

Economic Value of the Advertising-Supported Internet Ecosystem

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Index

Summary of Findings

1. Introduction

- 1.1 Purpose of the study
- 1.2 Structure of the Internet

2. Methodology

- 2.1 Bottom-up Employment-Based Approach
- 2.2 Value of Internet Exports to the Rest of the Economy
- 2.3 Time Spent on the Internet
- 2.4 Top-down Employment-Based Approach

3. The Hard Infrastructure of the Internet

- 3.1 The Form & Function of the Hard Infrastructure
- 3.2 The Hard Infrastructure is evolving
- 3.3 Firms respond to these new forces
 - 3.3.1 Transmission
 - 3.3.2 Connectivity
 - 3.3.3 Hardware
 - 3.3.4 Data Centers

4. Soft Infrastructure

- 4.1 Service Providers
 - 4.1.1 Information Technology (IT) Consulting
 - 4.1.1.1 Enterprise IT Consulting
 - 4.1.1.2 Public Sector & Military Systems Integration
 - 4.1.1.3 Other Internet IT Consulting
 - 4.1.2 Researchers
 - 4.1.3 Domain Registry Services
- 4.2 Software Vendors
 - 4.2.1 Analytics Software
 - 4.2.2 Customer Relationship Management (CRM) Software
 - 4.2.3 Network Security
 - 4.2.4 Video Software
 - 4.2.5 All Other Internet Software

5. Consumer Services Support

- 5.1 Marketing Support
 - 5.1.1 Advertising Agencies: Full Service
 - 5.1.2 Advertising Agencies: Digital & CRM
 - 5.1.3 Online Ad Networks & Exchanges
 - 5.1.4 Measurement & Analytics
- 5.2 Operation Support
 - 5.2.1 Financial Support Services
 - 5.2.2 E-learning Support
 - 5.2.3 Travel Services Support
 - 5.2.4 Healthcare Information Solutions
 - 5.2.5 Shipping
 - 5.2.6 E-government Support
 - 5.2.7 Web Enabling Services
- 5.3 General Enterprise Activity

6. Consumer Services

- 6.1 Content Sites
 - 6.1.1 News & Information
 - 6.1.2 Multi-genre Content
 - 6.1.3 Specialized Research & User Generated Content
 - 6.1.4 Online Music Services
 - 6.1.5 Games
 - 6.1.6 Online Video
 - 6.1.7 E-learning / Online Education
- 6.2 E-commerce
 - 6.2.1 Retailing
 - 6.2.2 Travel Services
 - 6.2.3 Financial Services: Banking, FinTech, Digital Payments & Currencies
- 6.3 On-Demand Economy
 - 6.3.1 Platforms & Services
 - 6.3.2 On-Demand Economy Workers

6.4 Social Networks & Services

6.4.1 Social Media Sites

6.4.2 Online Dating

6.5 Employment & Recruiting

6.5.1 Employment Services

6.5.2 Human Resources

6.6 Productivity Tools

6.7 Government. Services

7. Integrated Firms

7.1 Content Marketers Integrating Vertically into Transmission

7.2 Transmission Providers Integrating Vertically into Content

7.3 Integrating Vertically into Cloud Transmission and Data Services

7.4 Vertically Integrated Firm Conclusions

8. Our Conclusions Regarding Employment in the Internet Ecosystem

8.1 Employment

8.2 New Phenomena

9. Distribution of Internet Employment by Geography: Top-Down Approach

9.1 Allocation of Internet Employment to Congressional Districts

10. Societal Benefits of the Internet Ecosystem

10.1 Effects on News & Information

10.2 Effects on Business Models

10.3 Matchmaking for Societal Good

10.4 Communities of Interest: Ad Hoc Organizing

11. Corroboration

11.1 The Internet 'Exports' to the Rest of the Economy

11.2 Time Spent on the Internet

11.3 Comparison of the Methods

12. Conclusions

12.1 Defining the Advertising-Supported Internet Ecosystem

12.2 The Employment and Value of Economic Activity Enabled by this Ecosystem

12.3 The Geographic Dispersion of the Ad-supported Internet Ecosystem

12.4 The Companies Associated with the Ad-supported Internet Ecosystem

12.5 Contribution of Advertising to the Ecosystem

12.6 Conclusion

Summary of Findings

The ad-supported internet has been growing at about 20% per year for eight years:

Its growth is accelerating, and, though two decades old, shows the kind of growth normally associated with the take-off phase of an industry. We base this conclusion on a series of studies of this ecosystem performed every four years since 2008, of which this is the third.

Between 2008 and 2012, the number of jobs that rely on the U.S. internet ecosystem doubled from one to two million. Between 2012 and 2016, it doubled again to four million. The reason, as this report makes clear, is that the U.S. economy as a whole is increasingly an information economy, its fuel is data, and the internet ecosystem is increasingly the system it relies on for market-making.

The 2016 study finds that 4.1 million people owe their jobs directly to the advertising-supported internet ecosystem, and when compared to the two earlier studies we find that compound annual growth has accelerated from 18.5 percent to 19.6 percent, as seen in the following table.

Layer	2008 U.S. Employment	2012 U.S. Employment	2016 U.S. Employment
Infrastructure/Hard Infrastructure	140,000	420,000	304,393
Infrastructure Support/Soft Infrastructure	165,000	254,000	662,691
Consumer Services Support	190,000	435,000	1,068,364
Consumer Services	520,000	885,000	1,619,335
Integrated Firms ¹			442,218
Total	1,015,000	1,999,000	4,097,001
Growth in Employment (% per annum compound)		18.5%	19.6%

For each person whose job depends directly on the internet, further jobs, termed derived jobs, are created to meet their needs for schooling, entertainment, banking retail, government services, and so on. The table below shows our estimate of direct, derived, and total employment.

¹ In our previous two reports we depicted the internet as four horizontal layers. In this report we add a fifth element, a group of integrated firms, for reasons given in Chapter 7.

	2008 Report	2012 Report	2016 Report
Direct employment due to internet	1,015,000	1,999,000	4,097,000
Derived (indirect) employment	2,035,000	3,101,000	6,286,000
Total employment	3,050,000	5,100,000	10,383,000

Sector contribution to GDP is the sum of national income, corporate gross profits, and interest. As was done in 2008 and 2012, the sector contribution was taken to be proportional to sector income using the national average wage index published by the U.S. Social Security Administration. By this method, employment in the advertising-supported internet ecosystem contributed about \$1,121 billion to the U.S. GDP, more than double its previous contribution when last calculated in the 2012 study at \$530 billion. The industry accounted for 6 percent of the U.S. GDP, markedly higher than when it was at 3.7 percent in 2012.

The economic value of the advertising-supported internet ecosystem has grown at an accelerating rate, representing a 20 percent compound annual growth rate from 2012 to 2016—far outpacing the overall U.S. GDP average of 4 percent over the same four years.

	2008 Report	2012 Report	2016 Report
Direct employment due to internet	1,015,000	1,999,000	4,097,000
Direct and derived employment	3,050,000	5,100,000	10,383,000
Contribution of internet to GDP	\$300 billion	\$530 billion	\$1,121 billion
Growth in GDP (% per annum compound)		15.5%	20.0%
Share of Total US GDP	2.1%	3.7%	6.0%

The jobs growth benefitted the entire United States: There was internet-related employment in every congressional district of the U.S. The dispersion of the workforce was broad, with 116 congressional districts accounting for half of the employment, and 320 accounting for the other half. California’s Silicon Valley accounts for only four percent of jobs directly attributed to the ad-supported internet ecosystem. Another 10 percent is found in New York’s Manhattan, Virginia’s Arlington County, Boston’s Route 128, and Washington’s Seattle/Tacoma.

But the great majority of jobs, 86 percent, lie beyond the centers of internet concentration. This is because the internet puts people to work not only in digital headquarters, but wherever digital technology products are used – drivers matched to customers across the nation on ride-hailing platforms, small merchants in every city advertising on Silicon

Valley ad networks or the classified ads of Craigslist and transacting on the merchant platforms of Amazon and Microsoft, entrepreneurs funded by services like Kickstarter, farmers markets using payment facilitators such as Square, and social networks, recommendation engines, and search engines that help small sellers with small ad budgets to find customers even though they lack the resources to build nationally recognized brands. The centers of internet concentration are vital engines, but they employ only 14 percent of the people who earn livings from the ad-supported internet.

Major industries have blossomed in the past 4 years: Recreation, retailing, and work opportunities have all been affected.

Online video is one such area. It has been the most significant driver of new internet traffic between the 2012 study and this report, as Over-the-Top (OTT) Television began to enter the mainstream. This video delivery mechanism—in contrast to traditional broadcast and cable television transmission—relies on the open internet, supplied by a household’s internet service provider, and permits unprecedented control over what video to watch and when.

E-commerce also grew rapidly, and from a larger base. On its own it accounts for 976,000 jobs, almost a quarter of the entire direct employment base of the ad-supported internet ecosystem. It contains some very large and technically sophisticated enterprises, such as Amazon and Apple, which alone make up 26 percent of all e-commerce employment. But even more significant are the individual e-commerce merchants who sell on eBay, Etsy, Craigslist, and Amazon. Collectively they are 29 percent of employment. This thriving community of workers illustrates the economic opportunity created by the internet, not just to mobilize individuals, but to build the software structures they rely on for trading, payment, and fulfillment.

On-demand platforms are a third new growth area. These platforms match workers to employers in a range of industries. Part-time workers in the so-called gig economy, are in aggregate a full-time equivalent workforce of 147,000 people and likely to grow much larger.

User content is an umbrella term for self-publishing operating at much larger scale than at the time of the last report. Facebook’s global user community has doubled to 1.8 billion since 2012. There are 300 million people publishing on Twitter, and Snapchat—which didn’t exist at the time of the last study—now receives over 10 billion views per day. Collective knowledge sites such as Quora, Reddit, and Wikipedia, and the videos of ‘vloggers’ reviewing items from cosmetics to cars to sneakers, have evolved from novelties to regular web audience destinations. There is an industry of individual content creators, their agents and distribution networks specializing in influencer marketing, resulting in, for example, more than \$1.5 billion in revenue

and 35,000-plus full time equivalent jobs for U.S. YouTube creators.

Music's transformation from downloading to streaming is almost complete; Apple talks of discontinuing downloads altogether. Spotify, which had a trivial amount of revenue at the time of our last report, is now the dominant provider of music streaming, with approximately 100 million users of which close to 40 million are paying subscribers.

Cloud computing in the time since our last study has begun to deliver software as a service, which allows it to be consumed more flexibly and without substantial fixed cost. It enables digital firms to tailor information technology costs to needs.

Internet Infrastructure since the previous study has begun to evolve its backbone-and-branch pattern into one built around data centers, enabling co-location of data generator firms and data distributors. In the last four years, particularly as a result of the growth of demand of data-intensive services such as streaming video, much of the internet's data no longer travels on the backbone. Instead it moves on the edge of the network, from data suppliers to distribution nodes and on to homes. Firms such as Verizon and AT&T, traditionally handling transmission and distribution, have integrated into consumer service and consumer services support.

On the horizon we see the pace of data-driven entrepreneurship continuing in areas such as the internet of things, bots, financial technology (FinTech), technology-enabled healthcare, marketing technology (MarTech), and in publishing, as sites of media consumption become uncoupled from the sites of production. All suggest that accelerated growth will continue for the foreseeable future.

Changing everyday life created a total of 734,000 new jobs: The consumer-facing layer of the internet economy, which delivers products and services directly to consumers, was the segment with the largest growth in jobs since the last study in 2012. As the layer where firms come face to face with consumer demand, it is the layer where economic growth and consumer value originate.

Many small firms and one-person operations owe their jobs to the internet: The ecosystem's large firms accounted for only 56 percent of the 4,097,000 jobs. Mid-sized and small firms, and a sizable number of self-employed individuals, accounted for the rest.

Consumers did not pay for many of the internet's benefits: The under-recognized source of much of the internet's consumer value was the infrastructure supporting the consumer-facing services. Consumers could get the benefits of the internet at lower cost—and often, for services like Yelp, Facebook, Twitter, Snapchat and many others, for free—because entrepreneurs were building out a market-making infrastructure to make them profitable without large subscription fees. For example, digital advertising agencies,

advertising exchanges, and measurement and analytics companies which support content sites and marketers seeking to advertise on the internet, all grew in response to the increasing need to analyze and interpret the vast amounts of data generated by consumers of free and low-cost services.

Building this infrastructure was an important source of new jobs: One infrastructure sector in particular, the information technology (IT) consulting sector, accounted for 12 percent of all jobs in the ecosystem. This sector contains firms ranging in size from global giants like Accenture and Cognizant to smaller specialist firms and even one-person shops.

IT infrastructure is becoming accessible to smaller firms: As information technology evolves from enterprise software hosted on a firm's owned hardware to cloud-based services, opportunities emerge for small firms to apply IT resources once only available to global giants. As the internet reduces dependence on scale, entrepreneurs with good ideas but limited resources become a force for disruptive innovation in the U.S. economy.

The contribution of advertising to the ecosystem is very large: Just what do we mean by the term "advertising-supported"? In the pre-internet world 'advertising' referred to payments to media. If we apply this narrow definition of 'advertising' as payments to media for services that include search, display, classified, mobile, lead generation and email, then advertising contributed \$65 billion to the ecosystem. But in the pre-internet world that definition, imposed mainly by advertising agencies who were compensated in proportion to their purchases of paid media, did not cover advertising on so-called 'owned' media such as displays on the sides of a firm's trucks and buildings, nor did it refer to ways to make sales such as direct mail, catalog retailing, and telemarketing. With the decline of commission-based compensation in digital markets, it is unnecessary to draw lines between promotional activities that involve paid media and those that do not. The commercial activities that support the internet are all concerned with market-making. Payments to third-party media measure just a small fraction of what the internet does to make the markets that create the U.S. economy.

The internet serves many promotional purposes besides media advertising narrowly defined. Websites can serve as branded storefronts, point-of-purchase stimuli, as tools for conducting research online for offline purchase, and to transact online based on research offline. Websites can aggregate consumer reviews. Consumers can see products promoted and buy them in the same visit if they choose. They can download digital products and consume them online. They can share news about their purchases and opinions and review products and services on social media.

Therefore when we use the term "advertising-supported internet" we refer to all those internet-based activities that make markets. The ecosystem is in effect a digital system that makes markets in the online sphere and influences market-making in the offline sphere.

Its effects, including those of owned and earned media, are valued at its \$1,121 billion contribution to GDP.

There is no news in the observation that the internet has impacted contemporary life like no other technical product in living memory. With this report and its two predecessors we have tried to go much further. We have quantified its impact on job growth at three points in time, revealed a pattern of accelerating impact on the economy, and have found the most dynamic of its sectors. We hope that by deepening the understanding of the internet's role in the economy and its structure, we have provided data and analysis to inform policy choices as the advertising-supported internet economy continues to extend its reach and become a larger and more integrated part of the U.S. economy.

Chapter 1: Introduction

1.1 Purpose of the study

This study was commissioned by the Interactive Advertising Bureau (IAB) to understand the size, scope, and benefits, both social and economic, of the ecosystem of commerce in the United States that owes its existence to the internet. It follows the structure and method of two earlier studies also commissioned by IAB. We refer to the first study as the 2008 study as it used 2008 data. We refer to the second study as the 2012 study. It relied on data from the second half of 2011 and the first two quarters of 2012. This study, the 2016 study, uses data from the third quarter of 2015 and the first three quarters of 2016.

In commissioning these studies, IAB has sought to track over time the contribution that advertising on the internet has made to the internet ecosystem. Its goal has been to build a fact base to demonstrate the value of the industry to stakeholders including the public, advertisers, and policy makers in an objective and verifiable manner. Thus, IAB and the authors share a common interest in objectively determining the extent of the ecosystem that lives on the internet, and the contribution advertising makes to supporting it. Like most infrastructure, the internet is funded in a number of ways: there are fees paid to owners and builders for access to the internet, and there are purchases of equipment and services to build and operate elements of the internet for private advantage. Some funding takes the form of payments by marketers to publishers and other media for the right to market to the traffic. These payments lessen the cost that each user must pay to receive the benefits of the internet, and expands the size of the system that society can afford to have.

The study will estimate the value of the ecosystem that relies on the internet, expressed as a contribution to the United States' gross domestic product, and estimate the fraction of that value that is funded by advertising defined both narrowly as payments to media and broadly as market-making services.

The assignment was to:

- i. Define the advertising-supported internet ecosystem
- ii. Determine the employment and value of economic activity enabled by this ecosystem
- iii. Determine its geographic dispersion
- iv. Define the companies associated with the ad-supported internet ecosystem
- v. Determine the contribution of advertising to supporting the ecosystem

What is the advertising-supported internet ecosystem? What marks the boundary between it and the rest of the economy? Over the three studies we have applied a consis-

tent definition of the system as commerce-enabling, not the broader system that carries information for both commercial and non-commercial purposes. Over these three studies, therefore, our focus has been on activities that rely on the internet to promote marketplace exchange of products, services, and information.

What is the counterfactual: what marketplace exchange does not belong in the internet ecosystem? Obviously analog processes are excluded, such as the human elements of personal selling. And across the three studies we have excluded dyadic data transfers performed on private data networks that would have operated had the internet not existed. But in an increasingly data-driven world, many market-making processes are supplemented by data flows and they do belong in these studies.

A defining property of the internet is that it works with software running on higher or lower-layer data systems without restriction, something that has been the consequence of the software convention known as the Internet Protocol (IP.) The IP was designed to be separate from, and quite independent of, the higher-level software applications that run on it, creating an open platform that can carry data of any kind, whether written to be read by email, file sharing, video streaming, or website assembly software. (The World Wide Web, for example, which is often confused with the internet, is one of these higher-layer applications, running on the HTTP protocol.) The internet was also designed to be provisioned over many lower-layer physical networks such as coaxial cable, Ethernets, telephone networks, cable networks, and wireless networks, without the need to tailor them. The IP, in summary, has been such a remarkable economic force because it carries many kinds of data on many physical architectures, almost without restriction.

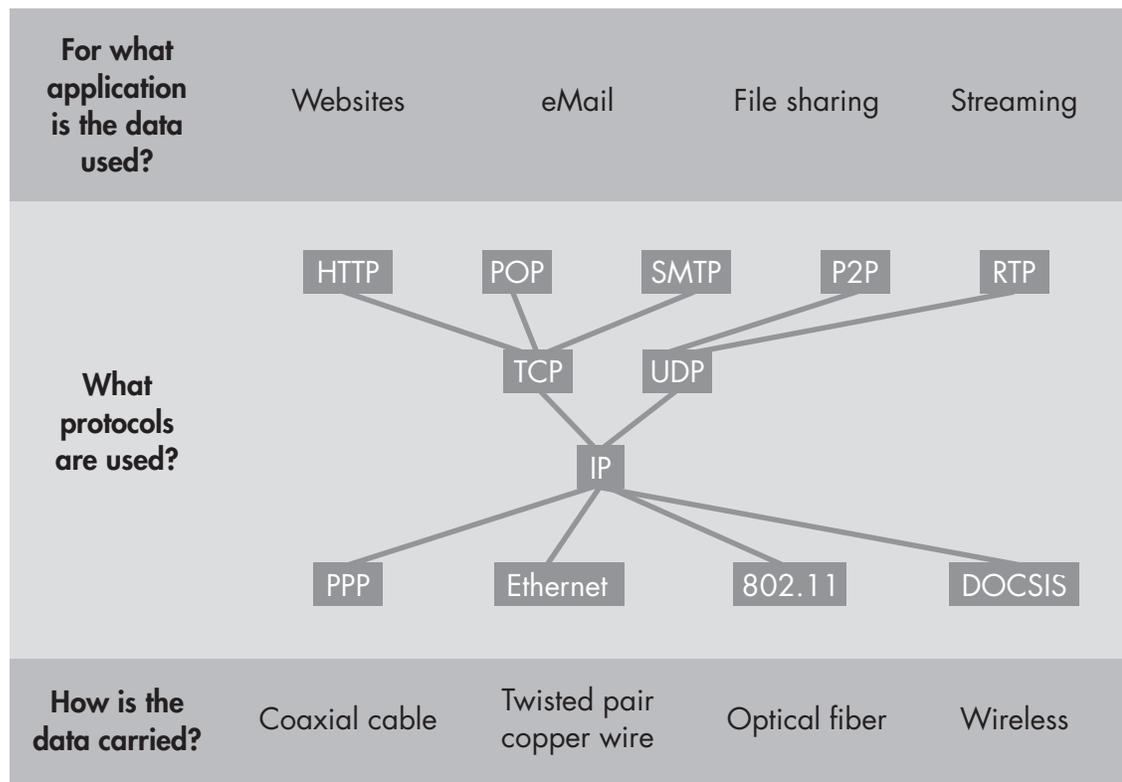
What is restrictive about the Internet Protocol is—as Robert Cannon² has argued—its unique address space. This address space is defined, and with it the internet can be defined, as the unique set of IP number addresses assigned by the Internet Assigned Number Authority (IANA), a department of the Internet Corporation for Assigned Names and Numbers (ICANN), a non-profit corporation based in California.

As Figure 1-1 illustrates, the IP is just one layer in a stack of protocols adopted to transmit data from various physical networks to various software applications, but it is a particularly important layer. The stack has an hourglass shape with a very distinct neck, so that many kinds of data pass through the IP layer of the stack. The IP enables packet switching, and is distinct from and independent of voice networks that rely on circuit switching³. Thus the IP links networks carrying digital information, and empirically is easily distinguished from networks carrying analog information, including voice transmissions.

² Cannon, Robert (2014). "Will the Real Internet Please Stand Up: An Attorney's Quest to Define the Internet" (March 2004). *Telecommunications Policy Research Conference 2002*. Available at SSRN: <http://ssrn.com/abstract=516603> or <http://dx.doi.org/10.2139/ssrn.516603>.

³ See for example Kahn and Cerff, "What is the Internet?" http://www.cnri.reston.va.us/what_is_internet.html

Figure 1-1: Internet Architecture



We use the term *internet ecosystem* to describe the object of this study: an aggregation of businesses that depends on and co-evolves with the internet infrastructure. The term does not have a long pedigree in economics, but it is useful here. It derives by analogy from a unit of analysis in biology, where it refers to an interdependent system of living organisms, from plants and animals to micro-organisms, taken together with the inert elements of their environment such as water and soil. Although the term has been used in business and economics since at least the 1970s⁴, it has become popular in more recent years in the information technology industry, where the interdependence of businesses relying on a common set of technologies is a central fact. Moore (1996) wrote of a business ecosystem as a "...community [of firms that] co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles."⁵

⁴ Boulding, K. (1978). *Ecodynamics: A New Theory of Societal Evolution*. Beverly Hills, CA: Sage.

⁵ Moore, James F. (1996). *The Death of Competition: Leadership & Strategy in the Age of Business Ecosystems*. New York: Harper Business.

The structure of a business or organizational ecosystem has been investigated by Mars, Bronstein and Lusch.⁶ They find that players interact in patterns that are sometimes mutually advantageous, sometimes competitive. They argue (as do Iansiti and Levien⁷) that some players act as keystones, in the sense that they occupy hubs in the exchange network whose health assures the health of the whole system. The ecosystem, they find, is a nested structure in which functions and priorities often overlap. These redundancies create resilience, and conversely their absence puts the system at risk of collapse. They argue that organizational ecosystems, unlike most biological ecosystems, have foresight and can anticipate conditions that might lead to system collapse. The more complex the system, and the more turbulent its evolutionary path, however, the more difficult it is to understand the interdependencies that put the system at risk. Finally, they emphasize the emergent nature of business ecosystems. While strategy and deliberate design are never irrelevant, they are not the determinants. An ecosystem cannot be designed into existence, although a legal regime, a regulatory regime, education, and access to capital can be designed to enable its continuity.

One question the study seeks to explore is the extent of the ecosystem's reliance on advertising to support it. Advertising can be read narrowly as payments by advertisers to publishers, following the precedent established in the pre-internet world. In that world 'advertising' did not cover advertising on so-called 'owned' media such as displays on the sides of a firm's trucks and buildings, nor did it cover direct mail, catalog retailing, or telemarketing. However, in the digital economy, this distinction underplays one of the important economic consequences of the internet. The marketing effects of the internet ecosystem, particularly those of owned and earned media, are very substantial. Payments to publishers do not measure all that the internet does to make the markets that create the economy.

The internet, in sum, serves many commercial purposes besides advertising in the narrow sense of the word. Websites can serve as storefronts, point-of-purchase stimuli, as tools for conducting research online for offline purchase, and to transact online based on research offline. Websites can aggregate consumer reviews. Consumers can see products promoted and buy them in a single visit. They can download digital products and consume them online. They can share news about their purchases and opinions and review products and services on social media.

Reflecting back to the policy goal of the study, we explore the internet's many advertising benefits besides those that come from narrowly-construed media spending. In addition, we explore the internet's non-business benefits.

