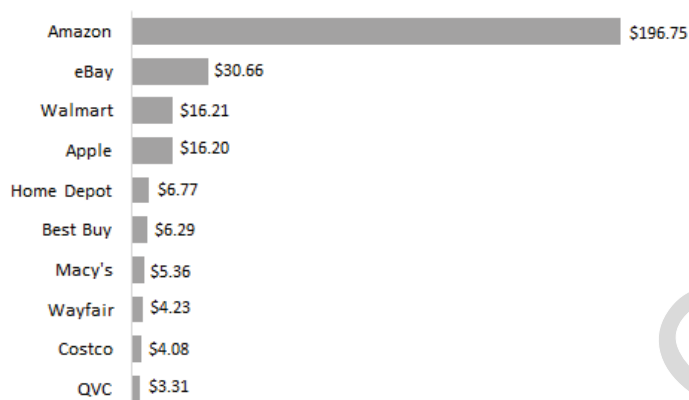
Source: Casewriters, adapted from Chart Builder, Capital IQ, Inc., a division of Standard & Poor's.

Exhibit 6 U.S. Voice-Enabled Speaker User Share, by Player, 2017



Source: From "US Voice-Enabled Speaker User Share, by Player, 2017," eMarketer, accessed May 2018.

Note: Individuals of any age who use a voice-enabled speaker at least once a month.

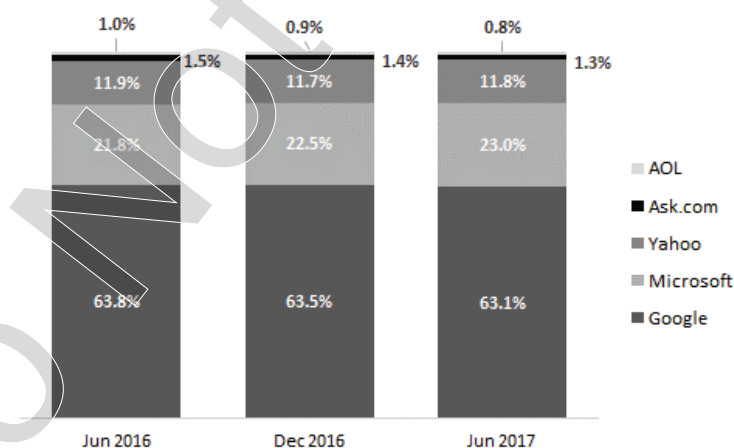
Exhibit 7 U.S. Top 10 Retail E-Commerce Sales, by Company, 2017 (U.S. \$, billions)

Source: Casewriters, recreated from "Top 10* Retail Ecommerce Sales, by Company," eMarketer, accessed May 2018.

Exhibit 8 Average Time Spent on Brands, November 2017

	Monthly Unique Users (millions)	Time Spent Per Month Per User (HH:MM:SS)	Sessions Per Month Per User	Average Session Duration (HH:MM:SS)
Google	211.9	2:21:55	558	0:07:31
Facebook	204.8	0:19:39	240	0:04:54
Amazon	191.6	0:08:48	50	0:10:30
Microsoft	185.1	1:00:46	236	0:06:18
Apple	122.8	0:07:18	80	0:05:29

Source: Casewriters, adapted from "Verto Index," Verto Analytics, December 2017, <https://www.vertoanalytics.com/verto-glossary-project-verto-index/>, accessed May 2018.

Exhibit 9 Monthly Share of U.S. Online Searches, Reach by Search Engine, June 2016–June 2017

Source: From "Monthly Share of Online Searches in the US, by Search Engine, June 2016–June 2017," eMarketer (from comScore MediaMetrix Multi-Platform), accessed May 2018.

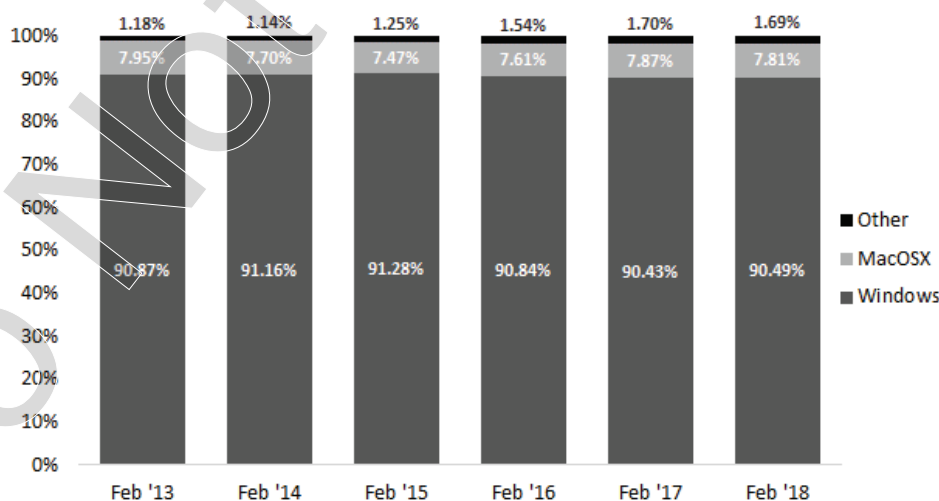
Note: Home and work locations; desktop only; excludes contextually driven searches that do not reflect specific user intent to interact with the search results.