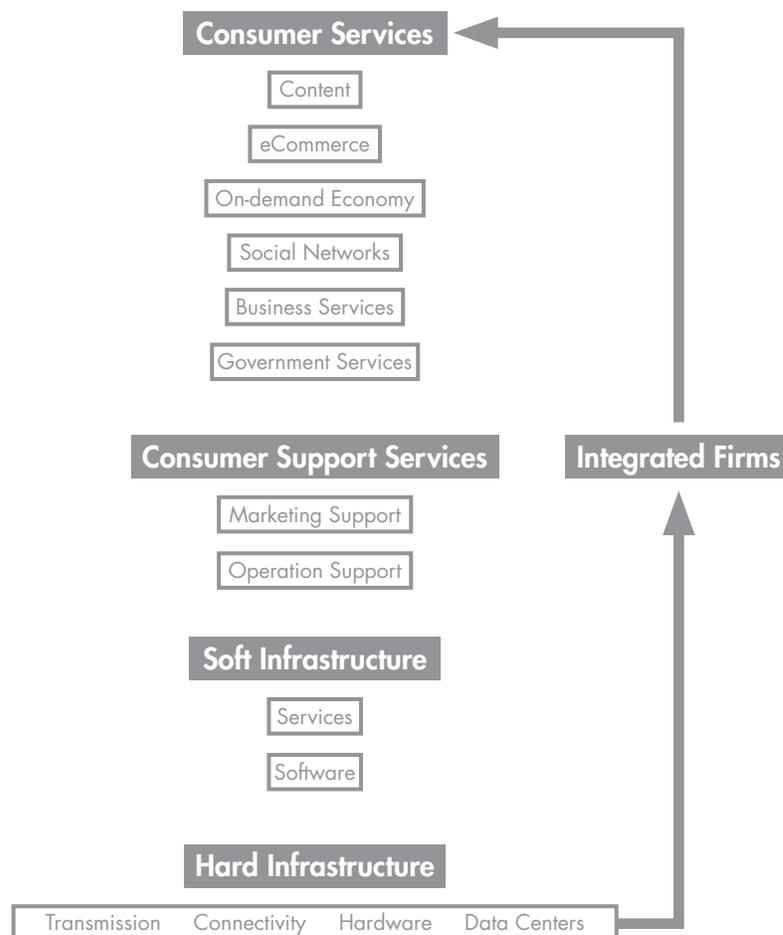
⁶ Mars, M., Bronstein, J. and Lusch, R. (forthcoming). The value of a metaphor: Organizations and ecosystems. *Organizational Dynamics*.

⁷ Iansiti, Marco and Levien, Roy (2004). *The Keystone Advantage: What the new Dynamics of Business Ecosystems Mean for Strategy, Innovation and Sustainability*. Harvard Business School Press.

1.2 Structure of the Internet

Our earlier studies describe the origins of the internet, and we shall not repeat that material here. Greenstein (2015) has an excellent and much richer account.⁸ The model used in this study follows that used in the 2012 report: a tree structure, whose hard infrastructure is analogous to roots, a soft infrastructure trunk, consumer services support making the branches, and consumer services, like leaves, corresponding to the services that consumers buy or receive in exchange for advertising services. The tree metaphor conveys the logic of the relative stability of the roots and trunk relative to the richness of the foliage. Since 2012, however, we have introduced an integrated category to contain firms whose scope runs from roots to leaves, as we will discuss in Chapter 7.

Figure 1-2: Structure of the Internet 2016



⁸ Greenstein, Shane (2015). *How the Internet Became Commercial*. University Press: Princeton, NJ.

Chapter 2: Methodology

A nation's gross domestic product (GDP) is the aggregate of incomes received by residents, both individual and corporate, as direct payment for current services to production, plus return on capital. This is equivalent to the sum of the values added at each stage of production by the industries and productive enterprises located in, and making up, the country's domestic economy. The national GDP can be decomposed into sector GDPs, which, in the same spirit, measure the economic activity of each sector. This approach estimates the internet sector GDP.

Our objective is to provide data that, together with reasonable assumptions, can be used to estimate U.S. economic activity attributable to the advertising-supported internet ecosystem. This report, as the 2008 and 2012 studies did, uses an employment-based methodology, and two methods to test the plausibility of the answer:

1. **Bottom-up Employment-Based Approach:** From a variety of sources we identify large firms in each layer of the internet, and use a range of public and private sources to estimate each firm's revenue and employment as well as estimates of aggregates of small firms and self-employed people. This method is precise with respect to the firms studied, but approximate with respect to relevant employment.
2. **What the Internet Exports to the Rest of the Economy:** We compute payments by firms for internet services, viewing the internet as if it were an island exporting to the rest of the economy.
3. **Time Spent on the Internet:** We value the time that users spend on the internet at its marginal value.

In addition, we use a top-down method to decide how to allocate the employment to geographies.

4. **Top-Down Employment-Based Approach:** From the U.S. Census Bureau's databases we identify categories of establishment with significant internet-related employment. As the U.S. Census Bureau protects the confidentiality of its respondent firms, this method is precise with respect to employment, but approximate with respect to firm contributions to the internet.

2.1 Bottom-Up Employment-Based Approach

This approach uses, as a starting point, the North American Industrial Classification System (NAICS) codes of firms studied in the 2012 report. For each NAICS code we

identify the largest employers, their total revenue and employment, and the proportion of revenue and employment that we attribute to the internet-related activities of the firm in the United States. The firm-by-firm assumptions that underlie these attributions can be obtained by requesting a spreadsheet from the IAB. In this report we review the assumptions behind the larger and most material of the estimates.

In addition, we make allowance for smaller firms by comparing our firm-by-firm enumerations to the number of employees counted in U.S. Bureau of Census reports and trade association indices, and where necessary we create 'all other' categories. For industrial activity that is too new to have been counted in the most recent business census, such as mobile phone application development, we make special adjustments described in the body of the report.

We allow for sectors comprising firms that were individually small but large in aggregate, namely local and state e-government services, small online retailers, and people working in large and mid-sized general enterprises performing work on the internet but not otherwise counted in the internet ecosystem. Finally, we count self-employed workers such as sellers on Etsy individual sellers on eBay, on-demand economy workers, and freelance individuals doing coding, content creation, and other services for web sites.

For each person directly employed in a particular sector of the internet ecosystem, other people work in sectors that supply the sector or that benefit from retail and service sector spending by these workers. The focal sector also helps to support taxation-dependent areas of the economy, such as government and public sector workers who are employed in federal, state, and municipal services, education, and the military. Thus, this indirect employment, computed by applying employment multipliers to the sector's employment, arises from supplier effects, re-spending effects, and government employment effects. The U. S. Bureau of Labor Statistics publishes statistics on industry employment requirements, which enable calculation of the labor inputs into a sector. Sectors differ in the size of their multipliers. Bivens⁸ computes indirect employment that ranges from 372 indirect jobs for every 100 jobs in durables manufacturing to 163 indirect jobs for every 100 jobs in business services. These estimates are inclusive of capital service usage. We take the appropriate ratio for the internet sector as 154 indirect jobs for every 100 jobs directly created, anchoring on the business services ratio and adjusting for consumer services and infrastructure firms.

We then apply a fully burdened labor cost, comprising wages and salaries, the cost of benefits, on-boarding, management overhead, vacation time, and facilities costs, to these employees.

⁸ Bivens, Josh (2003) Updated Employment Multipliers for the U.S. Economy, EPI Working Paper 268. Economic Policy Institute.

2.2 Value of Internet Exports to the Rest of the Economy

The direct economic value of the services that the internet provides to the rest of the U.S. economy is the revenue paid for the services 'exported' beyond the borders of the internet's economy to the rest of the U.S. economy, net of what is 'imported'. The major categories of export comprise advertising services, retail transactions (net of cost of goods) conducted on the internet, and direct payments to internet service providers. In addition, the internet generates an indirect economic value of activity that takes place elsewhere in the economy due to the internet sector. The same multiplier is used as was used for employment.

2.3 Time Spent on the Internet

The third method is based on the time that people 'give' to the internet. We rely on a number of studies of internet use, some of which were surveys of recalled behavior and others that were based on observation of actual behavior.

We estimate the value of an hour spent at work for a representative U.S. worker at \$19.07 per hour, derived from the average wage of non-management, non-agricultural workers in data published by the Bureau of Labor Statistics. There is no market price for an hour spent in recreation or leisure, although there is an opportunity cost. If work time is discretionary, then it has been argued (Bockstael et al., 1987¹⁰) that the wage rate measures the opportunity cost of leisure time. If not, and in particular for people in school or under-employed, the wage rate over-estimates the value of a leisure hour. As an approximation, we use 10 percent of the wage rate for leisure time.

2.4 Top-down Employment-Based Approach

The goal of this methodology is to map the location of employment in industries that are part of the internet ecosystem, to supply a broader distribution of employment than is available from the location of head offices. We use the U.S. Census Bureau's County Business Patterns (CBP) dataset, which gives the number of employees per county, both core and support, for each establishment in each of the approximately 700 five-digit codes of the North American Industry Classification System (NAICS).

From a detailed review of the industry definitions of each NAICS code, we identify 15 of the 700 that are likely to have meaningful amounts of internet-dependent employment. Three are entirely internet-dependent, and 12 are partially dependent. For the latter we calculate an 'internet-intensity' ratio for its NAICS code. From our bottom-up data, which includes each firm's NAICS code, we compute the code's internet revenue as a fraction of total U.S. revenue. For codes where our bottom-up analysis does not yield a representative sample of companies, we utilize Product Line Receipts from the 2012 Economic

¹⁰ Bockstael, N., Strand, I. and Hanemann, W. (1987), "Time and the Recreational Demand Model," *American Journal of Agricultural Economics*. 69 (2) 293-302.

Census as an indicator of the proportion of revenue sourced from internet work. We did not rely on this method to corroborate the bottom-up methodology because the two methods are not entirely independent, and because, as discussed below, while it is a good measure of the geographic distribution of employment, it is not a reliable measure of total internet employment.

Chapter 3: The Hard Infrastructure of the Internet

Internet traffic worldwide has grown rapidly in recent years and is expected to continue to grow. It is reported by Cisco's Visual Networking Index that the volume of mobile data traffic in 2015 had grown by 15 times since 2010. The same report forecasts that global IP traffic will grow from 72.5 exabytes per month in 2015 to 194.4 exabytes in 2020, an annual compound growth rate of 22 percent.

In this chapter we identify the firms and employment that make up what we call the Hard Infrastructure layer of the internet. We use this term to distinguish it from Soft Infrastructure, where the proportion of software and service to hardware is much greater.

3.1 The Form and Function of the Hard Infrastructure

In the Hard Infrastructure layer of the internet we identify four functions required to operate the internet: manufacture of hardware, long range transmission of data, shorter range connectivity between data generators or transmitters and data stores or consumers, and the storage and routing of data in data centers. These four functions generate employment in firms that specialize in one of the functions, in firms that concentrate on one but perform others, and, increasingly, in firms that perform infrastructure functions but are integrated across the entire internet stack. In this latter case we have analyzed the firms in Chapter 7, Integrated Firms.

When the internet was commercialized in the late 1990s, a number of firms in the telecommunications industry pursued the transmission opportunity. They invested heavily to lay fiber optic cable across the United States, Canada, Europe, Asia, and the oceans that separated them. Transmission infrastructure was radically oversupplied for the first decade of this century, including at the time of the first of our studies of the ecosystem in 2008. Voice and dial-up modem transmission of data placed little demand on the infrastructure. Bandwidth-intensive services such as video and music streaming, software as a service, mobile broadband transmission among cellphone towers, and big data analytics, began to emerge during the second phase, which began in second decade of the century, and began to deliver slightly improved economic returns to the firms that had built the fiber infrastructure.

However, the pattern we shall report is one in which infrastructure firms struggle to command the profitability of other internet layers. Infrastructure employment is declining not because the infrastructure is shrinking (it is not, witness the remarkable increases in traffic just reported), but because firms that were classified as infrastructure just four

years ago have so changed their business models that we have had to classify them elsewhere.

Some have integrated into more profitable superstructure businesses, hoping to capitalize on proprietary claims on the internet traffic carriers. We treat them in a new chapter, Integrated Firms. Others have exploited a new pattern to the internet's infrastructure, one that depends on software and services more than hardware.

3.2 The Hard Infrastructure is Evolving

This new infrastructure is termed the 'cloud'. It contrasts with the trunk and branch form of the first phase, which comprised a trunk made up of an intertwined and cross-connected set of long-haul fiber transmission lines known as the backbone, and branches to distribute data to the ultimate users. The distinction between transmission and distribution functions is a common feature of the infrastructures of utilities such as electrical power, telephony, and water, explained by the fact that transmission trunks, because they carry over long distances, are expensive to build but inexpensive to operate, with few customers to bill, while the distribution branches are dense structures with many customers to serve and bill. In our 2008 and 2012 reports, mirroring this first phase, we classified employers into transmission and distribution groups. Transmission firms were then (and to an extent still are) those that transmitted data over long-haul (inter-city) and short-haul (within-city) distances. Transmission systems were commonly shared among firms, and the largest firms entered into transit-free peering arrangements with one another. Distribution firms were (and to an extent still are) firms organized by the connection technology—cable, phone, and wireless. They moved data from the transmission systems to household and business subscribers and were commonly not shared. Indeed, a single subscriber could have relationships with several dedicated distributors, such as a cable subscription, a wireless subscription to a mobile phone, and occasionally a subscription to link an automobile to the internet. In the 2008 and 2012 reports, the three functions of hardware, transmission, and distribution, mapped relatively well onto three kinds of employer: the big telecommunications firms (telcos) handling transmission, cable operators, smaller telcos and wireless operators handling distribution, and the manufacturers making hardware and equipment.

At the time of this study we are beginning to see the backbone-and-branch pattern of the last two decades give way to the more fluid pattern of the cloud. Three factors are at work in this evolution, disrupting the separation of transmission and connectivity and indeed beginning to disrupt the separation of infrastructure from consumer services.

First, as consumers have sought more than one way to connect to the internet, it was attractive for connectivity firms to organize by customer and geography, not by technology. Cable operators offered voice-over IP phone service, and wireless and cable modem

internet connectivity. Telcos entered the wireless and optical fiber markets and largely displaced internet connectivity over copper wire. The opening up of millimeter wave spectrum presents the prospect of wireless systems that can carry large volumes of data. Google is backing away from its roll out of fiber transmission, anticipating a wireless option with much lower installation costs. Several of the transmission firms now have significant connectivity businesses and as the two functions integrate, the backbone and branch pattern becomes less discernable.

Second, consumers began to use data in volumes too great for the backbone to handle with transit-free peering. They sought connection to high bandwidth content producers such as Netflix, YouTube, and Facebook, particularly at the times of day that used to be called prime time, when many homes viewed video. Distribution firms sought ways to move this data directly to their household subscribers to enhance their user experience and strengthen the loyalty of subscribers to them. These distributors would co-locate Netflix's data transmission services, for example, in their own data centers at no cost to Netflix, and moving traffic from long distance transmission services to distribution services. Thus far from paying transmission firms to carry their data, suppliers of content valued by households found that distributors would carry data flows at no cost in the interests of winning the loyalty of their customers. These so-called 'edge providers' became part of the fourth function mentioned at the start of this section, data centers.

Data centers have long been an element of the internet's infrastructure, but in the post-backbone era of the internet their function is more fundamental to the internet's infrastructure. They, whether in the form of giant server farms or tiny co-location facilities, are the physical expression of the idea of the cloud.

Data centers, enabling co-location of data generator firms and data distributors, give the internet infrastructure its new shape. In the last five years or so, particularly as a result of the growth of demand of data-intensive services such as streaming video, much of the internet's data is no longer transmitted on the backbone. Instead this data moves on the edge of the network, from data suppliers to distribution nodes and on to homes. In this report we use the term data centers to refer to the location of jobs in firms that supply these edge flows. The largest data processors, Amazon, Google, and Facebook own their own server farms, and large data center firms including Akamai, Equinix, Rack-space, and the European firm Interxion, locate at points of high retransmission demand. A third group fills regions of less dense demand, including EdgeConneX and Cloudflare.

3.3 Firms Respond to These New Forces

In just the years between our last study and this one, firms that were traditionally responsible for transmission and distribution have responded to the commodification of this work by integrating into consumer service and consumer services support. Verizon,

whose roots are in the phone company Bell Atlantic, acquired the consumer-facing firms AOL and Yahoo. Charter Communications and Cox followed similar paths. As we write, the telco AT&T, having acquired satellite distributor DirecTV, is attempting to win regulatory approval to acquire the content provider Time-Warner. And firms born at the consumer-facing end of the traditional internet structure such as Amazon and Google are integrating back into the infrastructure business. As noted earlier, we devote a chapter to these fully and partially integrated internet firms.

We will summarize employment in the Infrastructure Layer under the four function headings, commenting where appropriate on firms that cross the boundaries between functions.

3.3.1 Transmission

Two of the six firms classified as Transmission firms in 2012 are now analyzed in the Integration chapter because, although they still contribute to transmission, they have sought revenue opportunities elsewhere in the internet ecosystem. They are AT&T with the acquisition of DirecTV, and its bid for Time-Warner, and Verizon with the acquisition of AOL and the potential acquisition of Yahoo. Four others, Sprint, Level 3, Inteliquent and CenturyLink, remain substantially in transmission.

Three firms with limited previous investment in transmission, Alphabet (Google), Facebook and Microsoft, are now important elements of the transmission infrastructure, also analyzed in the Integration chapter. Their undersea fiber-optic cables create private¹¹ dedicated capacity that links the United States with Asia and Europe.

Our estimate for Transmission Providers is \$25.7 billion and 43,269 jobs.

Table 3.3.1: Transmission Providers

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Sprint	\$11,109	10,356
CenturyLink	\$9,768	23,465
Level 3 Communications	\$4,240	8,466
Cogent Communications	\$404	836
Inteliquent	\$233	166

¹¹ Finley, K. (2016). "Facebook and Google Will Stretch Internet Cable from LA to Hong Kong." *Wired*, Oct 12, 2016.

Note that this segment is smaller than in the 2012 report. The conclusion is not that transmission employment has declined, but that firms that supply transmission must seek profitable operations in adjacent markets and so, in the four years since our last study have come to be classified in different ways.

3.3.2 Connectivity

As data storage has transitioned from local storage on a firm's own servers to distributed storage on a widely dispersed, often global, network of data centers, connectivity's role in the internet's infrastructure has grown. Data once stored on disk and backed up onto tape is now often backed up, managed and stored on a variety of systems that range from disk to tape to public and private cloud storage services. The evolution has been driven by growth in the quantity of data used in businesses, in the declining cost of disk storage, and the demand for redundancy in data storage. Storage increasingly taxes the internet.

Connectivity firms provide some transmission, and transmission firms offer connectivity, so there is a degree of arbitrariness in the distinction we are making between the two, but our general rule is that firms listed here retail connectivity to much smaller clients than do the transmission firms, particularly households, and often sell it as a complement to more profitable services delivered on their pipes, such as cable television and wireless telephony, or to internet services such as email and spam protection. Where once connectivity was envisioned as an opportunity to become a portal with proprietary content, it is currently viewed as a near commodity.

Our estimate for Connectivity Providers is \$27.4 billion in revenue and 48,986 jobs.

Table 3.3.2: Connectivity Providers

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Cable Providers		
Charter Communications	\$3,583	4,958
Altice (formerly Cablevision Systems Corp.)	\$1,290	2,798
Mediacom	\$270	753
Shentel	\$44	94
Internet Access		
Windstream Holdings	\$3,418	7,307
Telephone and Data Systems	\$1,993	1,510
Zayo Group	\$1,508	1,606
EchoStar	\$1,347	1,885
Harris CapRock Communications	\$859	3,936
Cincinnati Bell	\$806	2,243
Birch Communications	\$680	1,360
Consolidated Communications	\$471	1,083
Gogo	\$501	1,073
GCI (General Communications, Inc.)	\$400	969
DISH Network	\$439	545
Hawaiian Telcom	\$149	149
Novatel Wireless	\$140	600
FTC	\$35	100
HTC (Horry Telephone Cooperative)	\$64	64
Mobile Internet Access Providers		
T-Mobile U.S.	\$6,501	13,095
U.S. Cellular	\$2,674	3,200
TracFone Wireless	\$149	145
Iridium Communications	\$30	30
iPass	\$24	83

In 2012, we counted Connectivity as responsible for 91,000 employees. In 2016 we find only 49,000. However, another 45,000 workers, more than the entire difference between 2012's employment and 2016's, is accounted for by the fact that we moved Comcast, Cox Communications, and Time Warner, out of Hard Infrastructure and into other layers, because acquisitions and revenue growth in non-connectivity segments of their businesses changed our assessment of their core businesses. In sum, in this segment as in transmission, the workers have not been lost, but their employers have pursued broader strategies and we have had to classify them differently.

3.3.3 Hardware

Internet-related hardware comprises computers, servers, storage devices, routers, switches, desktop and laptop personal computers, wireless access devices, fiber optic cable, and broadband wireless equipment, among other components. Over the years there has been consolidation among hardware suppliers so that today hardware is one of the most concentrated of the internet segments.

There has been a shift in the last decade from manufacture of computing equipment to data handling, switching, and storage, with the growth in data centers, the cloud, and the shift from a linear to a networked structure. For example, the 2015 annual report of Cray Inc. notes that among its customers, "Data... and capacity needs are growing much faster than computational needs." At the same time personal access to the internet has migrated rapidly from machines configured for computing to mobile devices configured for communication, transforming, for example, Apple from a low share manufacturer of computers to the global leader by revenue in the mobile devices market, and coming at the expense of desktop manufacturers.

Demand for mobile devices has been driven in part by consumers who use them for video viewing or retransmission of video streams to widescreen monitors, under the general label of over-the-top (of the cable provider) services. This demand is fed by video supply from new media companies such as Netflix, Hulu, Google (YouTube), Amazon (Amazon Instant Video) and Apple (iTunes) whose employment is captured in other chapters of this report.

U.S.-based employment in this sector is more engaged in product design, software, marketing, sales and service than manufacturing. For example, the U.S. has lost employment to Asian factories (e.g. half of the 23,000 employees of CommScope are located outside the U.S.). Our estimates of the proportion of employment due to the internet are sensitive to the revenues of their lines of business, and in some cases we received guidance from people in the companies or industries. Our estimates are conservative.

Our estimate for Hardware is \$159.3 billion and 196,905 jobs.

Table 3.3.3: Hardware

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Apple	\$74,478	39,600
Cisco Systems	\$26,690	36,222
Qualcomm	\$18,202	23,760
Dell	\$18,013	48,034
NetApp	\$3,067	6,653
Ericsson	\$2,768	4,982
Juniper Networks	\$2,279	4,529
CommScope	\$1,910	10,350
F5 Networks	\$1,440	3,134
Seagate	\$1,350	1,880
Supermicro	\$1,161	420
Avaya	\$1,040	2,984
Brocade	\$566	1,160
Nimble Storage	\$300	1,000
Acer America	\$256	120
Extreme Networks	\$239	583
Ubiquiti Networks	\$200	180
Ruckus Wireless	\$179	480
Harmonic	\$160	541
Pure Storage	\$134	650
Digi International	\$106	444
Cray	\$50	20
CSP Embedded Computer	\$45	86

Hardware employment rose from 148,000 in 2012 to 196,000 this year. This growth is despite Hewlett Packard (23,000 employees) and IBM (36,000 employees) moving to the next chapter because they now do more work in consulting than in manufacturing. The last four years of the evolution of the internet ecosystem have favored mobile equipment manufacturers like Apple and Qualcomm and those like Cisco that have benefited

from growth in server sales, not mainframe computers. Manufacturing employment has held up well overall.

3.3.4 Data Centers

As discussed earlier in this chapter, the infrastructure of the internet is gradually migrating from a linear data flow pattern to a networked pattern, where data travels as much among firms on the periphery of the internet as on the backbone. The change shows up in employment. In 2012 we identified 5,500 people working at co-located data centers. In 2016 we find three times as many, 15,000 employees, and this number excludes employees in acquired data centers such as those at working at Savvis, which since 2012 became part of CenturyLink and are counted in its employment total.

Our estimate for Data Centers is \$6.1 billion and 15,233 jobs.

Table 3.3.4: Data Centers

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Equinix	\$1,460	3,782
Akamai	\$1,434	3,727
Rackspace	\$1,076	3,999
DuPont Fabros Technology (DFT)	\$452	113
CyrusOne	\$399	400
CoreSite	\$333	391
Internap	\$318	650
Quantum	\$314	900
Box	\$248	1,123
IO	\$99	148

Chapter 4: Soft Infrastructure

In distinguishing between Hard Infrastructure and Soft Infrastructure we follow the distinction drawn in prior studies. Hard Infrastructure refers to activity that is heavy on fixed assets, and Soft Infrastructure refers to software and services built on the Hard Infrastructure to make it technologically feasible to perform commerce online. We should also explain here the distinction between the firms in the Soft Infrastructure layer and its neighbor, the Consumer Services Support layer. Firms in the Soft Infrastructure layer offer general-purpose software and services, whose value appeals at least in principle to all upstream firms regardless of industry and without needing to be customized to a particular end user. Firms in the Consumer Services Support layer perform services that must be tailored to particular clients. The distinction is not perfect: ad agency media firms, located in the Consumer Services Support layer, do work that might be classified in the Soft infrastructure layer, while firms like Gartner and Forrester, in the Soft Infrastructure layer because they sell general reports, also do custom work. We maintain the distinction to follow the chapter structure of earlier reports.

Soft Infrastructure firms are either predominantly service providers or software vendors.

4.1 Service Providers

4.1.1 Information Technology Consulting

A very substantial industry performs a range of services that connect firms into the Hard Infrastructure of the internet. IBISWorld¹² notes that because capital requirements are low and many clients are quite small, the majority of these enterprises are small. Some are one-person outfits and many are independent. At the same time there exist very large firms designed to serve global clients, and others to serve very large U.S. military and government agency clients. IBISWorld claims from evidence from the Bureau of Labor Statistics that there are about 440,000 firms and sole proprietorships in this sector, and that it is one of the most resilient elements of the U.S. economy. We analyze the three kinds of consultant in three separate sections.

4.1.1.1 Enterprise IT Consulting

These firms serve the largest of clients, matching the footprints of their offices to the globally dispersed offices of their clients. Many of the relationships are several decades old, originating long before the internet in the complex multi-year systems integration projects required to implement enterprise resource planning software. While such projects continue, particularly in finance, insurance, and supply chain firms, innovations such as cloud services and big data analytics are creating demand for a different kind of inter-

¹² IBISWorld Industry Report 54151, IT Consulting in the U.S., September 2016

net consulting by the largest global enterprises. The innovations often originate in small venture-funded startups offering so-called ‘point solutions’ (specific narrow applications,) which, if they thrive, are acquired by enterprise IT consultants to give the startups access to the enterprise market. And instead of finding the decision makers in this market among corporate IT departments, they find them in divisions such as marketing and operations departments. In response, these enterprise IT consultants reposition as marketing and operations consultants. Thus Oracle acquired Datalogix and BlueKai (small startups in the 2012 study) and created the Oracle Data Cloud and Marketing Cloud, broadening its consulting authority to include marketing analytics and programmatic advertising. And IBM—by internal development of the Watson analytic engine and by acquisition of data suppliers such as the Weather Channel—has so evolved the nature of its consulting services that it was listed by *Advertising Age* in 2015 as the world’s ninth largest advertising agency.

Our estimates of the proportion of the revenues of these consulting firms that are due to the internet required careful separation of internet IT services from services that are independent of the internet. We relied where possible on segment information reported in 10-K filings, and, where not, on analogies with firms where filings or interviews gave us a basis for the distinction.

Our estimate for Enterprise Consulting is \$46.9 billion and 210,406 jobs.

Table 4.1.1.1: Enterprise Consulting Revenues and Employment

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
IBM	\$16,497	55,000
Hewlett Packard Enterprise	\$10,846	19,483
Oracle	\$5,344	19,617
Deloitte	\$3,391	15,225
Accenture	\$3,197	36,773
Cognizant	\$1,952	34,853
Capgemini North America	\$1,868	7,215
SAP America	\$1,280	2,778
CGI	\$740	6,065
FIS	\$495	4,125
Computer Sciences Corporation (CSC)	\$459	3,805
Unisys	\$422	3,217
Dimension Data	\$405	2,250

4.1.1.2 Public Sector and Military Systems Integration

IT consultants, particularly where the internet is concerned, often specialize in either military or government work because they need security clearances or because the work is so specialized as to demand single-minded focus.

Our estimate for Public Sector and Military Systems Integration is \$4.03 billion and 17,429 jobs.

We identified the following firms as working exclusively for such clients.

Table 4.1.1.2: Public Sector & Military Systems Integration

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
CACI International	\$1,498	7,960
Leidos	\$942	3,600
CSRA	\$574	2,430
Raytheon	\$573	1,504
ManTech International Corporation	\$233	972
NCI	\$67	400
Mercury Systems	\$54	193
LGS Innovations	\$50	130
American Systems	\$45	240

4.1.1.3 Other Internet IT Consulting

We enumerated a number of firms that did not belong in either of the previous two categories, but on the evidence that there were in excess of 400,000 IT consultants, we chose to estimate an 'all other' category. IBISWorld estimated that the revenues of the entire IT Consulting industry were about \$386.9 billion. Their study enumerated the four largest in the industry, which were, obviously, also individually enumerated by us. We could therefore see the proportion of IT consulting revenue that we determined to be internet IT consulting for those firms. We made the assumption that internet consulting was a higher proportion of revenue in enterprise consulting firms than in smaller, particularly sole proprietor firms (web design being separately tracked) and arrived at an estimate of about \$200 billion for the U.S. internet consulting industry. From that number we subtracted all individually enumerated firms, arriving at the "all other" revenue given in Table 4.1.1.3. It is a large number, but it is where a large part of the design of work suitable for migration to the internet is being done.

Our estimate for Other Internet IT Consulting is \$148.8 billion and 331,966 jobs.

Table 4.1.1.3: Other Internet IT Consulting

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
IGATE	\$1,143	3,348
SAIC	\$1,071	3,000
Syntel	\$872	22,083
BT Americas	\$546	3,500
Verint Systems	\$519	1,890
Virtusa	\$378	148
Datalink	\$361	298
Xerox	\$330	2,626
Computer Task Group (CTG)	\$272	2,723
Collabera	\$264	4,200
General Datatech (GDT)	\$242	264
Guidewire Software	\$231	965
AMAX Information Technologies	\$217	180
Bain	\$177	439
VisionIT	\$170	792
Datapipe	\$150	378
Telos	\$121	521
Progress Software	\$113	533
Globecomm	\$106	165
Workiva	\$102	785
Veritas	\$62	100
Edgewater Technology	\$47	200
Ciber	\$19	148
Deltek	\$17	80
All Other	\$141,300	282,600
FireEye	Included in "All Other"	
Fujitsu United States	Included in "All Other"	

Hitachi Data Systems (HDS)	Included in "All Other"
Idhasoft	Included in "All Other"
Infor	Included in "All Other"
Iron Bow Technologies	Included in "All Other"
Kofax	Included in "All Other"
Mentor Graphics	Included in "All Other"
Perficient	Included in "All Other"
PTC	Included in "All Other"
SHI International	Included in "All Other"
TeleTech	Included in "All Other"
Veeva Systems	Included in "All Other"
Verisk Analytics	Included in "All Other"

4.1.2 Researchers

Firms in this category produce industry-specific research and competitive analysis reports for companies in the technology industry, appealing primarily to those holding positions such as CIO, CTO, and CMO. Custom research and consulting is also usually on offer from these firms, as well as conferences, workshops, seminars, and webinars aimed at keeping industry personnel up to date with the latest developments in their respective areas of endeavor, and to assist executives with IT-related decision making.

Our analysis examined the top three providers of such services: Gartner, Forrester, and IDC Technologies. Gartner is the industry leader, with approximately 10,000 client organizations and global revenues of over \$2 billion. Forrester reported global revenue of \$313.7 million in 2015 and IDC Technologies reported \$156.3 million. There are many newer entrants, such as Cupertino's Constellation Research, which specializes in disruptive technologies and early adopter markets, and Seattle's RedMonk, whose analysts work directly with developers. An allowance equal to the sum of the enumerated firms is made.

Our estimate for Researchers is \$422 million and 1,722 jobs.

Table 4.1.2: Researchers

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Gartner	\$130	448
Forrester	\$72	311
IDC Technologies	\$9	102
All other	\$211	861

4.1.3 Domain Registry Services

Previously two discrete lines of business, domain registry and web hosting services are now often provided by a single entity. Domain registry is the business of selling domain names, or internet addresses, to organizations and individuals, while web hosting is the business of hosting websites on the internet, i.e. providing server space and connectivity so that individual websites can be accessed on the internet. Both or either of these lines of business may also include email hosting, website design, and data hosting services.

Notable changes in this industry include the launch of firms such as Squarespace, Weebly, and Wix, which combine domain registry and hosting with build-your-own website services, providing one stop shopping for individual proprietors and small to medium sized businesses setting up a web presence.

Domain registry is estimated to be a \$1.8 billion annual business in the U.S.¹³, with the top two firms accounting for over 60 percent of sector revenues. Web hosting is estimated to be responsible for about \$6 billion in annual revenues in the U.S. and is another example of a very long tail business, with the top four firms accounting for just under 10 percent of sector revenues and over 15,000 firms making up the other 90 percent of the market.¹⁴

Our estimate for Domain Registry Services is \$9.5 billion and 30,849 jobs.

¹³ IBISWorld Industry Report, "Web Domain Name Sales in the U.S.," November 2016

¹⁴ IBISWorld Industry Report, "Internet Hosting Services in the U.S.," April 2015

Table 4.1.3: Domain Registry Services

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Domain Registry		
GoDaddy	\$805	2,381
Verisign	\$639	611
Web.com Group	\$543	2,200
Neustar	\$393	927
Web Hosting		
Endurance International Group	\$395	1,381
1&1 Internet	\$350	1,750
Verio	\$93	206
Squarespace	\$83	373
Hostway	\$79	173
Limelight Networks	\$72	258
Wix.com	\$53	354
Bluehost	\$43	175
Weebly	\$7	60
All Other Web Hosting	\$6,000	20,000

4.2 Software Vendors

4.2.1. Analytics Software

This segment is largely the domain of companies that used to fall under the moniker of Business Intelligence (BI). Today's version of BI takes the form of tools, applications, dashboards, and visualization software that analyze raw, unstructured data housed within an organization.

The goal of these systems is to mine for insights so that firms can act, rather than react, and in turn remain competitive in their sector. Over the past decade there was considerable startup firm activity in this sector, with multiple acquisitions from firms such as IBM, Microsoft, SAS, and SAP. We analyze the largest U.S. firms in this sector that have not yet been acquired.

Our estimate for this sector is \$941 million and 3,596 jobs.

Table 4.2.1: Analytics Software

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Splunk	\$501	1,080
Cloudera	\$215	1,260
Tableau Software	\$81	375
Varonis	\$71	530
Qlik	\$49	181
Hortonworks	\$24	170

4.2.2 Customer Relationship Management Software

Customer Relationship Management (CRM) software helps firms manage interactions between a company and its customers, as well as interactions with potential customers and clients. The largest providers of CRM software are Salesforce, SAP, Oracle, and Microsoft, who together account for almost 60 percent of the market. As these firms are analyzed in other categories of this report we do not include them in our calculation in this section.

Our estimate for this sector is \$4.3 billion and 14,701 jobs.

Table 4.2.2: CRM Software

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
West	\$1,130	3,219
Sitel	\$878	3,456
Sykes	\$784	3,135
Synchronoss	\$526	1,724
Genesys	\$319	1,313
Convergys	\$215	215
LivePerson	\$160	664
Five9	\$120	375
CSG International	\$95	414
Stefanini	\$30	160
Fusion	\$10	26

4.2.3. Network Security

This segment is comprised of firms that create software that ensures security on online networks. Examples of such software include anti-virus software, firewall software, encryption software, and malware and spyware removal software. It is estimated to be an \$11 billion market, made up of 432 firms, of which one firm, Symantec, claims just under 14 percent market share. The top three firms account for 25 percent, and the 'all other' segment makes up the remaining 75 percent.¹⁵ We assume \$3 billion of this revenue is controlled by firms not integrated into large vendors analyzed elsewhere in the report.

One of the more significant changes in this industry is the 'bring your own device' environment in which many firms now operate, with employees using their own phones, tablets, and laptops in addition to company-issued devices and machines. This has led to new sources of threat to enterprise security systems, and startups and smaller firms comprising 75 percent of the 'all other' firms in this category have emerged to respond.

In turn there have been acquisitions, as large players found they could more quickly integrate new features and grow user bases by acquiring, rather than creating. Examples of such activity include Symantec's acquisitions of MessageLabs, Odyssey Software, Nukona, LiveOffice, PasswordBank, and Blue Coat Systems, which together provided the firm with offerings in messaging security, data cloud security, mobile security, password security, and cybersecurity. Note that one of the top firms in this segment, McAfee, has been fully integrated in the software offerings of Intel since 2015 and its revenues and employee count therefore appear under Intel's in the respective section of this report.

In the aftermath of the massive October 2016 DDoS attack on Dyn, which took down core internet services such as Twitter, Spotify, SoundCloud, and Reddit, security experts expect the size and frequency of such attacks to continue. According to one such expert, Brian Krebs, "the size of these DDoS attacks has increased so much lately thanks largely to the broad availability of tools for compromising and leveraging the collective firepower of so-called Internet of Things devices—poorly secured internet-based security cameras, digital video recorders (DVRs) and internet routers."¹⁶ Furthermore, the proportion of corporate cyber-attacks said to succeed is now one in three.¹⁷

Our estimate for Network Security is \$6.4 billion and 17,771 jobs.

¹⁵ IBISWorld Industry Reports, Security Software Publishing, U.S., April 2016

¹⁶ <https://krebsonsecurity.com/2016/10/ddos-on-dyn-impacts-twitter-spotify-reddit/>

¹⁷ <https://www.bloomberg.com/news/articles/2016-11-02/accenture-says-one-third-of-corporate-cyber-attacks-succeed/>

Table 4.2.3: Network Security

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Symantec	\$1,585	4,842
Fortinet	\$636	2,531
Barracuda Networks	\$222	1,029
Gigamon	\$222	357
Proofpoint	\$217	986
Intralinks	\$166	558
Imprivata	\$119	452
Qualys	\$115	357
Rapid7	\$83	576
GlobalSCAPE	\$20	83
All other independent firms	\$3,000	6,000

4.2.4. Video Software

Though the consumer internet began its life primarily as a service transmitting text and still images it is now primarily a pipe delivering high bandwidth video content. Digital native publishers such as Mashable, Vox, and Mic feature video as a matter of course on their sites and apps, while legacy news, information, and entertainment companies operating online are increasingly finding that they too are in the business of delivering video, and do so using internet protocols. In 2015 global video traffic delivered on the internet accounted for 70 percent of all consumer internet traffic, and networking hardware company Cisco estimates this number will rise to 82 percent by 2020.¹⁸

Consider that the amount of video uploaded to YouTube, a single provider, has rocketed from six hours per minute around the time of the acquisition by Google ten years ago to 500 hours per minute at the end of 2015, up from 300 hours per minute at the end of 2014.¹⁹ Other providers of video backbone on the internet include consumer brands such as Amazon, and enterprise providers such as Akamai and Limelight, whose revenues and employment are included in our Hard Infrastructure category.

¹⁸ <http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html>

¹⁹ <http://tubularinsights.com/hours-minute-uploaded-youtube/>

Therefore, our analysis of this category is limited to two firms: Brightcove and Synacor. Brightcove provides a cloud-based platform on which broadcasters such as A&E and Lifetime host their video content, along with thousands of digital publishers globally. Synacor also works with broadcasters such as CNN, as well as with cable and broadband providers.

Our estimate for Video Software is \$182 million and 612 jobs.

Table 4.2.4: Video Software

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Synacor	\$105	284
Brightcove	\$77	328

4.2.5 All Other Internet Software

Here we review four software sectors that collectively account for \$10 billion in revenue and employ 33,000 people. The first sector, database technology, contains some large software firms that are not yet relying on the internet for more than 25 percent of their software delivery. Examples are Red Hat, Linux’s leading open source operating system supplier, and Teradata, database supplier to some of the largest data warehouse-dependent corporations. The internet is, today, not yet a major delivery platform for either, though both have announced cloud-based initiatives for 2017.

The internet software sector supplies tools for managing networks, databases, applications, storage, security, and other systems across mainframe, mobile, and cloud computing environments. The sector includes broad scope vendors such as CA Technologies and many specialists.

We use the term logistics software to cover a number of vendors who automate the management of manufacturing, distribution, customer relationships, and financial applications. To the extent that these vendors emphasize cloud-based subscription services, we count them as part of the internet ecosystem.

Finally firms in the network access software sector create software that enables remote work and collaboration, most of which rides on the internet.

Our estimate for All Other Internet Software is \$10.6 billion and 33,639 jobs.

Table 4.2.5: Database, Internet, Logistics, and Network Access Software
(All Other Internet Software)

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Database Software		
Red Hat	\$639	2,742
Teradata	\$354	1,582
InterSystems	\$81	245
Lionbridge	\$58	618
Internet Software		
CA Technologies	\$1,279	3,495
RealPage	\$469	3,640
Epicor	\$423	1,000
EPAM Systems	\$411	1,016
BMC Software	\$330	930
Broadsoft	\$279	584
Demandware	\$152	707
Jive Software	\$144	530
Commvault	\$69	276
VASCO Data Security	\$23	51
RealNetworks	\$10	46
Logistics Software		
CalAmp	\$233	407
QAD	\$111	567
SciQuest	\$105	510
TIBCO Software	\$86	278
JDA Software	\$52	465
Tangoe	\$21	234
SPS Commerce	\$18	118

Network Access Software

Citrix Systems	\$1,783	5,163
Riverbed	\$956	2,241
NETSCOUT Systems	\$781	2,571
NETGEAR	\$780	578
j2 Global	\$632	1,411
inContact	\$195	890
LogMeIn	\$180	664

Chapter 5: Consumer Services Support Layer

Companies that offer customized solutions to firms in the Consumer Services chapter are analyzed in this chapter. Their products are often accompanied by professional services to tailor the solution for the client. However, the distinction between Soft Infrastructure and Consumer Services Support is not clear-cut. IT consulting firms such as Forrester and Gartner sell general reports that appeal to upstream firms regardless of industry, but also offer custom research for clients.

We analyze revenue and employment in the Consumer Services Support layer of the internet in two parts: Marketing Support and Operation Support. Marketing Support refers to the set of firms that help facilitate and promote the flow of commerce, entertainment, information and social interaction over the internet. Operation Support refers to firms that provide solutions that enhance customer productivity or enable them to deliver a good or service they could not otherwise do efficiently. The growing importance of the internet is evident for firms in the Consumer Services Support Layer, which have increasingly delivered their solutions through the Software as a Service (SaaS) model, in which the software is only accessible through the cloud. In addition, a number of firms exist whose business relies heavily on the internet to download applications or data onto local servers. For instance, MSCI Inc. delivers investment benchmark indexes to institutional investment firms, in some instances downloaded on a daily basis, but hosted locally, often for security reasons. Even if they are used and stored natively, digital products and services created by these companies rely on the internet for delivery.

In our prior study, search engines and portals accounted for over 25,000 internet employees in the Consumer Services Support layer. The search giant Google's restructuring and re-naming to Alphabet sought to provide more transparency as the scope of its business expanded. Alphabet now resides in the Integrator layer of the internet ecosystem as the company has made a foray into broadband services (Google Fiber), home automation (Nest), mobile operating systems (Android), and has over 15 mobile applications with more than one billion downloads.²⁰ In 2015, Verizon acquired AOL and is in the process of completing its acquisition of Yahoo, which would help to add scale to the company's search and digital content properties.

5.1 Marketing Support

Information may want to be free, as has been said since the early days of the personal computer revolution, but the reality is that the internet's information resources are avail-

²⁰ https://en.wikipedia.org/wiki/List_of_most_downloaded_Android_applications

able largely because of advertising. Advertising may appear in the form of banner, display, or search ads, or as is the case more recently, as content marketing or native advertising, which provides informative and/or entertaining brand-supported content to users in lieu of conventional ads.

The firms and technologies that make these services available—advertising agencies, ad networks and exchanges, data and analytics companies, and measurement firms, as well as self-employed web programmers, designers, and writers—are examined in this section on Marketing Support.

One of the outcomes of an always on media environment, accessible to users through phones, tablets, laptops, desktops, and display screens is a fragmentation of both audiences and attention. As a result, firms specializing in delivery of content, services, and technologies, have proliferated. Furthermore, with every click, swipe, pause, and share made visible and trackable, clients have an expectation of granular, often real time, information about consumers, as well as performance-based pricing from agencies.

The tables that follow in this section will break out the firms that inhabit both the traditional terrain of ad agencies and the newer firms in such sectors as 'ad tech,' which is short for advertising technology, programmatic selling and buying, data and analytics, and CRM (Customer Relationship Management).

With the rapid pace of change in this sector, merger and acquisition activity has been occurring at a substantial volume. In the first six months of 2016, for example, there were 204 deals valued at \$6.8 billion, compared to 85 deals valued at \$2.1 billion in the same period of 2015.²¹

Other notable changes in this sector since the time of our last report include:

- Digital ad spending meeting traditional ad spending for the first time, with each accounting for 36 percent of budgets.²²
- Mobile ad spending now growing at an annual rate of 45 percent²³, set to surpass desktop ad spending by 2017.²⁴
- Two-thirds of digital display ad spending is now taking place by way of automated, programmatic systems.²⁵

²¹ <http://adage.com/article/agency-news/digital-properties-dominated-mergers-acquisitions/305397/>

²² <https://www.emarketer.com/Article/Digital-Ad-Spending-Surpass-TV-Next-Year/1013671>

²³ <https://www.emarketer.com/Article/US-Digital-Ad-Spending-Surpass-TV-this-Year/1014469>

²⁴ <http://fortune.com/2016/06/20/mobile-internet-ad-spending-desktop/>

²⁵ <http://www.emarketer.com/Article/More-Than-Two-Thirds-of-U.S.-Digital-Display-Ad-Spending-Programmatic/1013789>

5.1.1. Advertising Agencies: Full Service

The full service agency sector has remained more or less stable since the time of our last report. It is one of many industries with a long tail distribution, with a reported 66,291 businesses in 2015 and the top four accounting for about 35 percent of revenues.²⁶

These top firms are generally holding companies, housing a variety of subsidiaries with specialties in specific areas. For example, WPP, one of the largest firms analyzed in this section, is the parent to Grey, Ogilvy & Mather, Young & Rubicam, J. Walter Thompson, AKQA, and others. Similarly, Interpublic is the parent firm to Campbell Ewald, Deutsch, Hill Holliday, McCann, R/GA, and others.

Our estimate for Full Service Advertising Agencies is \$11.75 billion and 52,953 jobs.

Table 5.1.1: Advertising Agencies: Full Service

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Omnicom Group	\$2,797	13,842
Publicis North America	\$2,763	11,936
WPP	\$2,439	8,851
IPG	\$1,191	5,294
Dentsu Aegis Network	\$442	3,882
All Other General Full Service Agencies	\$2,116	9,148

5.1.2 Digital & CRM Vendors

Concentration in this sector of Digital & CRM vendors is similar to that in the sector of full service agencies, with a small number of firms accounting for the bulk of revenues.²⁷

Our estimate for Digital & CRM Vendors is \$13.02 billion and 53,733 jobs.

²⁶ IBISWorld Report "Advertising Agencies in the U.S.," September 2016

²⁷ IBISWorld Report, "Digital Advertising Agencies in the U.S.," November 2015

Table 5.1.2: Digital & CRM Vendors

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Salesforce.com	\$4,667	13,300
Adobe Systems	\$2,446	6,269
Alliance Data's Epsilon	\$1,169	3,822
Dun & Bradstreet	\$459	1,403
Merkle	\$303	2,363
Constant Contact	\$367	1,120
Quotient Technology	\$237	553
Vivial (formerly Berry Company/Local Vox)	\$188	750
Marketo	\$177	804
Cision (formerly Vocus)	\$171	1,200
RhythmOne (formerly Blinkx)	\$167	316
Harte Hanks	\$152	1,200
HubSpot	\$155	960
MaxPoint Interactive	\$140	395
Dialog Direct	\$131	2,250
Gainsight	\$130	250
Bazaarvoice	\$128	484
Pegasus Solutions	\$117	699
Gyro	\$117	300
Tapjoy	\$100	500
Defy Media (Alloy Digital + Break Media consortium)	\$100	370
Martin Software	\$73	308
Sprinklr	\$50	550
TechTarget	\$47	612
All Other Digital & CRM	\$1,234	12,955

Whereas the traditional advertising agency world examined above has historically been based on a combination of skill, reputation, and relationships, digital agencies bear the additional burden of having to keep up to date with the latest technological devel-

opments and consumer behaviors associated with new software, platforms, and user experiences.

The growth of digital and mobile advertising noted above, with the former now accounting for 36 percent of total ad budgets and the latter increasing by 45 percent year-over-year, has led to the considerable growth of this industry segment.

The formidable amount of content production and consumption online, as well as its complexity across devices and platforms, has led to the generation of an unprecedented amount of data, sometimes referred to as “big data.” One characterization of big data is with the 3V’s: volume, variety, and velocity. Making this data intelligible and useful to industry is a sub-industry that has arisen, with firms creating a variety of tools and services with which brands and agencies can derive insights from these new locations of activity.

5.1.3 Online Ad Networks & Exchanges

Today’s media landscape is a world of content distributed across millions of websites, apps, and platforms, as opposed to the relatively small number of print, broadcast, and physical outlets available for advertising placement in the pre-internet and early internet worlds.

As a way to manage the volume of inventory on the supply side (publishers), and the demand side (advertisers), ad networks and ad exchanges emerged. The ad networks function as a kind of agent for publisher inventory that is made available for sale to advertisers, while the ad exchanges are technology platforms that create an open marketplace in which advertising space is bid upon and purchased, and is generally done by automated systems, in which case it is referred to as ‘programmatic’.

Our estimate for the U.S. revenues and jobs in this category is \$2.9 billion and 3,788 jobs.

Table 5.1.3: Online Ad Networks & Exchanges

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
MediaMath	\$800	375
Exponential	\$600	650
iAD ²⁸	\$341	195
Rocket Fuel	\$337	755
AppLovin	\$234	115
PubMatic	\$130	650
Tremor	\$174	335
YuMe	\$148	259
TubeMogul	\$146	454

5.1.4 Measurement & Analytics

This segment is made up of firms whose focus is the measurement of broadcast and digital audiences.

Some of these firms, e.g. Nielsen, offer solutions via subscription only for industry while others make consumer versions which are accessible online with a limited feature set available without a subscription. New developments in this sector include cross-device attribution and real time and cloud-based tools that make performance indicators available on demand for agencies and enterprise.

Our estimate for Measurement & Analytics is \$778 million and 4,272 jobs.

Table 5.1.4: Measurement & Analytics

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Nielsen	\$415	2,888
comScore	\$258	904
Quantcast	\$105	480

²⁸ Apple, iAd's owner, discontinued the selling and creation of iAd units in mid-2016, ceding the work to publishers. We assume that the revenue and employment shifted to different entities, but did not disappear.

5.2 Operation Support

5.2.1. Financial Services Support

The companies in this section provide software to support digital banking and the investment management industry. Robust growth in mobile banking, facilitated by expanding smartphone penetration and enriched functionality, was a key driver of the financial support services layer. In a 2011 U.S. Federal Reserve survey, 22 percent of mobile phone users with bank accounts had used mobile banking services in the previous 12 months; in the 2015 survey, this number reached 43 percent.²⁹

Spending on IT services has grown to address the needs of digital banking and payments such as enhanced digital security. Companies like Fiserv and ACI Worldwide provide a suite of software to support online banking and intermediaries involved in the global payments value chain. The investment industry is seeing traditional back office functions move to a software-as-a-service model. Some of the latest integrated software platforms help with asset allocation decisions, reporting, and billing and can improve service levels while lowering costs.

Our estimate for Financial Services Support is \$2.2 billion and 7,569 jobs.