Exhibit 10 Net Display Ad Revenues Worldwide, by Company, 2016–2020 (U.S. \$, billions)

	2016	2017	2018	2019	2020
Facebook	\$26.89	\$39.94	\$48.85	\$57.61	\$66.89
% change	57.4%	48.6%	22.3%	17.9%	16.1%
% of total	30.1%	35.5%	36.0%	36.0%	36.6%
Alibaba	\$8.78	\$13.52	\$18.30	\$23.28	\$28.44
% change	51.1%	53.9%	35.4%	27.2%	22.1%
% of total	9.8%	12.0%	13.5%	14.5%	14.5%
Google	\$10.28	\$12.75	\$14.23	\$15.88	\$17.33
% change	13.4%	24.0%	11.6%	11.6%	9.2%
% of total	11.5%	11.3%	10.5%	9.9%	9.5%
Baidu	\$2.04	\$2.44	\$2.96	\$3.60	\$4.28
% change	4.3%	19.5%	21.3%	21.4%	19.1%
% of total	2.3%	2.2%	2.2%	2.2%	2.3%
Twitter	\$2.25	\$2.11	\$2.22	\$2.38	\$2.52
% change	12.8%	-6.1%	5.3%	7.2%	5.7%
% of total	2.5%	1.9%	1.6%	1.5%	1.4%
Oath (Yahoo)	\$1.69	\$1.70	\$1.74	\$1.75	\$1.77
% change	0.7%	1.0%	2.0%	1.0%	0.9%
% of total	1.9%	1.5%	1.3%	1.1%	1.0%
Microsoft (LinkedIn)	\$0.71	\$0.80	\$0.88	\$0.95	\$1.03
% change	-	11.8%	10.0%	8.7%	8.2%
% of total	0.8%	0.7%	0.6%	0.6%	0.6%
Sohu.com	\$0.37	\$0.24	\$0.21	\$0.22	\$0.23
% change	-26.2%	-35.5%	-10.4%	3.3%	4.5%
% of total	0.4%	0.2%	0.2%	0.1%	0.1%
Other	\$36.27	\$39.16	\$46.39	\$54.41	\$60.44
% change	19.0%	8.0%	18.5%	17.3%	11.1%
% of total	40.6%	34.8%	34.2%	34.0%	33.0%
Total display ad spending	\$89.28	\$112.66	\$135.78	\$160.08	\$182.93

Source: From "Net Display Ad Revenues Worldwide, by Company, 2016–2020," eMarketer, accessed May 2018.

Note: Includes display advertising that appears on desktop and laptop computers as well as mobile phones, tablets and other internet-connected devices; net ad revenues after company pays traffic acquisition costs (TAC) to partner sites.

Exhibit 11 Operating System Market Share of Desktop PCs, 2013–2018

Source: Casewriters, adapted from "Global market share held by operating systems for desktop PCs, from January 2013 to February 2018," via Statista, accessed May 2018.

Exhibit 12 12 Steps to Prepare for the General Data Protection Regulation (GDPR)

1. **Awareness.** You should make sure that decision makers and key people in your organisation are aware that the law is changing to the GDPR. They need to appreciate the impact this is likely to have.
2. **Information you hold.** You should document what personal data you hold, where it came from and who you share it with. You may need to organise an information audit.
3. **Communicating privacy information.** You should review your current privacy notices and put a plan in place for making any necessary changes in time for GDPR implementation.
4. **Individuals' rights.** You should check your procedures to ensure they cover all the rights individuals have, including how you would delete personal data or provide data electronically and in a commonly used format.
5. **Subject access requests.** You should update your procedures and plan how you will handle requests within the new timescales and provide any additional information.
6. **Lawful basis for processing personal data.** You should identify the lawful basis for your processing activity in the GDPR, document it and update your privacy notice to explain it.
7. **Consent.** You should review how you seek, record and manage consent and whether you need to make any changes. Refresh existing consents now if they don't meet the GDPR standard.
8. **Children.** You should start thinking now about whether you need to put systems in place to verify individuals' ages and to obtain parental or guardian consent for any data processing activity.
9. **Data breaches.** You should make sure you have the right procedures in place to detect, report and investigate a personal data breach.
10. **Data Protection by Design and Data Protection Impact Assessments.** You should familiarise yourself now with the ICO's code of practice on Privacy Impact Assessments as well as the latest guidance from the Article 29 Working Party, and work out how and when to implement them in your organisation.
11. **Data Protection Officers.** You should designate someone to take responsibility for data protection compliance and assess where this role will sit within your organisation's structure and governance arrangements. You should consider whether you are required to formally designate a Data Protection Officer.
12. **International.** If your organisation operates in more than one EU member state (ie you carry out cross-border processing), you should determine your lead data protection supervisory authority. Article 29 Working Party guidelines will help you do this.

Source: Information Commissioner's Office, "Preparing for the General Data Protection Regulation (GDPR): 12 steps to take now," v2.0 201705, licensed under the [Open Government Licence](https://ico.org.uk/media/for-organisations/documents/1624219/preparing-for-the-gdpr-12-steps.pdf), <https://ico.org.uk/media/for-organisations/documents/1624219/preparing-for-the-gdpr-12-steps.pdf>, accessed May 2018.

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