Table 5.2.1: Financial Services Support

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Fiserv	\$741	3,102
MSCI	\$519	964
Investnet	\$388	999
ACI Worldwide	\$232	897
Bottomline Technologies	\$193	876
SS&C Technologies	\$171	731

5.2.2 E-learning Support

E-learning Support refers to a segment of companies that allow schools to deliver or manage learning through the internet. We estimate internet revenue of \$0.8 billion and 4,656 individuals employed in the sector, which is comprised primarily of two types of companies: Online Program Management (OPM) and Learning Management Systems (LMS).

²⁹ <https://www.federalreserve.gov/econresdata/consumers-and-mobile-financial-services-report-201603.pdf>

OPMs such as 2U, HotChalk, and The Learning House enable schools, often post-secondary institutions, to offer instructor-led classes online. Through a web-based platform, instructors can give lectures, lead group discussions, and display learning materials to a virtual audience. OPMs offer bundled services—which include a core platform, technology support, content development and marketing to prospective students—or unbundled services to help institutions meet each program’s specifications. Virtual learning allows universities to increase enrollment profitably without the cost burdens imposed by physical infrastructure and other overhead; it has gained wider acceptance and trust amongst employers over the quality of online programs. A recent survey by Eduventures, an education-focused research firm, found that 350 U.S. universities are engaged in OPM partnerships in the U.S. and this number should continue to grow supported by universities’ pursuit of additional streams of income.³⁰

An LMS is a cloud-based software application that provides a centralized platform to store and access education materials, deliver assessments, and track a student’s learning progress. A LMS also simplifies administrative functions like course registration and attendance metrics, and can capture and analyze data on the efficacy of digital content and user engagement. Blackboard, an incumbent firm offering a leading LMS, expanded its workforce by 30 percent since our last study. New entrants such as Instructure—with its branded LMS ‘Canvas’—are gaining momentum among reputable institutions of higher learning. Harvard University, for example, recently transitioned from its internally developed, decade old, LMS ‘iSites’ to a ‘Canvas’ solution. In addition to the post-secondary space, there are countless innovative K-12 LMS solutions, including functions to engage parents on the platform, which have attracted large user bases where monetization is not a strategic objective. ClassDojo, a leading K-12 mobile LMS app, was founded in 2011 is helping to improve teacher, student and parent communication and is actively used in two out of every three U.S. schools.³¹

Our estimate for E-learning Support is \$799 million and 4,656 jobs.

Table 5.2.2: E-learning Support

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Blackboard	\$534	2,340
2U	\$150	904
Instructure	\$69	725
HotChalk	\$12	400
Learning House	\$34	287

³⁰ <http://monitor.icef.com/2015/10/private-partners-helping-to-drive-growth-of-us-higher-education-online/>

³¹ <https://www.classdojo.com/press/>

5.2.3 Travel Services Support

Employment in Travel Services Support is primarily comprised of individuals who work for Global Distribution Service (GDS) companies such as Sabre and Travelport. GDS facilitates travel commerce by connecting travel providers, such as airlines and hotel chains, with offline travel and online agencies, such as Priceline and Expedia, and other travel buyers by displaying inventory, prices, and availability from travel suppliers allowing consumers to purchase that content through the marketplace. Growth of the GDS industry is bolstered by tailwinds from rising air travel—the International Air Transport Association, a trade association of the world’s airlines, forecasts global airline passenger growth of 3.7 percent per annum over the next 20 years and North America to grow 2.8 percent over a similar time frame³²—but they also face headwinds from the rise of meta-search travel websites and airlines promoting direct bookings.

Our estimate for Travel Services Support is \$1.2 billion and 1,906 jobs.

Table 5.2.3: Travel Services Support

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Travelport Limited	\$755	315
Sabre Corporation	\$455	1,399
Delta Technologies	\$15	192

5.2.4 Healthcare Information Solutions

National healthcare spending is a large sector of the U.S. economy, accounting for \$3 trillion in annual spending, and healthcare IT spending currently represents two percent of this sum.³³

Electronic health records (EHR) form the backbone of healthcare information solutions. EHRs are digital versions of a healthcare patient’s paper charts. Federal legislation—as part of the American Recovery and Reinvestment Act of 2009—created incentives to help do away with inefficient paper-based record keeping practices and support a wave of EHR platform adoption since our last study. Major beneficiaries include the companies Cerner, Nuance, and Epic, who together comprise about 85 percent of the hospital EHR market. As comfort with storing personal information in cloud is growing, many of

³² <http://www.iata.org/pressroom/pr/Pages/2016-10-18-02.aspx>

³³ <https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/nationalhealthexpenddata/nhe-fact-sheet.html>

the companies in the EHR industry have been shifting their software platforms from on premise onto the cloud, helping to facilitate the aggregation of data from various sources onto a single platform. These companies have also been developing tools, in partnership with hospitals, to provide a window into the overall health of the population, with the ultimate goal of identifying common risks and taking proactive steps to intervene. This trajectory is a natural evolution in digital innovation: as more personal health data is recorded and stored, advanced data analytics can be leveraged for insights to improve healthcare outcomes and lower costs. Analytics are also utilized to speed up drug development. Medidata Solutions Inc., for instance, offers a cloud platform with analytical capabilities to streamline clinical research and the drug development process.

Our estimate for Health Care Information Solutions is \$2.4 billion and 11,783 jobs.

Table 5.2.4: Health Care Information Solutions

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Cerner	\$1,130	5,619
Nuance Communications	\$460	2,293
Epic Systems	\$396	2,090
Medidata Solutions	\$298	967
CPSI	\$59	488
Meditect	\$41	326

5.2.5 Shipping

A large package shipping industry has developed to support the steady growth of e-commerce, which has averaged about 15 percent for the past six years.³⁴ We estimate that in 2015 about 11.6 billion packages were moved in the U.S., based on data published by FedEx, USPS and UPS and extrapolation to other shippers based on market share. Public statements of these shippers suggest that about 4.6 billion of these packages were e-commerce packages, and of them we infer 1.26 billion were shipped on behalf of Amazon. Of the Amazon packages UPS and FedEx moved about 400 million, with the rest carried by a combination of Amazon's own resources, USPS, and other carriers.

³⁴ <https://www.internetretailer.com/2016/02/17/us-e-commerce-grows-146-2015>

As there are thousands of shipping and logistics providers in the U.S. for our analysis we performed a roll up of firms in the U.S. that benefit from the delivery business enabled by e-commerce and arrived at revenue of \$30.3 billion and an employment contribution of 353,315.

Table 5.2.5: Shipping

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Shippers delivering online purchases	\$30,284	353,315

5.2.6 E-government Support

Companies in this segment provide technology and connectivity services to local, state, and federal government, enabling everything from official government websites (e.g. whitehouse.gov, data.gov) to, in the case of Silver Spring Networks, the cloud infrastructure on which public utilities operate in some locales. In such a scenario services are called 'network as a platform', and constitute yet another example of the modularizing of infrastructure we see throughout the ongoing evolution of the internet economy. A provider such as Tyler Technologies, by contrast, focuses on software solutions for local government and the public education system, while NIC Inc. is an IT service provider to 3,500 state and local government agencies.

Our estimate for E-government Support is \$829 million and 2,105 jobs.

Table 5.2.6: E-government Support

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Silver Spring Networks	\$426	567
NIC	\$292	859
Tyler Technologies	\$111	679

5.2.7 Web Enabling Services

We list here the substantial number of self-employed web designers, developers, and content creators whose work is not captured elsewhere in our study.

Our estimate for this segment is \$17.9 billion and 182,284 jobs. We used data from the U.S. Bureau of Labor Statistics (BLS) to assist us in the following process:

For app developers for mobile devices we followed the 2012 study's methodology. In our 2012 report we had relied on a study by Mandel³⁵ and no more recent source could be found. Therefore, we projected that app employment would grow from 2012 to 2106 at the rate at which it was growing in 2012.

For web content creators, we began with a 2015 BLS count of 189,840 writers and editors. We attributed 20 percent to web writing, assumed that 62 percent were self-employed, and took 22 percent as part-time³⁶ who could be disregarded. Multiplying these proportions yielded 23,540 people. But we list 10,000 writers on content sites that hire freelance writers and bloggers, so net incremental employment is 13,540.

For web computer programmers, we begin with the BLS 2015 total for software developers of 747,730. The proportion who work on web software development and are self-employed is anchored to our estimate of web developers since freelance development requires programming, and is deflated to 7.5 percent of the BLS number to allow for duplication of skills. This amounts to a six percent compounded growth rate since 2010.

For web developers and graphic designers, we note that the BLS reports a decline in the relevant employment categories. This may be because web hosting companies now offer simple do-it-yourself web creation tools (see Section 4.1.3.) Working from the 2015 BLS employment totals, our assumptions are that 20 percent of the graphic designers are web designers, 35 percent of U.S. web developers/computer programmers are self-employed, and that 14 percent in the categories of web developers and designers work part-time.³⁷ For writers our assumptions are that 20 percent of those identified by BLS data write for the web, that 62 percent are self-employed, and that 22 percent are part-time workers.³⁸ For all categories we make the assumption that the earnings from part-time employment are not material and therefore do not include them in our estimate. The table below breaks out the full estimates for revenues and employment. We estimate revenues for each occupation by multiplying fully-burdened labor cost derived from BLS average wages by employment.

³⁵ Mandel, M. (2012) "Where the Jobs Are: The App Economy," TechNet, South Mountain Economics LLC.

³⁶ The following site describes a comprehensive survey, but without attribution:
http://www.studentscholarships.org/salary_ca/102/web_designers_and_developers.php

³⁷ <http://www.studentscholarships.org/>

³⁸ <http://www.studentscholarships.org/>

Table 5.2.7: Web Enabling Services

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
App developers for mobile devices as contractors	\$6,077	61,897
Web computer programmers	\$5,680	56,267
Web developers and graphic designers	\$4,412	50,580
Web content creators (writers)	\$1,786	13,540

5.3 General Enterprise

Beginning with the 2008 study, an allowance was made for general enterprise omitted employment. By this we meant that there would be people working in large corporations, non-profit organizations, and government agencies, who owed their jobs to the internet but whose employers were not conspicuous members of the internet ecology. We performed detailed enumeration on about 440 firms and about 20 rolled-up firm groups and self-employed groups, but there are 29 million firms in the United States, of which six million are large enough to have a payroll. Granted, many have no internet employees and others make internet duties a part-time responsibility of one person, but in 2008 we made an allowance for general enterprise omitted employment at 100,000 people, and in 2012 at 170,000 people. Given that omitted employment should be proportional to growth in overall internet ecosystem employment, which had grown about fourfold since 2008, we estimated omitted employment to be 390,000 in 2016.

Table 5-3: General Enterprise Activity

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
General Enterprise Activity	\$97,500	390,000

Chapter 6: Consumer Services

6.1 Content Sites

Though the internet could not exist without the infrastructure and machinery mapped in the earlier chapters of the report, it is content and user experience that define the internet for its hundreds of millions of users in the U.S.

These consumer touchpoints include websites, apps, and messaging services. The content ranges from news to information, music, audio, photos, and video to services, and is accessed on phones, tablets, laptops, desktops, and living room screens. Some touchpoints take the form of platforms that create marketplaces for a range of services from dating and peer-to-peer lending to selling baby clothes. They may be sites that allow collective knowledge to be amassed, such as Wikipedia and Quora, sites such as DailyStrength.org that allow personal issues and burdens to be shared anonymously, sites such as IdeaConnection that encourages individuals to solve problems in exchange for financial reward, or SeeClickFix, which allows anyone in a community to report an issue of civic concern for remediation. Some are for-profit enterprises, some are not-for-profit. Some carry advertising, while others do not. Forms of funding run the gamut of one-time donations to subscriptions to affiliate marketing payments to advertising revenue shares to labors of love. It is, after all, the internet, where the business model or form of sustenance often comes after the act of publishing, not before.

The internet as a consumer-facing experience is now over 20 years old. For the generation born in the 1990s and now entering young adulthood, there has never been a world without the internet. It's not surprising therefore to see a long arc of evolution in the sources of publisher revenue, as well as short cycles of disruption. In 2016, after slow but relentless growth that began in the 1990s, advertising spending on digital media reached the level of spending on TV, each medium receiving 38 percent of total spending.³⁹ 2016 also marked five-years during which television viewing of 18 to 24 year olds decreased by more than nine hours per week. This drop in traditional media consumption represents approximately 40 percent of this demographic's television viewing time migrating to digital platforms or to other activities.⁴⁰

The sector of online news and information continues to roil, though over 20 years have elapsed since the introduction of the consumer internet. While on one hand of the equation we have a cornucopia of content, services, and tools availed to us in large part by the advertising-supported internet, on the other side of the equation we have the 70

³⁹ <https://www.emarketer.com/Article/TV-Digital-Dead-Heat-U.S.-Media-Dollars/1014552/>

⁴⁰ <http://www.marketingcharts.com/television/are-young-people-watching-less-tv-24817/>

⁴¹ <http://www.emarketer.com/Article/U.S.-Ad-Blocking-Jump-by-Double-Digits-This-Year/1014111>

million Americans using ad blockers in 2016, a 34 percent year-over-year increase that is projected to increase another 24 percent in 2017.⁴¹

But the internet is nothing if not endlessly adaptive, and in the wake of the vigorous uptake of ad blocking comes new formats, such as content marketing, branded content, and native advertising, which provide workarounds to the traditional ad formats under attack from the armies of blockers.

Since the time of the last report some of the most notable changes to the online content landscape have been:

- The further maturing of social media: Facebook grows to 1.7 billion users, Twitter to over 300 million users, and Snapchat—which didn't exist at the time of the last study—now receiving over 10 billion views per day.
- In music the shift from downloading to streaming is almost complete; Apple talking about discontinuing downloads altogether; Spotify which had a trivial amount of revenue at the time of our last report is now the dominant provider of music streaming, with approximately 100 million users of which close to 40 million are paying subscribers.
- The mainstreaming of UGC (User-Generated Content) from an activity viewed largely as a novelty to a format that occupies everything from comments sections in online newspapers to collective knowledge sites such as Quora, Reddit, and Wikipedia, to the videos of 'vloggers' reviewing items from cosmetics to cars to sneakers.
- An industrialization of individual content creators, agents and networks specializing in influencer marketing emerging, resulting in, for example, the more than \$1.5 billion and 35,000-plus full time equivalent jobs we have estimated for U.S. YouTube creators.

6.1.1 News & Information

This segment is comprised of the following types of companies and content which fall under the category of online news and information:

- The digital activities of such media industry cornerstones as Bloomberg, Gannett, and The New York Times Company.
- The not for profit entity the Wikimedia Foundation, which houses the user-generated encyclopedia Wikipedia, recipient of about eight billion monthly page views⁴² and the relatively small associated revenue of \$26.5 million.

⁴² <http://reportcard.wmflabs.org>

- The native-to-digital firms that are new wielders of influence in this landscape.

Native to digital firms examined include XO group (publishers of popular wedding, home, and lifestyle sites such as The Knot, The Nest, and The Bump), real estate database Zillow, and SheKnows Media. SheKnows is a firm new to our study, and is the parent company of a family of women's lifestyle brands such as StyleCaster.com, BlogHer.com, and DailyMakeover.com. It has emerged as the top digital media company in its sector, claiming 80 million monthly unique visitors and close to 200 million fans across social media platforms.⁴³

While content marketing and native advertising moved to the fore between our last study and this one, other publishing models, deemed innovative by some and controversial by others, retreated. In this category we find the following companies, whose revenue numbers fell considerably between 2011 and 2015 and/or businesses folded or were forced to sell assets due to legal proceedings.

- Demand Media – Roundly criticized for its 'content farm' model, with its low cost assembly line for content that matched the most popular terms and phrases searched. Its revenues halved between our two studies, and the company has divested itself of its Cracked.com and Trails.com brands as well as its domain name services.
- Gawker Media – A high profile defamation lawsuit led the company to liquidate its assets in 2016, with Univision Communications acquiring its online content brands (Deadspin, Gizmodo, Jalopnik, Jezebel, Kotaku, and Lifehacker) at auction.
- Glam Media – A content aggregator specializing in lifestyle content online, with third-party sites focused on such topics as beauty, health, food, fashion, entertainment, and parenting, the company, which came to be known as Mode Media and was hailed as a 'unicorn', i.e. a startup with a billion dollar-plus valuation, abruptly ceased operations in fall 2016.

Our estimate for News & Information is \$18.2 billion and 47,777 jobs.

⁴³ <http://www.brandchannel.com/2015/08/06/5-questions-sheknows/>

Table 6.1.1: News & Information

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Bloomberg	\$5,859	7,350
Thomson Reuters	\$4,108	17,494
RELX Group (formerly Reed Elsevier)	\$3,440	8,336
Gannett	\$677	4,301
Zillow	\$645	2,204
WebMD	\$636	1,740
Ancestry.com	\$549	1,074
The New York Times Company (Digital/Online Properties)	\$434	961
Bankrate	\$368	512
TrueCar	\$260	574
Answers.com	\$245	622
Everyday Health	\$232	700
United Online	\$155	145
Autobytel	\$133	200
Demand Media	\$126	350
XO Group	\$104	444
SheKnows Media	\$100	250
Mode Media (formerly Glam Media)	\$100	240
Wikimedia Foundation	\$27	280

6.1.2 Multi-genre Content

This category is distinct from the previous category of News & Information as the firms analyzed here publish and/or distribute content not merely across a wide variety of platforms but across a wide variety of topic areas.

Our estimate for Multi-genre Content is \$19.6 billion and 34,391 jobs.

Table 6.1.2: Multi-genre Content

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Time Warner	\$3,367	2,969
Viacom	\$3,309	2,429
Hearst	\$2,813	3,273
IAC/InterActiveCorp	\$2,376	3,700
Sony USA	\$1,868	4,840
Liberty Interactive	\$1,246	2,754
News Corporation	\$977	2,970
Discovery Communications	\$868	941
Tribune Media Company	\$650	1,750
Advance Publications	\$630	2,905
Disney	\$587	2,069
Meredith	\$316	765
CBS Interactive	\$230	1,894
Scripps Networks Interactive	\$137	158
Univision	\$94	139
BuzzFeed	\$85	650
Vice Media	\$50	185

As in the News & Information category above we once again find a meeting of old world and new world media companies here, with legacy media organizations such as Hearst acquiring digital upstarts Complex Media, and newer, digital native brands, successfully carving out territory alongside the name brands of broadcasting and publishing.

The following companies from the analog world are notable for their addition of digital entities to broadcast brands and/or the creation or acquisition of standalone digital brands:

- Scripps Interactive: e.g. HGTV, Food Network, DIY Network, Cooking Channel.
- Tribune Media Company: e.g. Tribune Studios, Tribune Digital Ventures, and the recently renamed newspaper publishing arm, Tronc.

- Discovery Communications: e.g. Discovery Channel, TLC, Animal Planet, equity interest in OWN (Oprah Winfrey Network).
- News Corp.: e.g. The Wall Street Journal, Harper Collins Publishing, Realtor.com, social media content agency Storyful.
- Time Warner: e.g. (via Turner Broadcasting) cable channels CNN, TBS, and TNT, pay-TV channels HBO and Cinemax, Warner Bros. TV, film, home video, and games.
- Hearst Corporation: e.g. major daily and weekly U.S. newspapers, 300 magazine titles including Cosmopolitan and Esquire, Hearst Television, Hearst Entertainment & Syndication Unit, and stakes in cable networks A&E and ESPN.

Existing alongside the expanding media portfolios of the firms named above are companies such as Vice Media, which entered the media landscape from the extremes of the margins, and now has equity stakes held by Disney and Rupert Murdoch's media empire. Vice's in-your-face, outlaw brand of journalism and entertainment, delivered across digital and analog media properties, has translated to annual revenues approaching \$1 billion.

Another company noteworthy in this category is BuzzFeed—a digital brand once synonymous with the disparaging term 'clickbait' that has become a rapidly growing and profitable media entity—enjoying seven billion monthly views as of early 2016,⁴⁴ covering everything from light fare such as entertainment gossip, food, and lifestyle stories to serious topics such as politics. In the case of the latter, the agility and ability of the BuzzFeed politics team shone to such an extent that CNN hired them away for its own Campaign 2016 digital coverage.⁴⁵

Looking at the data from the studies our team has conducted in 2008, 2012, and now 2016, it is evident that in the digital domain—unlike the bricks and mortar world of high barriers to entry—enterprises can go from barely being on the radar in one report to a dominant force in the next. The inverse is also true; category leaders can become also-rans in the course of four years, and entirely new categories can emerge, blindsiding incumbents whose gazes were fixed elsewhere.

An innovation that has emerged between the 2012 report and this study is the digital incarnation of sponsored and branded content. The concept itself—of brands aligning themselves with programming not about their brand but about general interest content meant to attract specific audience segments—is not new, harking back to the days of TV's soap operas and programs such as Mutual of Omaha's *Wild Kingdom*. What is

⁴⁴ <http://www.adweek.com/news/technology/buzzfeed-now-getting-7-billion-content-views-month-171182/>

⁴⁵ <https://www.washingtonpost.com/blogs/erik-wemple/wp/2016/10/03/cnn-hires-buzzfeed-scoopsters-for-its-digital-politics-coverage/>

different this time is the mechanical and technological end of things, such as the ability of this kind of content to:

- Bypass ad blockers (as the content is not identified by the system as an ad and is therefore delivered to the user/viewer/reader)
- Take on the look and feel of the publisher site where the content appears, hence the term 'native advertising', in which the sponsored content appears to be native—or fully integrated with—the publisher site on which it appears.
- Sponsored content can appear where audiences already are—the most popular social platforms, blogs, and sites, and offer content that speaks to their interests, as opposed to merely promoting a product or service.
- Targeting technologies can dynamically match the content most likely to appeal to the reader/viewer with such data points as demographics, psychographics, and purchase history. These techniques combine native advertising with programmatic technologies.

So popular is this more customer-centric approach to market that 31 percent of publishers report that they now have their own in-house facilities for the production of native advertising and branded/sponsored content⁴⁶ and robust digital publishing business models have been built upon the strategy, with the majority of BuzzFeed's revenues coming from native advertising, a significant portion of Vice's stemming from the same, and publications such as *The Atlantic* reporting 75 percent of its ad revenue coming from sponsored content, and *Slate's* revenue breakdown now at 50 percent sponsored content and 50 percent banner and display advertising.⁴⁷

2015 was also the first year podcasting—a technology that has been around for over a decade—appeared at New York's annual advertising Upfronts. The internet-enabled digital audio sector was buoyed largely by two factors, which developed in parallel:

- The runaway success of *Serial*, a true crime podcast downloaded 100 million times
- The early stages of industry maturation, evidenced by the appearance of podcasting networks such as Panoply, Gimlet, Earwolf, and networks and firms specializing in podcast advertising placement such as Midroll and Podtrac.

Relative to other advertising spends the dollars being directed to podcast advertising are infinitesimal—e.g. \$34 million compared to radio's \$17 billion and television's \$66 billion⁴⁸—but as the digital transformation of the content industries continues

⁴⁶ <http://www.foliomag.com/majority-of-publishers-use-their-own-editorial-staffs-to-produce-native-ads/>

⁴⁷ <http://www.nytimes.com/2016/07/25/business/sponsored-content-takes-larger-role-in-media-companies.html>

⁴⁸ <http://www.wsj.com/articles/podcasts-face-advertising-hurdles-1455745492>

to evolve we expect the former number to grow and the latter numbers to retreat in the years to come across digital audio services such as podcasts, streaming music services, and the digital live and on-demand services of traditional audio broadcasters.

6.1.3 Specialized Research & User Generated Content

In this section we report on services that aggregate consumer reviews, business reviews, and other ratings services. While Google dominates general purpose search and research online, and offers reviews, it has not displaced the demand for specialized research sites.

The innovation that characterizes most firms in this sector is merging of trust with a widely dispersed crowd with whom you don't have a personal relationship, and the resulting economy of reputations. A recent study suggests that two thirds of U.S. internet users trust businesses with positive online reviews more than businesses with no reviews,⁴⁹ so the economic impact of such sites is significant.

The largest of the specialized research firms are analyzed individually, and an estimate is made of all others. Note that our analysis of crowdsourced travel review site TripAdvisor is not included here as it appears in our section on online travel.

Our estimate for Specialized Research and UGC is \$933 million and 4,032 jobs.

Table 6.1.3: Specialized Research & User Generated Content (UGC)

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Yelp	\$495	1,998
Angie's List	\$344	1,730
Hoover's	\$94	304

6.1.4 Online Music Services

Music is often referred to as the canary in the coalmine for digital businesses, the first to be sent into the darkness, with other sectors able to look over its shoulder and observe the outcome, however dire. At present there's good news and bad news for this industry. While U.S. music business revenues have plunged by over 70 percent between 1999 and 2015⁵⁰ the better news is that the industry reported its strongest growth since the pivotal Napster era of the late 1990s.⁵¹ Revenues from digital music contributed the

⁴⁹ <http://www.emarketer.com/Article/Web-Users-Put-More-Stock-Consumer-Reviews/1012929>

⁵⁰ <https://redef.com/original/less-money-mo-music-lots-of-problems-the-past-present-and-future-of-the-music-biz>

⁵¹ <https://www.riaa.com/reports/2016-mid-year-riaa-shipment-and-revenue-statistics/>

majority of this income, as for the first time streaming topped paid downloads, a sales channel now in decline.⁵² This trend was buoyed by two factors: the growing popularity of music streaming services available in ad-supported freemium and ad-free paid formats, and the convenience of mobile listening via app and smartphone, with mobile listening representing 74 percent of digital audio consumption in the U.S. in 2015.⁵³

Our estimate for Online Music Services is \$2.5 billion and 3,163 jobs.

Table 6.1.4: Online Music Services

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Spotify	\$1,240	157
Pandora Media	\$931	1,997
iHeartMedia	\$312	935
Rhapsody	\$75	74

The major firms examined in this sector were Pandora, Spotify, Rhapsody, and iHeart-Media (formerly Clear Channel). The revenues of competitors Google Music, Apple Music (launched in 2015), and Amazon’s music service are captured in our analyses of those firms, which appear in the relevant categories of this report. Competitors such as Slacker and 8tracks were shown to have negligible revenues.

The big story in the digital music space since the time of our last study, published in 2012, has clearly been Spotify, surging from \$3 million in U.S. revenue four years ago to well over \$1 billion in 2015. Competitor Pandora almost quadrupled its U.S. revenues between 2011 and 2015, from \$274 million to \$931 million, and picked up additional users with its acquisition of streaming service Rdio, after it filed for bankruptcy in late 2015⁵⁴. Rhapsody, one of the pioneers in this space with a decade of operating history in online music, reported \$220 million in global revenue in 2015 and approached 3.5 million subscribers.⁵⁵ Rhapsody offers no free tier for its service, nor does the Jay Z-owned Tidal, which reported three million subscribers, of which 45 percent subscribed to the \$19.99/month tier and the other 55 percent to the \$9.99/month tier, for global revenues of approximately \$43.5 million in 2015.⁵⁶ Note that the company is

⁵² <http://ifpi.org/news/IFPI-GLOBAL-MUSIC-REPORT-2016>

⁵³ via eMarketer, “U.S. Digital Audio Listening Share, Desktop vs. Mobile,” published April 28, 2015.

⁵⁴ <http://www.billboard.com/articles/business/7519014/rdio-bankruptcy-story-how-it-happened-failing-streaming-service>

⁵⁵ <http://www.billboard.com/articles/business/6806086/rhapsody-2015-global-subscribers-growth-streaming>

⁵⁶ <http://www.billboard.com/articles/business/7317891/tidal-one-year-anniversary-by-the-numbers>

headquartered in Europe, with small numbers for U.S. revenue and employment and is therefore not broken out separately in our numerical analysis.

Particularly notable in the 'all other' category is SoundCloud. Launched in 2008, the site enjoys a user base of 175 million users, and is a favorite of both fans and musicians for its distinctly non-commercial slant. The venture capital-backed company received an injection of \$70 million from Twitter in 2016⁵⁷ and in fall 2016 the *Financial Times* reported that Spotify was in advanced talks to purchase the company.⁵⁸

The search for a sustainable business model in this sector continues. Even the largest companies continue to struggle with profitability. Spotify, with its 30 million paying users in 2015 representing about 30 percent of its user base, reported losses of almost \$200 million in 2015⁵⁹, Pandora's losses were reported at over \$170 million⁶⁰, Rhapsody's at \$35 million⁶¹, and SoundCloud is reported to have spent \$63.8 million to generate \$19.7 million.⁶²

Profitability eludes all players in this sector, for these reasons:

- Licensing costs remain high, with industry leaders Pandora and Spotify reporting as much as 70 percent of revenues being paid out to rights holders⁶³, who are generally the music labels.
- Most users opt for the free, ad-supported service as opposed to the ad-free, freemium service.
- High sales and marketing costs as new entrants such as Apple, Amazon, and Tidal enter the space.

6.1.5 Games

The video game industry, once dominated by console-based, offline play continues to shift to online play and revenue. For example, Activision's 2015 10-K filing reported an increase of \$605 million for revenues from digital online channels, representing 57 percent of the company's total revenues. This figure compares to 43 percent in the previous year. Similarly, EA (Electronic Arts) reported digital revenue of \$2.4 billion in 2015, or 57 percent of total revenues.

⁵⁷ <http://www.nytimes.com/2016/06/15/business/media/twitter-invests-70-million-in-soundcloud-music-service.html>

⁵⁸ <https://www.ft.com/content/d03bedbe-85bb-11e6-8897-2359a58ac7a5>

⁵⁹ <http://www.musicbusinessworldwide.com/spotify-revenues-topped-2bn-last-year-as-losses-hit-194m/>

⁶⁰ <http://www.musicbusinessworldwide.com/pandora-losses-hit-170m-last-year-as-listeners-shrunk/>

⁶¹ <http://www.billboard.com/articles/business/6897287/rhapsody-losses-double-2015>, March 2, 2016

⁶² <http://www.billboard.com/articles/business/6873893/soundcloud-earnings-2014-19-7-million-burning-cash-building-future>

⁶³ <http://www.musicbusinessworldwide.com/spotify-contract-three-major-labels-wants-pay-less/>

In the sector of games played on social platforms, the previous darling of the industry, Zynga, experienced a revenue drop of approximately 33 percent between our 2012 study and this report, and King Digital, the company behind approximately 180 titles, the most popular of which is Candy Crush, was acquired by Activision Blizzard in 2015.

Note that we account for the gaming revenues of Microsoft and Sony in their respective categories in this report.

Our estimate for Games is \$3.7 billion and 8,683 jobs.

Table 6.1.5: Games

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Activision Blizzard	\$1,186	1,856
Electronic Arts	\$978	1,881
Zynga	\$506	1,360
Take-Two Interactive	\$366	804
Ubisoft	\$358	2,400
Nintendo of America	\$279	382

6.1.6 Online Video

The most significant shift between the 2012 study and this report is the mainstreaming of OTT Television, which stands for “Over-the-Top,” referring to the delivery mechanism, which is not the traditional broadcast television signal but the open internet, supplied by a household’s or mobile device’s (smartphone or tablet) internet service provider. There are over 100 OTT services operating in the U.S., most of which are ad-free and subscription-based, while some are advertising supported, such as YouTube. The top companies in this sector in the U.S. are Netflix, Hulu, Amazon’s Prime Video, Facebook’s recently launched video platform, and Google’s YouTube. Netflix alone is currently responsible for more than 35 percent of peak internet traffic in the U.S.⁶⁴ and online video as a category is projected to make up about 70 percent of mobile traffic and 80 percent of fixed data traffic by 2018.⁶⁵ Note that our segment calculation below includes the revenues and employment that can be attributed to the creators whose videos populate YouTube.

⁶⁴ <http://www.statista.com/chart/1620/top-10-traffic-hogs/>

⁶⁵ <http://digiday.com/platforms/ott-video-going-5-charts/>

Our estimate for Online Video is \$6.35 billion and 38,796 jobs.

Table 6.1.6: Online Video

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Netflix	\$3,051	2,231
Hulu	\$1,500	1,000
Vevo	\$210	375
YouTube partners and contributors	\$1,584	35,190

In 2015 YouTube, with its over one billion users, reached more 18 to 34 year olds and 18 to 49 year olds than any U.S. cable network. The online video platform's U.S. revenue has jumped from our estimate of \$640 million in the 2012 report to \$4-to-\$5 billion in 2015. The network of individual video creators, or YouTubers, has similarly expanded at a remarkable rate.

These creators—also referred to as 'YouTubers'—work across genres such as comedy sketches, candid camera pranks, beauty tips, food how-to's, 'fascinating facts' lists, and video game commentary. A source contacted at YouTube reported that millions are now participating in YouTube's Partner program, in which ad revenues are split between creators and the platform at the rate of 55 percent and 45 percent respectively, and that the number of YouTube channels earning six figures has increased by 50 percent year over year.

Tables 6.1.6a and 6.1.6b break out the earnings, genres, and countries of origin of the year's YouTubers.

Table 6.1.6a: Top 10 YouTube Partners 2016

	Revenue (\$M)
PewDiePie (Sweden) Genre: Game Commentary	\$15.0
Roman Atwood (U.S.) Genre: Comedy	\$8.0
Lilly Singh (Canada) Genre: Comedy	\$7.5
Smosh (U.S.) Genre: Comedy	\$7.0
Tyler Oakley (U.S.) Genre: Entertainment	\$4.5
Rosanna Pansino (U.S.) Genre: Food	\$6.0

Markiplier (U.S.) Genre: Game Commentary / Comedy	\$5.5
Germán Garmendia (Chile) Genre: Comedy/Music	\$5.5
Rhett and Link (U.S.) Genre: Comedy	\$5.0
Colleen Ballinger a.k.a. Miranda Sings (U.S.) Genre: Comedy/Music	\$5.0

Source: <https://yourstory.com/2016/12/forbes-2016-youtube-celebrities/>

Table 6.1.6b: Top 100 YouTube Channels By Country

2016 Top 100 YouTube channels by country of origin	# of channels
United States	46
Brazil	11
Great Britain	7
Canada	5
India	4
Mexico	4
Spain	4
Netherlands	3
Australia	2
Chile	2
Norway	2
Ukraine	2
Argentina	1
Colombia	1
El Salvador	1
Germany	1
Ireland	1
Jamaica	1
Russia	1
Sweden	1

Source: <http://www.tubefilter.com/2016/09/19/top-100-most-subscribed-youtube-channels-worldwide-august-2016/>

We have calculated the U.S. revenue for YouTubers for 2016 as \$1.58 billion, and have excluded the percentages paid to MCNs (multi-channel networks) such as Maker, Studio 71, Machinima, or Style Haul. To measure the impact of this new area of endeavor on the U.S. economy we estimated revenue based on the number of FTE (full time equivalent) employees contributing to the sector. Our revenue estimate of \$1.58 billion assumes each FTE employee earns \$48,000, the median income for a U.S. worker in 2015. When expressed as FTE workers, YouTube creators represent 35,190 U.S. jobs in 2015, a momentous jump from the approximately 1000 FTEs attributed to U.S. YouTubers in our previous study conducted four years ago.

6.1.7 E-learning / Online Education

Since the days of the popularization of the consumer internet, online learning has carried the promise of a democratizing of education and training, breaking access to knowledge away from the previously exclusive domain of institutions and campuses. Anyone who could get on the internet, whether at home, work, or in public facilities such as libraries and social agencies, could also have the ability to take courses, classes, or diploma programs.

Our estimate for E-learning / Online Education is \$6.7 billion and 58,387 jobs, with close to half of the revenues ascribed to the top two providers.

Table 6.1.7: E-learning / Online Education

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Apollo Education Group	\$1,937	25,704
DeVry Education Group	\$765	5,343
Career Education Group	\$687	5,416
Grand Canyon Education	\$623	2,555
Bridgepoint Education	\$556	6,890
Scholastic Corporation	\$501	2,535
Capella Education Company	\$430	2,887
Strayer Education	\$308	366
American Public Education, Inc. (APEI)	\$297	2,866
HealthStream	\$209	972
Skillsoft	\$200	467

Renaissance Learning	\$162	670
ITT Educational Services	\$146	1,441
Follett	\$135	275

In our 2012 report in addition to the assortment of online courses and classes offered by such companies as Bridgepoint, Capella, and Renaissance, we noted the arrival of e-learning providers such as Khan Academy, which offers its services for free, supported by grants from foundations such as the Gates Foundation. In fact Bill Gates himself and his children are avid users of the service that promotes accessible, lifelong learning.⁶⁶ Khan Academy now boasts close to two million subscribers on YouTube and is nearing one billion views on its channel with videos on topics ranging from physics to calculus, history, and economics.

Other new entrants in this sector are the MOOCs (Massive Open Online Courses), usually hosted by universities. MOOCs offer high quality courses online, and generally do so with an open enrolment policy, i.e. prerequisites are not required. Fees are generally not charged to participate though for an additional payment of approximately \$50 a certificate of completion is made available to students. Among the most well-known MOOC providers are edX and Coursera, with courses and instructors hailing from top institutions such as Harvard, MIT, and Stanford.

In the years between this report and the last, firms such as Udemy and Udacity have emerged, the former offering a platform on which anyone can create and teach a course, and the latter offering ‘nanodegrees’ (certification for specific work-related skills). However, these and other e-learning firms examined are not yet large enough to warrant inclusion in this study.

E-learning has experienced periods of tremendous growth over the past 15 to 20 years of its existence but has also experienced pullback in some areas. Despite the substantial sector revenues and employment numbers reported above, the following two examples provide illustrative if not cautionary tales when it comes to online education, particularly when access to federal funds is involved.

- ITT, a nationally accredited institution with a focus on business or technical courses, had close to \$1 billion in revenue in 2015. Nonetheless, due to questionable business practices, the U.S. Department of Education banned the school from accepting students using government-provided financial aid in the summer of 2016⁶⁷ and by the fall of 2016 ITT had closed its doors.

⁶⁶ <http://www.inc.com/lisa-calhoun/bill-gates-uses-this-tool-to-teach-his-kids-should-you.html>

⁶⁷ <http://www.ed.gov/news/press-releases/department-education-bans-itt-enrolling-new-title-iv-students-adds-tough-new-financial-oversight>

- Apollo Education Group, better known as the parent company of University of Phoenix. At one time the company was among Google’s largest clients for search-based advertising, explaining its ubiquitous presence on websites, blogs, and YouTube. The size of its student body decreased from 460,000 to 213,000 in 2015, and graduation rates were reported as being in the single digits.⁶⁸

6.2 E-commerce

We report on e-commerce in the following segments:

- Online retailing (combining pure play digital retailing and hybrid online/offline)
- Online travel services
- Online financial services including day-to-banking, investment, digital payments and currencies, and the new sector of FinTech, or financial technology

6.2.1 Retailing

Most of the nearly \$5 trillion in U.S. retail sales occurs in stores. In 2016, retail e-commerce accounted for just 7.1 percent of all retail sales.⁶⁹ However it was where over 60 percent of retail growth took place. The trade publication internet Retailer reports that e-commerce grew by 15 percent in the U.S. in 2015, while retail sales grew by just 1.5 percent.⁷⁰

In the table that follows we identify the online revenues of firms in the top 10 of online e-commerce, and roll up separately those from 11 to 500 and those beyond the 500th. We then give our estimates of the aggregate retail sales by individuals and small firms selling on e-commerce platforms.

Our estimate for e-commerce activity by retailers is \$319.8 billion and 770,211 jobs.

⁶⁸ <http://money.cnn.com/2015/03/25/investing/university-of-phoenix-apollo-earnings-tank/>

⁶⁹ <http://www.emarketer.com/Article/U.S.-Retail-Sales-Near-5-Trillion-2016/1013368#sthash.pEZAKvxY.dpuf>

⁷⁰ <https://www.internetretailer.com/2016/02/17/us-e-commerce-grows-146-2015>

Table 6.2.1: Top U.S. E-commerce firms

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Amazon ^A	\$57,337	122,324
Apple ^B	\$12,000	28,571
Dell ^B	\$8,500	20,238
Walmart.com	\$8,355	19,892
Macys.com	\$5,581	13,288
Staples.com	\$4,730	11,262
HomeDepot.com	\$4,268	10,161
Costco.com	\$3,290	7,833
OfficeDepot.com	\$3,194	7,604
QVC Group	\$2,665	6,346
Retailers 11 to 500	\$176,939	421,283
Retailers beyond 500	\$11,000	35,000

^A Accounted for in Integrated Firms chapter
^B Accounted for in Hard Infrastructure chapter

Our estimate begins with enterprise retailing on the internet and includes both pure play online retailers and offline retailers who sell online appear in this category. Also, we assume, based on a sample of pure play online retailers, that each employee generates \$420,000 of revenue and make our estimates accordingly.

The revenue and employment in this category breaks down as follows:

- The three largest U.S. online retailers are Amazon, Apple, and Dell and, because they have other lines of business, are not recorded here. Amazon is treated in the chapter on Integrated Firms, and Apple and Dell are analyzed within the Hard Infrastructure chapter.
- The total U.S. e-commerce revenues for the remainder of the Top 10 retailers is \$32.08 billion and our internet-dependent employment estimate is 76,386.

We estimate the total for U.S. e-commerce for retailers 11 through 500 in 2016 as \$176.9 billion and 421,283 jobs, and assume an additional \$11 billion of revenue and 27,500 employees for U.S. e-commerce for retailers 500 and below.

Next we account for sellers on sites such as Amazon, eBay, Craigslist, and Etsy in the U.S., in the following table:

Table 6.2.2: Individual sellers

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Amazon sellers	\$247,985	45,500
eBay sellers	\$34,302	187,489
Etsy sellers	\$1,680	35,339
Craigslist sellers	\$600	13,333

Full time employment estimates were arrived at from estimates of the total number of sellers per platform, and applying the U.S. Social Security Administration estimate of median personal income, less platform commissions (where relevant) and payment provider commissions (where relevant).

Craigslist, eBay, and Etsy have always been home to individual merchants, ranging from one-off sellers of saleable goods in attics and garages to people like Ryan Finley, who, on the site recraigslist.com, documents how he makes his full-time living, supporting a family of seven, by buying, repairing, and then re-selling items on Craigslist. “It’s the only business I’ve ever started that didn’t fail,” Finley wrote in a blog post,⁷¹ and his success as an independent online merchant is far from isolated.

In a similar vein, Amazon has shifted from being primarily a platform for traditional retail conducted in the online environment to a platform for small online sellers, able to flex their entrepreneurial muscle by becoming third party merchants. In fact, half of the goods sold at Amazon.com now originate with third party merchants, who are reported to number two million with sales in excess of \$130 billion.⁷²

In Jeff Bezos’ annual letter to shareholders the Amazon CEO reported that of the two million third party merchants, approximately 70,000 are earning salaries of more than \$100,000 per year. Bezos also pointed out that this growth of the number of third party merchants, and their revenue numbers, can be attributed to entrepreneurs using the platform to create their own lines of branded products, thus allowing them to charge higher prices than merchants simply reselling items.⁷³

⁷¹ <https://priceonomics.com/post/16529584021/how-to-make-it-on-craigslist>

⁷² <http://www.seattletimes.com/business/amazon/amazon-to-host-forum-for-its-marketplace-merchants/>

⁷³ <http://www.seattletimes.com/business/amazon/amazon-to-host-forum-for-its-marketplace-merchants/>

Also meriting a closer look in this segment are the operations of Craigslist. The no frills site began life as a modest email list of things to do in San Francisco in the mid-1990s and has since replaced the classifieds section of newspapers worldwide, once a \$16 billion marketplace.⁷⁴ The impact of Craigslist on the print newspaper industry has been dramatic—revenues from classified ads have reportedly dropped by over 70 percent since 2000.⁷⁵ Annual revenues at Craigslist have tripled to \$343 million since our last analysis conducted in 2012 and have doubled in the past year, all this achieved with a lean core staff of 40 in the company’s San Francisco headquarters.

Craigslist’s growth can be attributed to the continued mainstreaming of the online selling site as well as a new fee of \$5 being charged for auto and truck ads by dealers, said to bring in another \$40 million in annual revenue on top of the fees already being charged for job postings in select cities, apartment brokers in New York City, therapeutic services in the U.S., and ticket sales by dealers in the U.S.⁷⁶

While many of the top online retailers earned revenues in the tens of billions, our analysis also includes companies whose playing field can be found in highly personalized, customized goods and services.

This digital enabling of physical goods specializing in niche areas has led to the success of such firms as:

- Blurb, which enables on-demand and do-it-yourself book publishing of long tail, aka niche, topics. For example, the company is said to be responsible for “the world’s largest” collection of books about women’s roller derby teams.”⁷⁷ Blurb is profitable, with revenues of over \$100 million since 2014.⁷⁸
- Café Press, where the range of customizable goods goes far beyond t-shirts, baseball caps, and mugs to include shower curtains, lunch bags, license plate frames, and phone cases.
- Stamps.com, a company that brings the convenience of online purchasing to one of the most inconvenient tasks, i.e. buying stamps. This postage on-demand service reported revenues of \$214 million in 2015.

⁷⁴ <http://3taps.com/papers/Craigslist-by-the-Numbers.pdf>

⁷⁵ <http://www.forbes.com/sites/stevenrosenbaum/2015/01/26/the-craigslist-economy-is-booming/>

⁷⁶ http://www.craigslist.org/about/help/posting_fees/

⁷⁷ <http://fortune.com/2014/05/06/blurb-acquires-hps-magcloud-aims-to-dominate-long-tail-publishing/>

⁷⁸ <http://fortune.com/2014/05/06/blurb-acquires-hps-magcloud-aims-to-dominate-long-tail-publishing/>

6.2.2 Travel Services

The mainstreaming and affordability of tablets and smart phones, combined with the growth of the app marketplace has led to an array of new consumer behaviors related to researching and booking travel.

This segment examines the firms that provide internet-dependent travel services to U.S. consumers, comprising travel comparison shopping, travel review sites, aggregators, and travel booking done using the internet, including both traditional offline travel agencies using the internet and digital-only agencies such as Expedia and Priceline, referred to in industry parlance as OTAs (Online Travel Agents/Agencies). We also include flights booked directly with airlines on their own sites, a substantial and growing source of airline revenue.

While from the consumer's point of view TripAdvisor is thought of as a review and recommendation site, we include it in this section as the bulk of its revenues come from click-based advertising which direct users to the sites of hotels, airlines, cruise companies, and OTAs.⁷⁹

Our estimate for Travel Services is \$55.1 billion and 23,943 jobs.

Table 6.2.2: Travel Services

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Southwest Airlines	\$15,431	926
American Airlines	\$8,364	502
Delta Airlines	\$8,262	496
United Continental Airlines	\$6,711	403
Expedia	\$3,703	10,489
Alaska Airlines	\$3,023	181
Priceline	\$1,817	3,200
JetBlue	\$1,537	92
Virgin America	\$872	52
TripAdvisor	\$701	1,805
CheapOair	\$274	1,400
Thomas Cook	\$109	218
Travelzoo	\$89	312
Maritz Travel	\$64	127

⁷⁹ <http://ir.tripadvisor.com/secfiling.cfm?filingID=1564590-16-12862>

Though there are over 100 airlines operating in the U.S. the top 10 carried 80 percent of the passengers in 2015 and the top four—American, Delta, Southwest, and United (now United Continental)—account for 60 percent of the market.⁸⁰ Our analysis also includes three of the smaller U.S. carriers—Alaska, JetBlue, and Virgin—and accounts for the remainder of airlines in an ‘all other’ category.

In order to avoid paying commissions to OTAs in a high competitive, price-sensitive industry many airlines are now promoting direct bookings on their own websites. Some airlines reported direct bookings to their sites in their annual SEC 10-K filings, and we were therefore able to use those figures, such as those of Alaska Airlines, which broke down its sales channel as 60 percent through alaskaair.com, 23 percent through traditional agencies, 11 percent through OTAs (Expedia, et al.), and six percent through the reservation call center. Southwest Airlines is particularly notable in this category, with its 10-K filing reporting 79.4 percent of its passenger revenues occurring via its own website, as Southwest does not use the OTAs to generate leads and sales.

For those carriers that did not separate out bookings direct to their own website in their 10-K filings we used the benchmark of 34 percent provided in the 2015 study “Benefits of Preserving Consumers’ Ability to Compare Airline Fares.”⁸¹

6.2.3 Financial Services: Banking, FinTech, Digital Payments and Digital Currencies

In our last report published in 2012 the big shift noted in the banking industry was two-fold:

- The eclipsing of the opening of financial products in the online vs. the branch environment
- The top five banking activities—bill payment, viewing balances, viewing statements, retrieving transaction histories, and transferring funds—took place primarily online.

In the years since 2012, the banking industry has undergone additional significant shifts as the proliferation of smartphones has enabled functions such as the photographing of checks for deposits, thus further reducing the need for individuals to visit banks in person.

Our estimate for Financial Services is \$26.3 billion and 72,233 jobs.

⁸⁰ via Mintel July 2016 Report on U.S. Airline Industry

⁸¹ Morton, F., “Benefits of Preserving Consumers’ Ability to Compare Airline Fares,” May 2015, http://www.traveltech.org/wp-content/uploads/2015/05/CRA.TravelTech.Study_.pdf, p. 8.

Table 6.2.3: Financial Services: Banking, FinTech, Digital Payments and Digital Currencies

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Banks 1 to 4	\$509	1,273
Banks (All Other)	\$2,995	4,279
Credit Cards Roll Up	\$11,808	29,520
FinTech Roll Up	\$3,375	17,707
Financial Services Roll Up	\$4,676	14,017
E-Trade	\$1,428	3,400
Interactive Brokers Group	\$1,097	473
Charles Schwab	\$181	542
Blucora	\$118	772
TD Ameritrade	\$105	250

To arrive at these figures we used the following method: First, we performed two industry 'roll ups', one for the top four banks in the U.S. in 2015, and a second for the remainder of U.S. banks. The logic for proceeding in this fashion is that the four largest firms claim 27.2 percent of the market, with the market share of the fifth firm being less than one percent.⁸² We therefore performed an analysis of the remaining 72.8 percent of the market with an 'all other' category.

The top four banks analyzed were Wells Fargo, Bank of America, JP Morgan Chase, and Citibank. The total of their 2015 global revenues is \$145.3 billion, from which we deduct \$40.83 billion as revenue due to credit cards, accounted for separately in this study.

Of the remaining \$104.5 billion we estimate \$90.9 billion, or 87 percent, as U.S. revenue. The figure of 87 percent is based on a review of the respective company's 10-K filings with the SEC (Securities and Exchange Commission). The 10-K filings also provided us with the basis for our estimate of \$380,000 of annual revenue generation per employee. Our estimate for the internet-dependent U.S. revenue for the top four banks is \$891 million and we ascribe 1,273 FTE (full time equivalent) employees to this revenue figure.

We performed a similar analysis for the 'all other' category of U.S. banks and our findings were \$2.99 billion in internet-dependent U.S. revenue and 4,279 FTE jobs.

Our calculation for internet-dependent employment in this sector uses the sum of people employed in the digital marketing departments (i.e. those involved in online advertising, social media marketing, mobile marketing, email and online chat customer service), as well as those who work in online banking operations and on the mobile app teams. For employees in digital marketing we assume 100 employees per \$50 billion of revenue, based on employment figures for similarly scaled retailers. For those involved in online banking and mobile app operations we assume 600 people per \$50 billion of revenue.⁸³

The evolution of work flow in the banking industry from face-to-face encounters with tellers in brick and mortar bank offices to online and mobile transactions times and places convenient to customers has merely been phase one. In the past handful of years, we have seen the emergence of the FinTech (short for financial technology) sector, a multibillion dollar market attracting vigorous venture capital funding and experiencing exponential growth in consumer uptake and revenues. Take for example the credit marketplace Lending Club, which in 2015 managed \$460 billion in assets, employed 1000 people, and had revenues of \$730 million with a business based on technology-enabled peer-to-peer lending that offers borrowers better rates than traditional banks and provides lenders with more attractive returns than the fraction of a fraction of a percentage that has been the norm for bank deposits over the past several years.

As evidenced by this business model the impact of the internet on the banking industry now goes far beyond the mere digitization of conventional banking functions and shifts to what could be thought of as radical alternatives, if not systemic threats, to the legacy processes that defined the industry for decades. The status of the physical bank that occupied a building resembling a Greco-Roman temple and operated in a formal, almost governmental, manner, is now unquestionably being challenged by companies that operate entirely in the digital sphere and offer efficiencies unimaginable in a pre-internet world.

FinTech covers businesses ranging from 'robo-advisors' that offer automated personal wealth management for a fraction of the price of financial advisors (usually 0.25 percent in lieu of the mutual fund industry average of 1.3 to 1.5 percent), peer-to-peer lending powered by predictive analytics and algorithms, digital payment systems that allow individual payments, group payments, and even micropayments, and crowdfunding platforms that support everything from artistic endeavors (e.g. Kickstarter, Indiegogo) to honeymoons (Honeyfund) to personal needs, charities, and community projects. In the case of the latter segment, GoFundMe, the primary platform of its kind, now raises \$100 million per month for such non-commercial activities, with the company retaining a five percent fee for facilitating transactions.

⁸³ Forrester report "Staffing and Hiring for eBusiness," 2011

In this sector we also find innovative business models such as the following:

- CircleUp, which enables investing in consumer product startups.
- Coinbase, the world's largest digital currency company, used by consumers, merchants, and software developers, with 3.8 million consumer wallets and over \$3.5 billion in Bitcoin transactions.
- CommonBond, a marketplace for student loans that offers better rates to borrowers and better returns to lenders.
- Kabbage, offering fully automated financial services to small businesses.
- Mozido, a mobile payment platform focusing on the two billion owners of mobile phones who are 'unbanked' (i.e. do not have bank accounts).

In addition to these swaths of innovation in the financial industry, another sizeable change on the horizon is the blockchain, a.k.a. the decentralized ledger behind such digital currencies as Bitcoin. It is estimated that by 2017 it will be used by 15 percent of banks for activities ranging from payments and lending to real-time information sharing within the enterprise.⁸⁴

6.3 The On-Demand Economy

A new world of flexible work has emerged between the time of our prior report and this one. It is distinct from the world of freelance or contractor work for its ability to be conducted at the discretion of the worker, in, e.g., the spare few hours on a Thursday night or a Sunday evening, or can be pursued full time, with the individual worker able to set his/her hours. So widespread has on-demand economy work become that in 2016 the U.S. Commerce Department proposed a new classification, 'digital matching firms', in an attempt to create a more accurate description of the world of platform-enabled flexible labor.⁸⁵

The economic foundation of the on-demand economy is the platform business, which, rather than build physical assets and infrastructure, builds an online destination through which buyers and sellers can transact. *Platform Revolution* (2016) authors Parker, Van Alstyne, and Choudary describe platforms as "...bring[ing] together producers and consumers in high-value exchanges. Their chief assets are information and interactions, which together are also the source of the value they create and their competitive advantage."⁸⁶

⁸⁴ <http://fortune.com/2016/09/28/blockchain-banks-2017/>

⁸⁵ <http://fortune.com/2016/09/15/gig-freelance-economy-size/>

⁸⁶ <https://hbr.org/2016/04/pipelines-platforms-and-the-new-rules-of-strategy>

Characteristics of the platform-enabled on-demand economy include:

- Access over ownership (consumer point of view)
- Flexibility over fixed hours (worker point of view)
- Options and modularity of choice – e.g. a spare room instead of hotel, a shared ride instead of a cab

We divide this category into two sections:

- The platforms that enable on-demand goods and services (and the revenues these firms derive from fees and commissions)
- The workers who provide the on-demand services that power this new economy

6.3.1 On-Demand Platforms & Services

The firms that make such work possible are known as platform firms, which, rather than build the infrastructure of taxi fleets or delivery services, create a platform for matching buyers and sellers of services. Among the most well-known of such firms are Airbnb, taxi alternatives Uber and Lyft, and delivery on-demand services Instacart, Grubhub, TaskRabbit, and Postmates.

Our estimate for Platforms & Services is \$2.4 billion and 12,803 jobs. Note that the individuals who provide the goods and services to the platform companies are detailed in Section 6.3.2, entitled “On-Demand Economy Workers.”

Table 6.3.1: Platforms & Services

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Uber Technologies	\$865	6,700
Lyft	\$525	3,000
Airbnb	\$450	1,184
Grubhub	\$358	1,094
Postmates	\$100	350
Instacart	\$100	350
TaskRabbit	\$4	125

6.3.2 On-Demand Economy Workers

In addition to drivers for, e.g., Uber and Lyft and delivery persons for, e.g., TaskRabbit and Postmates, we also include people in the U.S. who serve as Airbnb hosts in our calculation. Note that we do not include the merchants and artisans selling on platforms such as eBay, Etsy, Amazon, and Craigslist in this category, but we do account for them in the e-commerce section of this report.

Our estimate for On-Demand Economy Work is \$6.04 billion and 134,160 jobs.

Overall, our research suggests that there are 54 million to 68 million people who are independent earners, to varying degrees, and with varying dependence on the internet, in the United States. This figure may be compared with that of McKinsey Global Institute, whose 2016 report entitled “Independent Work: Choice, Necessity, and The Gig Economy” found that this segment of workers is significantly larger than previously thought. McKinsey estimates that up to 30 percent of workers in Western Europe and the United States (162 million people, of which almost 60 million are located in the U.S.) are independent workers, covering the gamut from those who supplement their main income with a handful of hours of on-demand economy work weekly to those who are able to perform such work as a primary source of income.⁸⁷

The McKinsey report divides on-demand economy workers into four segments: 30 percent who are free agents by choice, 40 percent who are deriving supplemental income from their activities, 14 percent who make their primary living with on-demand work (but who would prefer traditional employment), and 16 percent who are in financially unstable situations and perform the work out of economic necessity.

To arrive at our estimate, we used the following median figures:

- Airbnb hosts: \$4,100 per annum⁸⁸
- On-Demand Driving and Delivery Services: \$10-15/hourly⁸⁹ (\$30,000 per annum FTE).

We then ascribed a discounted SSA (Social Security Administration) median income of \$30,000 to the first category of 30 percent free agents. We then assumed that the 40 percent who are supplemental income workers do so for an average of eight hours per week at \$15/hour or \$480 per month x 12 months, for an annual income of \$5,760, or 11.7 percent of the FTE salary of \$48,880. The remaining 30 percent (the sum of the 14 percent and 16 percent in the third and fourth categories) have been attributed a discounted SSA median income of \$15/hour.

⁸⁷ <http://www.mckinsey.com/global-themes/employment-and-growth/independent-work-choice-necessity-and-the-gig-economy>

⁸⁸ <http://bgr.com/2016/07/08/airbnb-profits-new-york-city-annual-revenue/>

⁸⁹ <http://uberdriverdiaries.com/how-much-do-uber-drivers-really-make/>

To assist us with distributing the on-demand economy work geographically we factored in the following findings:

- “Between 2010 and 2014, the 25 largest metros accounted for more than 80 percent of the net growth in gig economy firms in the ride-sharing sector, with 90 percent concentrated in the largest 50 metros.”⁹⁰
- “In 2015...a total of 550,000 Airbnb listings in the United States [were identified]. California leads all states with 125,803 total properties listed, with New York in second place at 94,976 Airbnb rentals.”⁹¹

6.4 Social Networks & Services

This category includes the social platforms in everyday use by hundreds of millions in the U.S., the most popular of which provide forums for entertainment, artistic expression, business networking, and of course socializing, whether on desktop, tablet, or phone. Our definition of a social platform is one in which the user’s experience is improved by the number and quality of connections s/he has. We also include as a subcategory the online dating sector, which initially made meeting mates as easy as a click on a website, and more recently has introduced features optimized for mobile, such as touch-screen swiping, location features, and integration with one’s social networks.

6.4.1 Social Media Sites

What began as pastimes in dorm rooms or wild ideas hatched by Silicon Valley start-ups, social media sites have since become the de facto home pages of the internet for billions of people worldwide. Platforms such as Facebook, Twitter, and Snapchat are the ‘go to’ online destination for those wishing to socialize, discuss and debate, or just post pictures and videos. These social sites have replaced the portals of the first generation consumer internet and the search engines that followed.

Note that the revenues of the largest social platform, Facebook, are accounted for in our section on Integrated Firms, to which Facebook belongs due to its business operations outside of social networking.

Our estimate for Social Media Sites is \$3.4 billion in revenue and 8,893 jobs.

⁹⁰ <http://www.citylab.com/work/2016/10/the-gig-economy-and-the-rise-of-cities-as-platforms/503795/>

⁹¹ <http://blog.airdna.co/2015-in-review-airbnb-data-for-the-usa/>

Table 6.4.1: Social Media Sites

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
LinkedIn Corporation	\$1,846	5,811
Twitter	\$1,443	2,534
Pinterest	\$88	330
Snapchat	\$39	218

Twitter, though often criticized for its inability to turn a profit, also grew significantly in the years between our two studies. In 2011 the company’s U.S. revenue was estimated to be a mere \$20 million, whereas by 2015 that figure had swelled to \$1.44 billion. The problem with Twitter, then, is not its ability to generate revenue, but its ability to continue to grow its user base, while reining in what are reportedly very high sales and marketing costs. These costs are estimated at approximately 40 percent of revenue, a rate that is more than double that of competitors such as Facebook and Google. Similarly, the company’s R&D costs index higher than competitors, running at approximately 28 percent of revenues.⁹²

Snapchat, which, at the time of our last report was a niche app specializing in rapidly vanishing photos has since become a media powerhouse. It now enjoys partnerships with major traditional media publishers such as NBC and National Geographic as well as newer publishers Vice and BuzzFeed and has surged to over 10 billion views per day. Though the figures we report for U.S. revenues and employment for 2015 are a modest \$39 million and 218 employees, we note here that eMarketer’s projections for Snapchat’s ad revenue for 2016 and 2017 are \$367 and \$935.5 million respectively.⁹³

Another social site that has risen to prominence since our last study is Pinterest. Its numbers for 2011 were \$130,000 of U.S. revenue and 21 employees, whereas for 2015 we estimate revenues of \$88 million and a staff of 330. The visual scrapbooking site continues to ramp up its offerings on the back end with a variety of ad tech companies and on the front end pairing social media influencers with brands and agencies.⁹⁴

Though acquired by Microsoft in the summer of 2016 LinkedIn appears as a separate entity in our analysis of the state of the internet economy through to the end of 2015.

⁹² <http://www.reuters.com/article/us-twitter-m-a-restructure-analysis-idUSKCN12L0EQ>

⁹³ <http://adage.com/article/digital/snapchat-ad-sales-reach-935-million-year-emarketer/305722/>

⁹⁴ <http://www.adweek.com/news/technology/pinterest-enlists-top-creators-and-production-shops-craft-posts-marketers-174121>

It grew from U.S. revenues of \$522 million in 2011 to \$1.85 billion in 2015, with the U.S. employee headcount rising accordingly from 1,200 to 5,811.

It is also worth mentioning the firms in this category whose stars fell in the years between our studies. News ‘up-voting’ site Digg was one of the earliest social media phenomena yet by mid-2012 the brand and technology (though not all the assets) were sold to a venture capital firm for just \$500,000.⁹⁵ Check-in site Foursquare had similarly been touted as a ‘next big thing’ company at the time of our previous study. For 2015 Hoovers reported a fairly modest \$50 million in revenue for the company.

6.4.2 Online Dating

The dating marketplace comprises online and offline activities, with online (websites and apps) accounting for \$1.8 billion, or 75 percent of the \$2.4 billion in U.S. revenue in 2015, and offline activities such as singles events, speed dating, and matchmakers making up the other 25 percent.⁹⁶

Our estimate for Online Dating is \$1.1 billion and 2,018 jobs.

Table 6.4.2: Online Dating

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
eHarmony	\$312	190
Zoosk	\$100	74
Sparks Networks (jdate.com, christianmingle.com, blacksingles.com, etc.)	\$46	194
All other	\$709	1,560

Note: IAC dating apps such as Match.com, Plenty of Fish, and Tinder—with collective revenues of \$633M—are accounted for in the Multi-Genre Content section of this chapter.

The dating firms that are individually enumerated comprise \$458 million of IBIS’s estimate of industry value of \$1.8 billion⁹⁷. A further \$633 million comes, according to IBIS, from the dating sites of IAC (Match.com, Plenty of Fish, Tinder, OKCupid, and others.) Therefore the “all other” entry in the Online Dating table is \$709 million. IBIS gives this industry’s employment as 8,296, of which we take 75 percent to be online, and we compute the “all other” employment to be 1,560 after allowing for IAC’s employment.

⁹⁵ <http://www.forbes.com/sites/jeffbercovici/2012/07/12/digg-once-worth-164-million-sold-to-betaworks-for-500k/#722978b42c66>

⁹⁶ via eMarketer, U.S. Dating Service Revenue Share by Type, June 2015

⁹⁷ IBISWorld Reports, U.S. Dating Services April 2016.

The story of how this sector has developed is two-fold: On the one hand, it is a story of industry consolidation of the original web-based dating sites such as Match.com, OKCupid, and Plenty of Fish, all of which are now owned by IAC (Interactive Corp.), which also holds a majority stake in Tinder. On the other hand it is the story of a shift to app-based dating tailored to the mobile user experience on smartphones. Note that the revenues and employment of IAC are captured in the Multi-Genre Content category earlier in this chapter.

Some dating sites are subscription-based, such as Match.com and eHarmony, charging users between \$30 and \$60 per month. Free options such as OKCupid and Plenty of Fish obtain the bulk of their revenues through advertising, though these sites often offer premium, ad-free versions of their service. Many free sites also offer users the ability to 'boost' their profile with additional features, or to see if their message to a user has been viewed, for a fee. Both demand and revenues have grown in this sector since our last study as the stigma of using dating sites has abated and niche, ethnic, and religion-based dating sites have emerged.⁹⁸

Our analysis of this sector has taken the 'top down' approach, breaking out the internet-dependent revenues for the industry as a whole, as well as a 'bottom up' approach, examining the revenues and employment of the larger individual firms.

Our estimate for app-based mobile dating, the biggest development in this sector since the time of our last study, is \$468 million.⁹⁹ These matching services have been optimized for the mobile experience of a touch screen, social network connections, location check-ins and interstitial moments. Some have likened these apps to real life video games, where players are pushed streams of photos and swipe left to indicate lack of interest and right to signal potential interest and follow up with instant messages.

Among the most popular of such apps are Tinder, Bumble, Hinge, and Happn, which incorporate features such as notifying you when you physically cross paths with someone in real life, introducing you to people with whom you have Facebook friends in common, or scanning your iTunes collection and making suggestions based on shared musical tastes.

6.5 Employment and Recruiting

This category comprises online employment sites (e.g. Indeed, Monster) and the sector of software focused on human resources, payroll and benefits, and recruiting.

⁹⁸ IBISWorld, U.S. Industry Reports, Dating Services, April 2016

⁹⁹ IBISWorld, U.S. Industry Reports, Dating Services, April 2016

6.5.1 Employment Services

Job hunting was one of the earliest sectors to migrate to the internet, led by Monster in the mid-1990s. Since then, online recruiting has grown to a multibillion dollar business in the U.S., growing annually by approximately 15 percent.¹⁰⁰ Note that LinkedIn is not included in this segment as it appears in the category of social networks in our report. The 'all other' category noted in the table below includes firms such as Snagajob, The Ladders, and Dice.

Our estimate for Employment Services is \$1.5 billion and 8,567 jobs.

Table 6.5.1: Employment Services

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Monster	\$426	2,368
Indeed	\$300	1,200
CareerBuilder	\$145	1,500
Care.com	\$139	799
All other	\$500	2,700

Most job sites are free to use for jobseekers, whether posting or browsing, with revenues typically generated through the sale of advertising, subscriptions with premium features, and fees charged to recruiters and firms seeking employees.

New to our report in this sector is Care.com, a platform for matching caregiving services providers, from pet care and housekeeping to child care and senior care, with those in need of such services. Notable acquisitions in this sector include the Netherlands-based multinational human resource consulting firm Randstad which acquired Monster, and Microsoft which acquired LinkedIn, both in 2016.

6.5.2 Human Resources

Software systems designed for human resources functions such as payroll and benefits, recruiting, and employee wellness programs, appear in this category.

Our estimate for Human Resources is \$1.1 billion and 5,628 jobs.

¹⁰⁰ IBISWorld Online Recruitment Sites in the U.S.: Market Research Report, February 2016

Table 6.5.2: Human Resources

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Sage	\$406	1,455
Paylocity	\$230	1,800
Paycom	\$225	1,461
Ceridian	\$198	830
Ellucian	\$44	82

Human Resources software is being covered in our report for the first time. In the past we accounted for HR and payroll software in the NAICS code of 511210/Software Publishing, and examined firms such as Saba and Sage. Additionally, we accounted for HR software functions in the revenues of large firms such as Oracle and SAP, which acquired companies specializing in this space. Oracle acquired PeopleSoft and Taleo, and SAP acquired SuccessFactors in late 2011 for \$3.4 billion.

For this report we are separating out the category of HR software, owing to both its evolution and growth. An analyst of HR technology writing recently in Forbes referred to this industry as being in a state of “disruption...and reinvention...fueled by mobile apps, analytics, video, and a focus on team-centric management.”¹⁰¹

Software in this category facilitates the employee lifecycle from recruitment to retirement, including skills upgrading and work/life balance, and the more instrumental functions of tax filing, payroll administration, and benefits processing.

A noteworthy change in this industry is the shift from complex and expensive in-house HR software systems that were based on client/server architectures to a model based on cloud computing, cross-platform functionality, and the widespread use of such features as video and gamification (e.g. the awarding of points and badges for specific behaviors.)¹⁰²

6.6 Productivity Tools

This segment encompasses services delivered online that assist businesses with both B2B and B2C tasks, ranging from printing, graphics, and file backup to accounting software and package delivery. We use the term ‘Productivity Tools’ for this category.

Our estimate for Productivity Tools is \$5.6 billion and 14,091 jobs.

¹⁰¹ <http://www.forbes.com/sites/joshbersin/2016/07/18/the-hr-software-market-reinvents-itself/#3003447a4930>

¹⁰² <http://www.forbes.com/sites/joshbersin/2016/07/18/the-hr-software-market-reinvents-itself/>

Table 6.6: Productivity Tools

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
Intuit	\$2,907	5,340
Cimpress (formerly VistaPrint)	\$781	3,520
Web.com	\$543	2,200
LifeLock	\$587	788
Dropbox	\$240	720
Carbonite	\$137	623
SourceMedia	\$131	530
Shutterstock	\$149	220
SuperMedia Information Services (superpages.com)	\$99	150

Among the firms analyzed individually, we note:

- Intuit's 10-K filing indicates that the company's Connected Services segment (i.e. internet-dependent) is responsible for generating 73 percent of 2015 revenue, compared with 50 percent in 2008. Intuit reported that 95 percent of 2015 revenues of \$4.2 billion originated in the U.S.
- Dropbox: The San Francisco-based company enables file hosting and group collaboration in the cloud. Whether a two-person group or a large organization, file hosting, synchronization, storage, and live collaboration across geographies no longer require investment in software and hardware. Though privately held and therefore not disclosing financials, its annual revenues are said to be near \$0.5 billion.¹⁰³

6.7 Government Services

The sector of internet-dependent federal government services exists in a unique category in our study. It does not generate revenue but it does create substantial employment.

Our estimate for Government Services jobs is 327,440.

In our 2012 study we estimated approximately 2,000 internet-dependent federal government services jobs. To arrive at that estimate we singled out the most popular and high profile U.S. government sites such as Census.Gov, USA.gov, and Whitehouse.gov.

¹⁰³ <http://www.forbes.com/sites/miguelhelft/2015/07/29/dropbox-is-under-siege-but-its-not-slowing-down/#988495925325>

Today the U.S. government has a much more comprehensive digital strategy, with many more sites and digital resources, as reported on the website of the U.S. Government's Chief Information Officer: "Over the past few years, the Administration has launched a number of Open Data Initiatives aimed at scaling up open data efforts across the Health, Energy, Climate, Education, Finance, Public Safety, and Global Development sectors. The White House has also launched Project Open Data, designed to share best practices, examples, and software code to assist federal agencies with opening data. These efforts have helped unlock troves of valuable data — that taxpayers have already paid for — and are making these resources more open and accessible to innovators and the public."¹⁰⁴

To estimate the number of internet-dependent jobs in the U.S. Government we consulted the President's IT (Information Technology) budget for 2016.¹⁰⁵ Total expenditure on internet-dependent IT systems and services was given as \$81.68 billion. We divided this figure by \$250,000 per head, our estimate of cost (labor and equipment) per employee, to arrive at the estimate of 327,440 jobs.

¹⁰⁴ <https://playbook.cio.gov/>

¹⁰⁵ https://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/omb_presidents_it_budget_for_fy_2016_summary_chart.pdf

Chapter 7: Integrated Firms

Until this point the narrative of the growth of the internet has been told as if it was unfolding in four independent chapters, each covering a horizontal layer, from infrastructure to consumer services. As an organizing principle it has worked reasonably well, and has served our purpose since 2008. However, it is an approximation. Since the internet's birth there have been firms that did not fit tidily into just one of the layers.

From the earliest days of the internet there have been attempts to break from the horizontal layer structure and create vertically integrated ecosystems within which, it was hoped, users of the internet would find rich and diverse content and services delivered under contract by their Internet Service Providers. These integrated firms were called portals. Yahoo was a portal in the late 1990s, as were Excite, MSN, and Lycos. Each acquired content sites with the goal of increasing the time that consumers spent inside their portal because it catered to their wants and needs. The most successful of the portals was, for a while, America Online, and its brief merger with Time Warner was undertaken in 2000 in the expectation that this vertical integration would deliver users an improved experience where they would find engaging content and tools under one roof. Eventually Google contributed to the disintegration of the AOL/Time Warner ecosystem by positioning itself as a pure search tool without specialist content.

In our 2012 study, we dealt with the firms that did not fit tidily into one layer or another by dividing the internet-dependent revenues of these firms among layers. However, by 2016 the firms had grown and we found it difficult to accurately divide their contributions among discrete layers.

We chose therefore to examine these firms on their own terms, so that we could take a view on whether this reversion to the vertically integrated business model was again a transitory pattern or this time a robust feature of the internet and an expression of consumer preferences. The firms we study in this chapter are listed in the following table.

We found that the internet-related employment of the integrated firms was 442,000, which is about 11 percent of the internet employment base, and revenue was \$273 billion.

Table 7.1: Integrated Firms

	2016 U.S. Internet Revenue (\$M)	2016 U.S. Internet Employees
AT&T	\$65,860	126,269
Verizon	\$65,576	88,534
Amazon	\$57,337	122,324
Alphabet (Google)	\$34,800	28,434
Comcast	\$20,821	39,084
Microsoft	\$15,984	22,200
Facebook	\$8,513	5,965
Cox Enterprises	\$4,500	9,408

The patterns of integration are not identical. We see two main groupings: content marketers integrating into transmission, and transmission companies acquiring content, and a third, the more idiosyncratic integrations of Microsoft and Amazon.

7.1 Content Marketers Integrating Vertically into Transmission

The integration path from content to transmission is most clearly seen in the recent actions of Facebook and Google. Facebook has grown global revenues by more than any other internet-dependent firm in the time since our previous study, from \$3.7 billion in 2011 to \$17.9 billion by the end of 2015. The user numbers behind Facebook's success are similarly impressive, reaching 1.5 billion in monthly active users by the end of 2015. Constantly refining and developing their core product, Facebook also keeps its eye fixed on startups, whether their focus is a sophisticated, innovative technology such as the Oculus virtual reality offering, or something less technically complex, such as Instagram, which quickly captured the imagination of users worldwide. When acquired by Facebook in 2012 the photo-snapping app had under 100 million users but gave the social network the world's largest repository of photographs. By the end of 2015, after two years integrated with Facebook, the Instagram user base reached 500 million. Other Facebook acquisitions of note between the time of our last report and this one include the 2013 acquisition of Atlas, the advertising technology suite owned by Microsoft, and the 2014 purchase of WhatsApp, the world's most popular free messaging app.

This activity on its own does not qualify Facebook for treatment as an integrated firm because these acquisitions are all extensions of its publisher role. But to house its photo stock, which grows by hundreds of millions daily, its video stock, and its platform services

for more than a million web sites and hundreds of thousands of applications that use the Facebook Connect platform, it has had to build storage infrastructure in four very large data centers and has two more under construction.¹⁰⁶ In addition it has joined an investment consortium to lay the Pacific Light Cable Network from Los Angeles to Hong Kong, and helped build a transatlantic cable from Bilbao in Spain to Virginia in the U.S.¹⁰⁷

Google has had a longer history of expansion into transmission, starting with a bid on wireless spectrum in 2008. It created the Access¹⁰⁸ division of Alphabet in 2015 to house initiatives such as the manufacturing of a \$200 home router, a project to partner with an Indian public broadband provider known as Rail-Tel, and fiber installations in Kenya and Ghana. The largest venture is known as Google Fiber, providing broadband internet and cable television access in eight U.S. cities. Cost difficulties have led to a halt in laying of fiber optic cable to homes, and a search for a high-band wireless alternative.

7.2 Transmission Providers Integrating Vertically into Content

There have been some vigorous moves by cable operators and phone carriers into areas of content. Two cable operators, Comcast and Cox, and two telecommunications companies, Verizon and AT&T, have embarked on a range of acquisitions intended to diversify revenue sources.

Comcast is the largest home internet service provider in the United States by virtue of operating the country's largest cable network. The cable infrastructure's near-exclusive control of transmission of entertainment is being challenged. Consumers are increasingly able to unbundle cable's previously very profitable channel bundles, in particular by buying audio, video, and other media over the internet directly from content publishers, using over-the-top delivery services that gives ISPs, including cable operators like Comcast, no ability to share in the revenue of the content they transmit.

Anticipating a decline in the value of its infrastructure relative to the digital content that it carries, Comcast has repeatedly tried to buy content providers. It bid for Disney unsuccessfully in 2004, but in 2011 it completed the acquisition of NBCUniversal, giving it a significant presence in many internet-dependent entities including a share in Hulu.

Verizon, the largest wireless communication service provider in the U.S., has pursued a similar pattern of large-scale integration into consumer services. It acquired AOL in 2015 and is likely to close on Yahoo in 2017.

¹⁰⁶ Data Center Knowledge, September 2016 <http://www.datacenterknowledge.com/the-facebook-data-center-faq/>

¹⁰⁷ Wong, J., Quartz. October 17, 2016 <http://qz.com/811032/google-goog-and-facebook-fb-are-building-a-new-transpacific-submarine-cable/>. Retrieved 11/8/2016.

¹⁰⁸ Bergen, Mark, "Meet Access, the Google Unit That's Taking On Comcast and the Rest of the Cable Biz," Recode. November 30, 2015 <http://www.recode.net/2015/11/30/11620972/meet-google-alphabets-access-and-energy-division-home-to-google-fiber>

Cox Enterprises, a privately held corporation, has followed a different path to content, concentrating its focus on the automotive sector. Through Cox Automotive it owns a number of automotive content properties including Kelley Blue Book and Autotrader.com, and connected services in the automotive vertical, in particular Dealertrack which provides online finance and insurance services to dealers.

AT&T's acquisition of DirecTV, satellite infrastructure provider, is not per se a step on the path to integration, but if its offer to acquire Time Warner is successful it will have made one of the largest moves to tie infrastructure to content. And even if it is not successful, AT&T has a substantial stake in the consumer services support layer of the internet through AT&T AdWorks, which since the DirecTV acquisition has grown to an annual revenue of \$1 billion in digital and cross-device advertising sales.

7.3 Integrating Vertically into Cloud Transmission and Data Services

Microsoft's multiple revenue and employment groupings would have been more difficult to classify than perhaps any other firm in our universe had we not created an Integrated Firms layer, and even with this layer its pattern of diversification is relatively *sui generis*. It reports revenue in six segments, two of which load to some degree onto the internet. The first, Devices & Consumer Licensing contains the search engine Bing, and gaming software and devices that range from the substantially internet-dependent Minecraft software and the internet-accessible Xbox hardware, to some non-internet dependent gaming. It also contains the phone division, which appears to be declining in strategic importance. The second, Commercial Licensing, contains Skype, whose revenues are not separately reported. We assume \$2.5 billion from a 2013 report with a conservative 10 percent growth per year.¹⁰⁹ This segment includes the successful cloud entry, Azure, and its customer relationship management tools.

The significance of firms like Microsoft to the growth of the internet lies perhaps in the path they point to for enterprise information technology integration. Firms that can build on long and strong historical relationships with large enterprises can pioneer cloud-based business markets for their clients. In this respect Microsoft's \$26.2 billion acquisition of LinkedIn, intersecting it with Salesforce and Workday, points up a role for the internet in business life as large as social media's role in personal life.

Amazon is the last firm examined in this chapter, and like Microsoft its path to integration is *sui generis*. Amazon's core business is e-commerce, where it is dominant and increasing in dominance. It is useful to review here the e-commerce picture and Amazon's place in it, because e-commerce accounts on its own for about 20 percent of the employment in the entire internet ecosystem. There are more than 500 retailers selling online in the USA, and although offline sales are 92 percent of all U.S. retail today the online sector is growing. Remarkably, Amazon sells a fifth of all that is sold, and its

¹⁰⁹ <http://www.bloomberg.com/news/articles/2013-02-19/microsoft-s-skype-unit-approaching-2-billion-in-annual-revenue>

share is growing not declining as the sector grows. It alone captured 60 percent of all growth in 2015. This unusual pattern, in which the largest firm in an industry grows and increases its share as it grows, suggests increasing returns to Amazon's scale. The larger it gets, the more strongly it competes, likely because its technology investments yield higher returns than those of competitors.

Amazon's integration has been from the consumer service layer to the consumer services support and soft infrastructure layers. By offering its technology investments as infrastructure to the market generally it has grown its scale and the attendant benefits to its core business. And by offering advertising and customer management services to third-party vendors selling on its platform, it has similarly grown scale in consumer services support.

7.4 Integration Conclusions

Google, Facebook, and Amazon provide platform services to clients, mainly retailers, publishers, or advertisers, which in some instances limit access and control over client firms' applications, content, and media when they run on their services. The data generated by their services is their first-party property, not the property of the client firms. In exchange for the benefits of these ecosystems, the clients earn a return on their investments in the form of retail sales, advertising revenues, and ad audience exposures that are competitive with, and often better than, the returns to be earned in the open internet, while providing more control and safeguards over user experience. As of 2016 these ecosystems are extremely successful and are experiencing tremendous growth.

It appears that the cable providers and telecommunications companies reviewed earlier in this chapter are accumulating assets with the goal of being able to offer similarly complete services to marketers. Some depend on regulatory approval, and others on the ability to acquire complementary businesses at reasonable prices, but it seems likely that all of the firms listed here will eventually offer suites of marketing services as well.

Will these ecosystems be more successful than the vertically integrated companies of the past? First it should be clear that 25 years ago it was consumers who were captive to these ecosystems, while today it is marketing firms. But more generally, the ecosystems are not monopolies. Marketing firms can and do run campaigns in multiple environments, and allocate resources where they see the best results. Provided objective measures of results are available, integrated firms will only thrive if they deliver better results than combinations from among the open internet.

Chapter 8: Conclusions Regarding Employment in the Internet Ecosystem

In this chapter, we combine the findings of the five layers of the internet ecosystem into a whole. The five previous chapters analyzed employment in the internet ecosystem by identifying 412 of the largest firms for individual analysis in 48 relatively homogeneous clusters. Additionally, we identified 23 groups of firms or self-employed individuals for collective analysis. Of these, 10 were “all other” clusters, generated whenever the distribution of firms by size in one of the 48 clusters left a significant number of uncounted firms. Another nine clusters accounted for self-employed workers such as sellers on Etsy and individual sellers on eBay, on-demand economy workers, and freelance individuals doing coding, content creation, and other services for Websites. We made allowances in two cases for sectors comprising firms that were individually small but large in aggregate, namely local and state e-government services, e-commerce merchants beyond the top 10, and people working in small units of large and mid-sized general enterprises not otherwise counted in the internet ecosystem who owed their jobs to the internet.

8.1 Employment

Total direct employment in the internet ecosystem is 4,097,001, of which 2,313,000 came from the 412 individually enumerated firms. Therefore, our enumeration of large firms produced 56 percent of the 4.1 million people directly employed in the internet ecosystem. The remainder worked in mid-sized and small firms or were self-employed individuals. Total employment is distributed as follows across the five layers of the ecosystem, with employment for 2008 and 2012 shown for comparison:

Table 8.1: Direct Employment in the Internet Ecosystem

Layer	2008 Employment	2012 Employment	2016 Employment
Infrastructure/Hard Infrastructure	140,000	420,000	304,393
Infrastructure Support/Soft Infrastructure	165,000	254,000	662,691
Customer Services Support	190,000	435,000	1,068,364
Consumer Services	520,000	885,000	1,619,335
Integrated Firms			442,218
TOTAL	1,015,000	1,999,000	4,097,001
Growth in Employment (% per annum compound)		18.5%	19.6%

Thus the 2016 bottom-up analysis finds that the number of jobs that rely on the U.S. internet ecosystem has doubled each four years. Almost a million new jobs were added by early 2012 to the million that were found in the 2008 study, and a little more than two million were added by late 2016 to the two million were found in the 2012 study.

Thus we find that the number of people employed directly in the production of services to the internet ecosystem is about 4.1 million. For each person directly employed, other people work in sectors that service the needs of this person, such as schooling, entertainment, banking, insurance, and retail. The person pays taxes that support employment in federal, state, and municipal government services, education, and the military. This indirect employment arises from supplier effects, re-spending effects, and government employment effects. It is standard practice to apply a multiplier to the direct employment to account for the indirect employment that would be lost if the direct employment did not exist. The U.S. Bureau of Labor Statistics (BLS) publishes statistics on industry employment requirements, which enable calculation of these multipliers. Sectors differ in the size of their multipliers. Bivens¹¹⁰ has computed indirect employment multipliers that range from 372 indirect jobs for every 100 jobs in durables manufacturing to 163 indirect jobs for every 100 jobs in business services. These estimates are inclusive of capital service usage. Hann, Viswanathan, and Koh¹¹¹ used a range of multipliers from 2.4 to 3.4 in their analysis of the Facebook app economy, while Mandel used 0.5 in his report on the app economy. We have chosen a conservative multiplier of 1.54, the ratio used in our earlier reports. Thus our projection of employment due to the advertising-supported internet ecosystem is 4.1 million direct jobs and 6.3 million indirect jobs, for a total employment of 10.4 million people.

Sector contribution to GDP is the sum of national income, corporate gross profits, and interest. As was done in 2008 and 2012, the sector contribution was taken to be proportional to sector income using the national average wage index published by the U.S. Social Security Administration. We used a wage index of \$48,880 and a proportional factor of 2.21 for consistency with past reports, to give a contribution per direct and indirect job of \$108,000. By this method, employment in the advertising-supported internet ecosystem contributed about \$1,121 billion to the U.S. GDP.

Applying the same procedure to 2008 and 2012 employment, we generate the contributions of the internet ecosystem to GDP in prior years:

¹¹⁰ Bivens, J., 2003. "Updated Employment Multipliers for the U.S. Economy." EPI Working Paper No. 268.

¹¹¹ Hann, IH, Viswanathan, S., Koh, B. "The Facebook App Economy." Center for Digital Innovation, University of Maryland, 2011

Table 8.2: Contribution of the Internet Ecosystem to U.S. GDP

	2008 Report	2012 Report	2016 Report
Direct employment due to internet	1,015,000	1,999,000	4,097,001
Direct and derived employment	3,050,000	5,100,000	10,383,000
Contribution of internet to GOP	\$300 billion	\$530 billion	\$1,121 billion
Growth in GDP (% per annum compound)		15.5%	20.0%
Share of Total US GDP	2.1%	3.7%	6.0%

8.2 New Phenomena

This study, concerned with what *is*, risks neglecting what *will be*. In the selection of firms and clusters of firms our attention was inevitably drawn to the large sites of value. So in our previous studies, for example, the mobile internet barely rated consideration in 2008 but by 2012 was becoming significant. Smartphones began to outsell personal computers in 2011.

In this report, the influence of the mobile internet is pervasive at every level from hard infrastructure to consumer services. Omitted are two new phenomena which are, as mobile computing was before, on the fringes of the report but not yet large sites of value or employment.

The first is the Internet of Things (IoT). The term is used to describe objects, some location-bound and some mobile, that are networked. The objects can range from devices, to vehicles, to buildings, even to elements of the human body, and they become part of the IoT when they are embedded with sensors, actuators, software, and network connectivity so that they collect, transmit, and exchange data. IoT is a core platform in initiatives branded as Smart City and Smart Energy Management Systems, as well as more mundane applications such as media audience tracking, fleet vehicle monitoring, and home automation.

The presence of IoT is understated in this report for two reasons. First many infrastructural elements and applications are built on mobility and use its infrastructure. Firms that are dominant in the Infrastructure chapters already earn some of their revenue from IoT products and services. Examples are Cisco, Intel, Qualcomm, Ericsson, and Microsoft. Others not as large—such as, LogMeln, Red Hat, and Novatel—earn revenue for IoT software not separately identified as such in our tables. Second, many applications are too small today to meet our minimum threshold for inclusion.¹¹² These firms include

¹¹² See <http://www.postscapes.com/companies/> for a detailed list of IoT companies.

Samsara, Notion, Hologram, and Losant, pioneers in IoT hardware such as Gainspace, Particle, and Libelium, software producers such as ProSyst, Litbit, and Antmicro, and cloud vendors such as Ayla Networks and Xively. And there are systems integrators who specialize in IoT such as Amyx, ThinkLogix and Flex.

So while there is no breaking out of IoT-sourced revenues in this report, some is caught in the net of firms that we analyzed. It is inevitable that IoT will impose a very significant load on the internet over the five years to come.

A second new phenomenon too small today to warrant much attention in this report is artificial intelligence and its concrete manifestation, bots. The phenomenon is not new, but successful implementations are. Microsoft's dancing paper clip, a personalization of artificial intelligence to address and anticipate problems in using the Microsoft suite of office productivity tools, was an early failure—Clippy the paper clip was annoying and counterproductive. Today bots are beginning to be welcomed, and used for everything from simple customer service queries to complex financial transactions.

Familiar as Apple's Siri, bots combine a conversational interface with artificial intelligence capabilities. Bots are now entering everyday life. *The New York Times* uses one built within Slack, a cloud-based team collaboration tool, to detect which articles are being viewed and shared at unusually high rates and therefore are likely to go viral. The Silicon Valley startup Trim has built a bot that cancels unwanted recurring subscriptions and has even been programmed to argue with Comcast's customer service representatives to negotiate a lower bill.¹¹³

The O'Reilly technology newsletter explains, "A good bot is a marriage of low-friction interface and artificial intelligence. The interface lets a user ask a question, state a fact, or express a wish in text or speech. The AI takes familiar human language, extracts information from it, organizes it, and acts on it."¹¹⁴

The two topics on the fringes of this report, bots and the IoT are not independent in many foreseeable applications. Autonomous transportation for example would require the marriage of AI and IoT. A fleet of self-driving vehicles, such as construction or earth-moving vehicles aligned on a single task, might be construed as a single entity, a robot extending across distance, each vehicle a client and a server.

¹¹³ <http://fortune.com/2016/11/16/trim-comcast-bot/>

¹¹⁴ <https://www.oreilly.com/ideas/why-2016-is-shaping-up-to-be-the-year-of-the-bot>

Chapter 9: Corroboration

Chapter 8 finds that the advertising-supported internet ecosystem contributes about \$1,121 billion to the U.S. GDP in 2016. We now attempt to corroborate this conclusion from two unrelated perspectives.

9.1 The Internet 'Exports' to the Rest of the Economy

In this method we first estimate the direct economic value of the services that the internet provides to the rest of the U. S. economy, which is the revenue paid for the services performed for the rest of the U.S. economy beyond the borders of the internet ecosystem. The services were of three kinds.

First, the ecosystem exported advertising. The sum of search, display, classified, mobile, lead generation and email advertising services in the last half of 2015 and the first half of 2016 was \$65 billion according to the interactive Advertising Bureau.¹¹⁵ Second, the ecosystem exported retail services. Retail revenues are estimated in this report at \$604 billion, and with an estimated gross margin of 50 percent for cost of goods the service produces value of \$302 billion. Third, the ecosystem provided internet access, for which it charged the rest of the economy, as estimated in this report by summing the transmission and connectivity segments of the Hard Infrastructure layer, at \$210 billion. Thus total net exports were the sum of these three payments, \$577 billion.

To translate the ecosystem's payments for services into a sector GDP we applied an indirect employment multiplier of 1.54. By this method, the advertising-supported internet ecosystem contributes about \$888 billion to the U.S. GDP in 2016.

9.2 Time Spent on the Internet

The third method is based on valuing the time that people give to the internet. We relied mainly on the eMarketer September 2016 report of Time Spent with Media.¹¹⁶ We also consulted the 2015 American Time Use Survey of the BLS released June 2016¹¹⁷ and we gave consideration to the report of comScore for October 2016. Neither however took adequate account of over-the-top, internet-delivered, video or mobile video. Therefore, we relied on the eMarketer estimate.

The eMarketer report finds that people over 18 in the U.S. spend 310 minutes each day on all internet activities on desktop computers, laptop computers, and mobile devices. Note that this analysis reports the sum of minutes spent with each medium, without any

¹¹⁵ http://www.iab.com/wp-content/uploads/2016/04/IAB_Internet_Advertising_Revenue_Report_HY_2016_Final-POSTED.pdf

¹¹⁶ <http://totalaccess.emarketer.com/Results.aspx?dsNav=N:1240>

¹¹⁷ <http://www.bls.gov/news.release/pdf/atus.pdf>

attempt to account for simultaneous use of more than one medium. Our need here is for the fraction of the day spent in some form of online activity, so we made a subjective allowance for duplication.

The U.S. population over the age of 18 is 240 million. We have estimated the value of an hour spent at work for a representative U.S. worker at \$23.50 per hour, based on annual earnings of \$48,880 derived from the average wage of non-management, non-agricultural workers published by the Bureau of Labor Statistics¹¹⁸. There is no market price for an hour spent in recreation or leisure, although there is an opportunity cost. It has been argued by Bockstael et al.¹¹⁹ that the wage rate measures the opportunity cost of leisure time. If not, the wage rate over-estimates the value of a leisure hour. As an approximation, we use 10 percent of the wage rate for leisure time, and we take 75 percent of online time as leisure time. With these assumptions, 310 minutes per day incurs an opportunity cost of \$3,451 billion annually. But, as just noted, not all of this amount is true opportunity cost, as some internet use occurs in parallel with other use, as when internet browsing occurs while listening to streamed music in background, and private use occurs in parallel with workplace activity. We take duplicative use to be two thirds of all use, so we adjust our estimate of the contribution of the internet to GDP by this method to \$1,150 billion.

9.3 Comparison of the Methods

Thus we have three estimates: \$1,121 billion by method one, \$888 billion by method two, and \$1,150 billion by method three. The purpose of the second and third methods is, as stated in the methodology chapter, to provide some degree of independent corroboration for the first method, and, given that they are reasonably aligned, we believe method one has been corroborated.

¹¹⁸ http://www.census.gov/compendia/statab/cats/labor_force_employment_earnings.html accessed August 24, 2012.

¹¹⁹ Bockstael, N., Strand, I., and Hanemann, W. (1987). Time and the Recreational Demand Model. *American Journal of Agricultural Economics*. 69 (2), 293-302.

Chapter 10: Distribution of Internet Employment by Geography: Top-Down Approach

This chapter is intended to show the dispersion of economic benefits of the internet ecosystem across the U.S., and the change in dispersion since 2012.

10.1 Methodology

U.S. Federal statistical agencies use the North American Industry Classification System (NAICS) to categorize business establishments for the purpose of collecting, analyzing and publishing data. By detailed review of NAICS definitions, we concluded that 15 of the approximately 700 five-digit NAICS codes contain most of the employment in the internet ecosystem.

We then relied on the U.S. Census Bureau's County Business Patterns (CBP) dataset to determine the counties in which the employees in those NAICS codes worked. The CBP reports the number of employees by NAICS code and county in establishments listed in the Census Bureau's Business Register, a database of all known single and multi-establishment employer companies, but excludes among others Postal Service employees, private households, public administration, and most establishments reporting government employees. For these exclusions we relied on our bottom-up estimates of jobs and distributed them across counties in proportion to the size of the county as discussed later.

The Census Bureau is not permitted by law to disclose information that identifies the number of people employed at a particular establishment. Therefore in the limited number of cases where it is easy to infer an establishment's identity because there are so few establishments in a county, or because one establishment in a county is conspicuously much larger than the others, the CPB reports the number of establishments but not employment for that county. When employment is not reported, it is referred to as suppressed. In each of the 15 NAICS codes studied here we replaced a county's suppressed employment by an estimate calculated as follows. For each NAICS we have the sum of nationwide employment, and can compare it to the sum of all unsuppressed county employment, yielding the nationwide total for suppressed employment for that NAICS code. We allocate the suppressed employment to counties in proportion to the number of establishments in that county whose employment was suppressed.

As Table 10.1.1 shows, suppression was not significant in the largest of the 15 NAICS codes that we studied, so that most of the employment that we reported was sourced directly from the CPB, except in the excluded categories noted above.

Table 10.1.1: Summary of Selected NAICS Codes

NAICS Code	Industry Title	Number of Establishments*	Total Employment*	% of Total Employment Suppressed at the County Level
541510	Computer systems design and related services	244,266	1,917,805	2%
541610	Management consulting services	183,288	995,296	2%
541800	Advertising, public relations, and related services	49,767	479,649	3%
523120	Securities brokerage	23,217	277,213	12%
517110	Wired telecommunications carriers	19,834	587,792	15%
454111	Electronic shopping	18,844	196,608	20%
518210	Data processing, hosting and related services	17,933	301,569	10%
511210	Software Publishers	17,411	332,271	6%
519130	Internet publishing and web search portals	12,997	186,112	5%
492110	Couriers and express delivery services	10,374	547,194	22%
517210	Wireless telecommunications carriers	7,939	132,139	35%
517910	Other telecommunications	7,182	80,285	33%
334200	Communications equipment manufacturing	2,286	88,296	29%
334100	Computer and peripheral equipment manufacturing	1,721	161,347	30%
454112	Electronic auctions	756	10,370	81%
N/A	Employment in industries excluded from the CBP**	N/A	1,116,918	N/A

* Totals include U.S. territories

** Many employed and self-employed people are not counted in the CPB survey, discussed above as "exclusions."

From our short list of 15 relevant NAICS codes, we determined that two were entirely internet-dependent, and the remaining 12 were partially internet-dependent.

To determine the fraction of internet employment to use when a NAICS code was partially internet-dependent, we used one of two methods. If possible we relied on data compiled from our bottom-up analysis, using companies' internet revenue and total U.S.

revenue, to calculate an 'internet-intensity' ratio for each NAICS. Each company in our bottom-up analysis was assigned its appropriate NAICS code. If we had a representative sample of companies for a particular NAICS, we computed the 'internet-intensity' ratio and then estimated fractional employment for the NAICS by multiplying its 'internet-intensity' ratio by its total employment.

If our bottom-up analysis did not result in a representative sample of companies for a selected NAICS, we utilized Product Line Receipts from the 2012 Economic Census. This data contains the dollar amount of receipts collected by many individual product lines within each NAICS industry and also highlights valuable detail about the types of products and services the NAICS industries sold. For each of the selected NAICS industries, all Product Line Receipts were reviewed to identify which Product Lines could be considered a part of the internet ecosystem. To estimate fractional employment for a NAICS, we multiplied its ratio of internet-related Product Line Receipts to Total Product Line Receipts by its total employment.

As mentioned above, the CBP does not assign Postal Service, private households, and government services employees to counties. We make an allowance for this by incorporating: (i) 30 percent of U.S. Postal Service employment (the proportion of revenue generated from the shipping of e-commerce packages from our bottom-up analysis); (ii) full-time equivalent employment of individual sellers on sites such as Craigslist, Amazon, Etsy, and eBay; and (iii) e-government employees. We allocated this employment to counties in proportion to county populations.

In this manner we were able to assign 3.192 million internet-dependent employees to NAICS codes (Table 10.1.2), to states (Table 10.2), and to congressional districts (Table 10.3.1).

Table 10.1.2: Internet-Dependent Employment for Selected NAICS Codes

NAICS Code	Industry Title	% of Internet Dependent Employment	Total Internet Employment Including Allocations
541510	Computer systems design and related services	25%	477,958
517110	Wired telecommunications carriers	50%	290,311
541800	Advertising, public relations, and related services	50%	238,503
454111	Electronic shopping	100%	196,227
519130	Internet publishing and web search portals	100%	184,709
492110	Couriers and express delivery services	30%	163,536
541610	Management consulting services	10%	98,837
518210	Data processing, hosting and related services	30%	91,066
334100	Computer and peripheral equipment manufacturing	50%	80,507
511210	Software Publishers	20%	66,333
523120	Securities brokerage	20%	55,341
334200	Communications equipment manufacturing	50%	43,909
517910	Other telecommunications	50%	40,255
517210	Wireless telecommunications carriers	30%	39,086
454112	Electronic auctions	100%	10,334
N/A	Employment in industries excluded from the CBP**	100%	1,115,127
TOTAL			3,192,039

Our top-down estimate of 3.192 million internet-dependent employees is less than our bottom-up estimate of 4.1 million employees. The reason is that in this section we modeled internet-dependent employment for only the most relevant 15 NAICS industries, those with a meaningful level of internet activity, and for which we could as a practical matter estimate fractional internet employment. The CBP enumerates county-level business statistics for over 700 NAICS industries at the 5-digit level, accounting for tens of millions of employees. Had we examined every 5-digit NAICS code, the proportion of internet-dependent employment to total employment in the codes beyond the big 15 would have fallen rapidly, and the lower the proportion, the less confidence we would have had in our estimates. But across the whole 700 segments, small errors in estimation would have accumulated to become a large error in the final answer. In the bottom-up

methodology there are errors too, but the errors are random and therefore self-correcting. In the top-down methodology, the errors increase as the fraction of internet employment in the NAICS sectors decreases, and are therefore not self-correcting.

We conclude that the top-down methodology is a reasonable estimate of the lower bound on the size of the internet ecosystem, and a reasonable basis for conservatively allocating employment to U.S. counties and congressional districts.

10.2 Results by State

We show in Table 10.2 the ranking of employment by state, and the growth since our 2012 report. Employment in 2012 is based on the same 15 NAICS codes and the same rules for allocation that were used in this report.

Table 10.2: Internet-Dependent Employment by State and District of Columbia

State	Internet Employment	% of Total U.S. Internet Employment	Growth since 2012 Report (100% implies double)	State	Internet Employment	% of Total U.S. Internet Employment	Growth since 2012 Report (100% implies double)
1 California	478,157	15.0%	117.0%	27 Connecticut	35,814	1.1%	93.5%
2 Texas	253,097	7.9%	116.9%	28 South Carolina	35,248	1.1%	118.2%
3 New York	243,003	7.6%	113.2%	29 Louisiana	29,828	0.9%	111.1%
4 Florida	181,349	5.7%	110.0%	30 Kansas	25,885	0.8%	80.9%
5 Illinois	132,516	4.2%	106.6%	31 Oklahoma	25,737	0.8%	90.9%
6 Pennsylvania	109,382	3.4%	103.1%	32 Iowa	24,344	0.8%	103.8%
7 Washington	108,079	3.4%	119.7%	33 Nevada	22,134	0.7%	102.1%
8 Virginia	106,567	3.3%	99.7%	34 Arkansas	21,149	0.7%	113.3%
9 Georgia	104,613	3.3%	111.1%	35 Nebraska	18,310	0.6%	102.0%
10 Ohio	102,524	3.2%	111.2%	36 District of Columbia	18,088	0.6%	122.6%
11 New Jersey	95,131	3.0%	99.0%	37 Mississippi	18,012	0.6%	102.1%
12 Massachusetts	94,808	3.0%	100.5%	38 New Hampshire	15,447	0.5%	105.7%
13 North Carolina	91,521	2.9%	126.8%	39 Idaho	14,159	0.4%	110.4%
14 Michigan	77,116	2.4%	105.7%	40 New Mexico	13,164	0.4%	97.1%
15 Colorado	67,895	2.1%	104.6%	41 West Virginia	11,792	0.4%	107.1%
16 Arizona	67,382	2.1%	138.6%	42 Hawaii	10,100	0.3%	96.8%
17 Maryland	61,898	1.9%	100.6%	43 Maine	9,850	0.3%	99.4%
18 Missouri	57,128	1.8%	121.6%	44 Rhode Island	9,542	0.3%	111.2%
19 Tennessee	55,619	1.7%	111.4%	45 Montana	8,813	0.3%	98.0%
20 Minnesota	54,519	1.7%	107.4%	46 Delaware	8,168	0.3%	107.7%
21 Indiana	50,550	1.6%	107.5%	47 South Dakota	7,093	0.2%	103.6%
22 Wisconsin	45,246	1.4%	107.5%	48 Alaska	6,402	0.2%	246.0%
23 Kentucky	39,008	1.2%	109.0%	49 North Dakota	6,067	0.2%	113.3%
24 Utah	38,083	1.2%	110.3%	50 Vermont	5,682	0.2%	102.8%
25 Oregon	36,339	1.1%	104.2%	51 Wyoming	4,306	0.1%	108.7%
26 Alabama	36,033	1.1%	103.7%	TOTAL		100.0%	

10.3 Results by Congressional District

As is to be expected, a small number of congressional districts are home to a high concentration of internet employment. What is more interesting is the extent to which internet employment is dispersed beyond these concentrations. Our calculations show no congressional district has fewer than 1,296 people dependent on the internet whether as employees or as self-employed people. And as shown in Table 10.3.1, the areas of high concentration of internet employment account for only about 14 percent of the ecosystem's total employment.

Table 10.3.1: Distribution of Internet Ecosystem Employment by Congressional District

	Employment	Percent
First 14 congressional districts	443,728	14%
Next 102 congressional districts + DC	1,149,897	36%
Final 320 congressional districts	1,598,414	50%
TOTAL	3,192,039	100%

The top 14 congressional districts are shown in the next table:

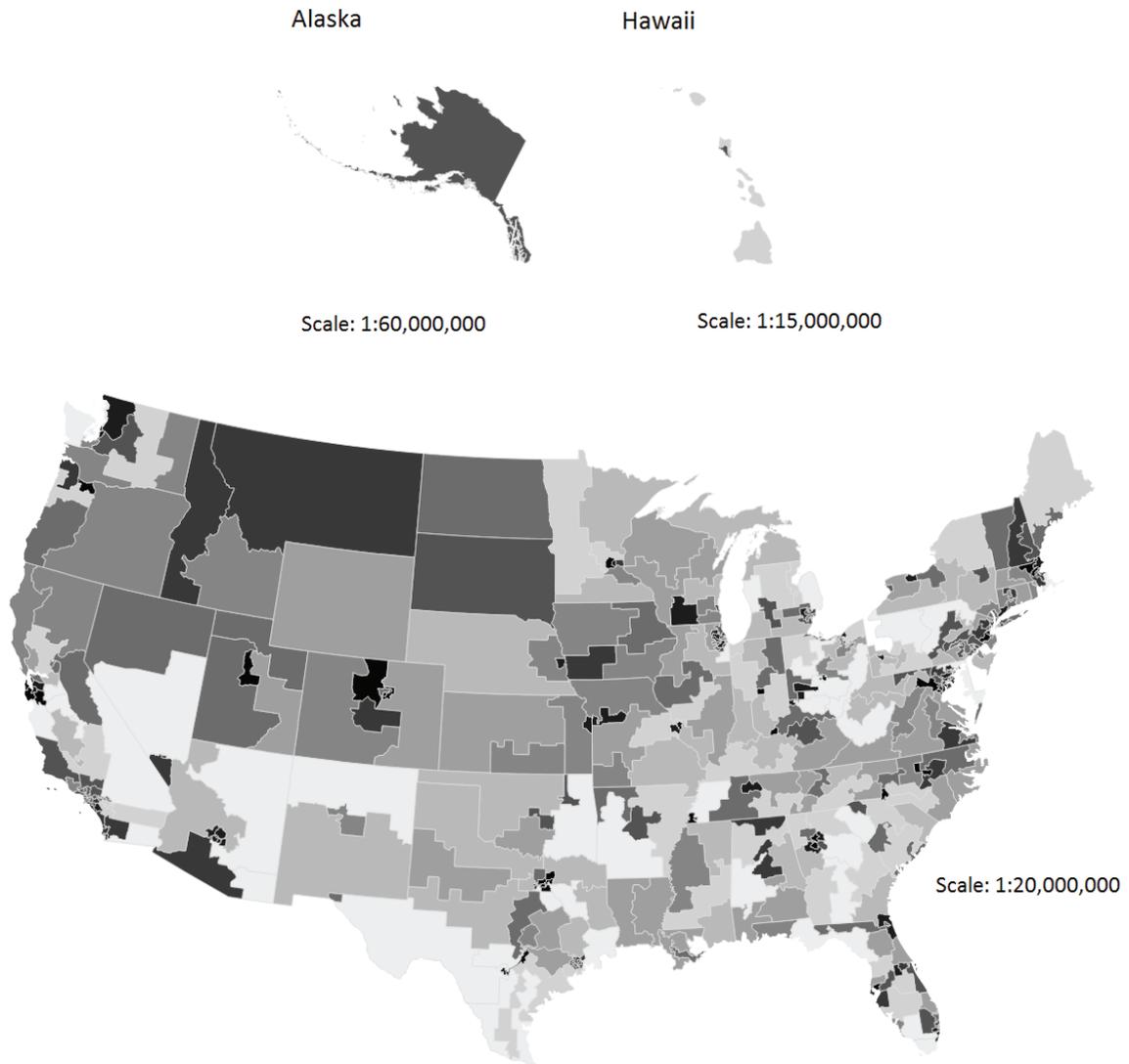
Table 10.3.2: Top 14 districts

		Employment	Description
California	Congressional District 19	53,873	San Jose
New York	Congressional District 13	43,382	Upper Manhattan
California	Congressional District 17	36,891	Silicon Valley (Sunnyvale, Cupertino)
California	Congressional District 12	34,576	City of San Francisco
Washington	Congressional District 7	33,435	Seattle
Washington	Congressional District 9	32,972	Bellevue, Tacoma
New York	Congressional District 12	31,429	East Manhattan
New York	Congressional District 10	31,240	West Manhattan and parts of Brooklyn
Virginia	Congressional District 8	28,281	Arlington County and parts of Fairfax
California	Congressional District 18	24,642	Palo Alto, Redwood City, Menlo Park, etc.
Utah	Congressional District 4	23,967	Salt Lake County
California	Congressional District 14	23,942	San Mateo, Burlingame, South SF
Texas	Congressional District 35	23,876	San Antonio, Austin
Massachusetts	Congressional District 5	21,222	Eastern Massachusetts, Route 128

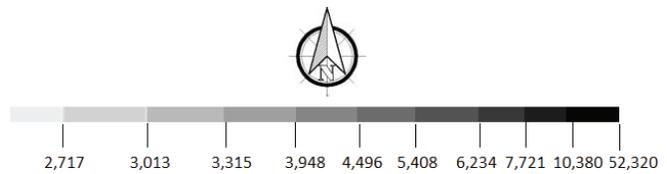
Figure 10.1 plots employment onto U.S. congressional districts, and Figure 10.2 breaks out four dense regions of the country. The congressional districts are graded into deciles, from the 10 percent of districts with fewest establishments to the 10 percent with the greatest number.

Note that congressional districts with large land masses but small populations are visually prominent in these maps. Thus Montana, with only one congressional district but 8,816 internet employees, is in the ninth decile of the distribution of congressional districts, and its dark black shading makes it appear more prominent than the state of Washington, which has 108,000 employees across 10 congressional districts. For similar reasons the lightly populated first congressional district in the state of New York, located on the eastern end of Long Island, is visually more prominent than all of the rest of Manhattan.

Figure 10.1: Mapping of Internet Ecosystem Employees onto Congressional Districts



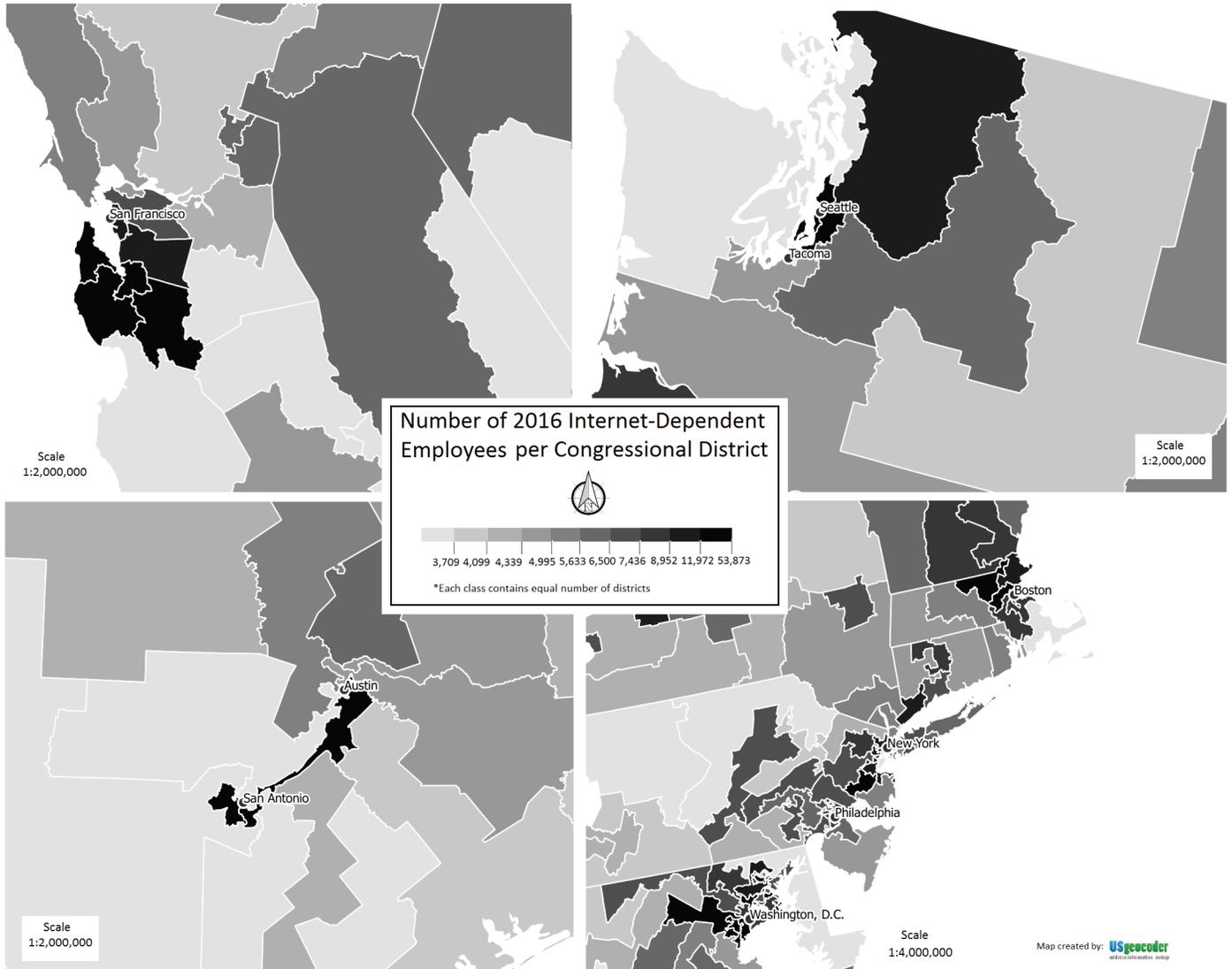
Number of Internet-Dependent Employees per Congressional District



*Each class contains equal number of districts

Map created by: **USgeocoder**
address information on steroids

Figure 10.2: Detail Maps clockwise San Francisco, Seattle/Tacoma, DC to Boston, :San Antonio/Austin



Chapter 11: Societal Benefits of the Internet Ecosystem

The impact of the internet is more profound than the economic effects laid out in Chapters 3 through 8. A multitude of social benefits are also generated, feed economic benefits, and lead to a virtuous cycle in which consumers' and citizen's needs are met by for-profit businesses and community-focused organizations.

At the same time, society has moved well beyond the novelty of the narrative that everyone can have a blog, website, podcast, or YouTube channel. While it is true on the surface that expression has become democratized, functioning in an environment of extreme abundance of content and ideas poses a new set of challenges. By default, all voices on the internet compete globally, but also have the agility and low startup costs that make adjusting or changing course relatively easy, and in this way small scale has the potential to be used competitively against large scale legacy processes, and by insurgent actors against entrenched institutions.

This chapter provides an overview of the array of business models, organizational structures, and consumer behaviors and preferences that characterize the highly participatory internet ecosystem. What started as a government-funded research project in 1969 is now more private than public, and a potent social, cultural, technological, and economic force.

11.1 Effects on Business Models

The internet ecosystem has brought new business models to the fore, all of which are represented, to varying extents, in this report. One could say that if there is a defining characteristic of digital, networked business models it is that they defy the conventional economic wisdoms of eras gone by. What else explains the multi-billion dollar businesses built on foundations such as handing the keys to your home to complete strangers or providing services free of charge to all but three percent of your customer base?

New internet-reliant business models include:

- Content discovery platforms that give digital publishers access to new audiences at scale, such as Refinery29, BuzzFeed, and Elite Daily.
- The platform economics that underlie businesses such as Uber and Airbnb, and the new range of choices they make available to consumers.

- Freemium business models, buoyed by the tiny costs of serving incremental digital customers, enable the building of profitable businesses with just a single digit percentage of customers paying.
- Flexible, self-scheduled, independent work, whether in the form of delivery services such as Instacart and TaskRabbit or on platforms through which contract employment can be obtained, e.g. Behance, Upwork, and HourlyNerd.
- The blockchain, a public, distributed ledger of digital transactions that allows instant verifications to take place without a centralized authority; already in use by forward-thinking artists and dozens of top financial institutions.
- IaaS (Infrastructure as a Service): Capabilities that can be accessed via the cloud enable startups with modest budgets to use enterprise level technology at a fraction of earlier costs.

These new business models make possible a variety of enterprise activity that could not exist without the internet. A sampling includes:

- Sellers on eBay, Etsy, Amazon, and Craigslist enumerated in the On-Demand Economy workforce section of this report, who may earn supplemental income or full time income by creating and/or selling items online.
- The modularization of services, as seen with online firms such as Talkspace.com. Based in New York City, Talkspace has over 1,000 licensed therapists, available via text and chat apps, so that dealing with personal problems is convenient, in the moment, and more affordable than face-to-face therapy (e.g. \$32 per week for unlimited therapy via messaging,¹²⁰).
- ThePennyHoarder.com: What began as a personal finance blog written by a college dropout grew into a media company with \$20 million in revenue and over five million active subscribers.
- The combination of free courses and 'nanodegrees', or highly focused certifications, offered by online learning platform Udacity, made possible through partnerships with tech companies requiring workers with skills taught in the courses they sponsor.

11.2 Matchmaking for Societal Good

Matchmaking is another hallmark of internet-enabled systems, able to reduce and sometimes even eliminate the inefficiencies and frictions of transactions in the physical world. Not coincidentally, one of the first business categories to flourish online was dating; traditional matchmaking augmented by digital, networked technologies. Today the match-

¹²⁰ <https://www.talkspace.com/online-therapy/faqs/> - t4

making capabilities of the internet extend beyond dating to the labor market, personal safety, and social inclusion.

Examples include:

- **TechHire:** While private educational institutions promote courses and training in STEM (Science, Technology, Engineering, and Math), TechHire is a U.S. government-supported initiative that aims to address the gap between the close to six million job openings in the tech sector and the tens of millions of Americans seeking employment. Across all states TechHire serves as a network through which employers with hiring needs, training institutions, and job seekers connect. Many of the job seekers are not from traditional tech backgrounds, and the program encourages employers to hire “based on mastery, not history...[and] adapt curricula to respond to employer demand signals with programs that focus on competencies and job placement.”¹²¹
- **Sit With Us:** Some internet-enabled services aim to solve the big problems, such as TechHire, while others are content to take on the smaller problems, such as the unhappiness brought on by eating lunch alone in the high school cafeteria. Developed by 16-year-old Natalie Hampton of Sherman Oaks, California, Sit With Us is an app that makes finding lunch table buddies discreet and easy.
- **Circle of 6:** A free safety tool originally designed to help college students leverage their social networks for protection. For example, two taps inside the app lets your network know that you want to be interrupted, thereby being provided with a way to exit a potentially dangerous situation, e.g. at a bar or club. The app is now widely available for iOS and Android and is being used beyond students and campuses.

11.3 Communities of Interest: Ad hoc Organizing

The ability to bring together like-minded individuals, whether within the same geography or dispersed across great distances, is another defining trait of internet-reliant businesses. The resulting societal good accrues benefits to communities in the form of innovation, public policy, and even unique methods of financing.

Projects and initiatives that take advantage of ad hoc organizing include:

- **Reinvent.net:** An open community of innovative minds interested in convening “...a mix of smart, knowledgeable, innovative people from a wide range of fields to work on solving the big challenges of our time.”¹²² Those challenges include manufacturing, health, political systems, food and water supplies, and more.

¹²¹ <http://techhire.org/about/>

- Peers.org: This organization aims to make the economy of on-demand work and services practical and sustainable. Initiatives include systems that make finding and managing flexible work easier, and facilitating portable benefits for independent workers.
- Civic Media: This program seeks to enhance participation in civic life, online and offline, organizing, communicating, and executing plans and projects that enhance the experience of life in cities and add a new dimension to citizenry. Sample civic media projects include:
 - Action Path, a location-based platform that surveys citizens for feedback on community projects.¹²³
 - Community PlanIt, an online game that places players in the roles of a diverse group of stakeholders and challenges them to build the necessary trust and skills to complete time-limited civic planning missions.¹²⁴
 - GetCalFresh, an app that supports the two million Californians eligible for food assistance by streamlining the application process, providing efficient client services, and treating those in need with dignity.¹²⁵
- Indiegogo's partnership with MicroVentures¹²⁶: Crowdfunding is nothing new, but the ability for anyone to hold an equity stake in a new and exciting product or company is. Rather than just receiving a reward level perk and/or the product if a campaign is successful, this program lets crowd funders benefit from supporting an innovation early. Indiegogo has raised over \$1 billion for over 200,000 projects ranging from apps and games to physical products.

While not exhaustive, this list provides a view into an internet-enabled world of community and opportunity that extends beyond traditional definitions of collaboration and even of business. We expect such initiatives to continue to develop as devices become cheaper, smaller, and more powerful, and connectivity is built into wearable devices and household objects.

¹²² <http://reinvent.net/about>

¹²³ <https://civic.mit.edu/action-path-0>

¹²⁴ <https://elab.emerson.edu/projects/civic-media/community-planit>

¹²⁵ <https://www.codeforamerica.org/products/getcalfresh>

¹²⁶ <https://equity.indiegogo.com/>

Chapter 12: Conclusions

The conclusions of this report are organized around the tasks set out in the project assignment:

1. Define the advertising-supported internet ecosystem.
2. Determine the employment and value of economic activity enabled by this ecosystem.
3. Determine its geographic dispersion.
4. Define the companies associated with the ad-supported internet ecosystem.
5. Determine the contribution of advertising to the ecosystem.

12.1 Defining the Advertising-Supported Internet Ecosystem

As described in Chapter 1, the internet ecosystem is an internet-dependent market-making and business-enabling system within the broader economy, defined by activities that rely on the internet to promote exchanges of products, services, and information.

It is striking to find that the ecosystem so defined has grown at a faster rate in the past four years than in the previous four years. As Chapter 8 reports, the gross national product the U.S. has accelerated its dependence on the internet, reflecting the fact that it is increasingly a data-driven economy.

The ecosystem's structure is broadly unchanged from earlier studies, with firms concentrated in four horizontal layers. However, as we discuss in Chapter 7, a numerically small but economically large group of firms has begun to integrate vertically across the horizontal layers. These firms compete with each other to provide integrated solutions to the marketing challenges of brand marketers, but compete also with ad hoc alliances of firms in the horizontal layers.

12.2 The Employment and Value of Economic Activity Enabled by this Ecosystem

The ecosystem employs 4.1 million people directly, and 6.3 million people indirectly, as laid out in Chapter 8. It contributes \$1,121 billion to U.S. GDP. Both employment and economic value have grown at an accelerating rate since our first study in 2008.

Three sub-sectors of the ecosystem stand out as drivers of this acceleration: digital commerce, cloud-based delivery of software and services, and streaming consumption of entertainment, but hardly any element of the economy has been untouched. The pace of data-driven entrepreneurship in areas such as IoT, bots, financial technology (FinTech), marketing technology (MarTech), and in publishing, as sites of media consumption

become uncoupled from the sites of production, all suggest that accelerated growth will continue for the foreseeable future.

When analyzed by horizontal sector, job growth was fast in the consumer-facing layer, among household names like Facebook, YouTube, Uber and Airbnb. However, it was fast too in the less glamorous Soft Infrastructure and Consumer Services Support layers that underpin the high-profile brand name consumer services. Consumers could get the benefits of the internet at lower cost, or even, for services like Yelp, Facebook, Twitter and many others, for free, because entrepreneurs were building out support services to make them leaner and more profitable. It may even be (though our report does not prove it) that growth in these support layers made it unnecessary to grow employment in consumer-facing services as fast as their revenues grew, if it made these services more efficient.

What is clear is that data drives internet innovation, and a rich sub-ecology of consumer support services grows up to make sense of the data. In matters of regulation it is as important to consider impact on the support services as on the rest of the structure.

12.3 The Geographic Dispersion of the Ad-supported Internet Ecosystem

By relying on the U.S. Census Bureau's allocation of internet-intensive NAICS code employment to the counties of the United States, and mapping counties to congressional districts, we found in Chapter 10 that there was internet-related employment in every congressional district of the U.S. The dispersion of the workforce was broad, with 116 congressional districts accounting for half of the employment, and 320 accounting for the other half.

Certainly, the popular conception that internet work is concentrated in Silicon Valley is not false. Five congressional districts on the South San Francisco Peninsula employ 174,000 of the people identified in the census data. And there are other concentrations, such as three districts in Manhattan that together account for 106,000 people, the Seattle/Tacoma cluster, the Austin/San Antonio cluster in Texas, and Boston's Route 128 corridor. But it would be wrong to overstate the degree of concentration. Some 86 percent of employment is outside of the 14 most internet-intensive congressional districts, spread throughout the entire nation.

12.4 The Companies Associated with the Ad-supported Internet Ecosystem

In contrast to methods that rely exclusively on the surveys of the U.S. Department of Commerce, which respect the anonymity of respondent establishments, our method

enumerates by name the 400 or so largest firms in the internet ecosystem. And it points to many smaller companies that contribute to the vibrancy of the ecosystem. As noted in Chapter 8, our enumeration of large firms produced 2.3 million, or 56 percent, of the 4.1 million people directly employed in the internet ecosystem. The remainder ranged from mid-sized and small firms to self-employed individuals.

12.5 The Contribution of Advertising to the Ecosystem.

In the pre-internet world 'advertising' referred to payments to media. It did not cover advertising on so-called 'owned' media such as displays on the sides of a firm's trucks and buildings, nor did it cover direct mail, catalog retailing, or telemarketing. If we apply this narrow definition of 'advertising' as payments to media for services that include search, display, classified, mobile, lead generation and email, then advertising contributed \$65 billion to the ecosystem.

But advertising, when defined more broadly as market-making and business-enabling, is the whole of the ecosystem. Its effects, including those of owned and earned media, are reflected in its \$1,121 billion contribution to GDP. Payments to third-party media measure little of what the internet does to make the markets that create the economy.

The internet, in sum, serves many market-making purposes besides media advertising narrowly defined. Websites can serve as storefronts, point-of-purchase stimuli, as tools for conducting research online for offline purchase, and to transact online based on research offline. Websites can aggregate consumer reviews. Consumers can see products promoted and buy them in the same visit if they choose. They can download digital products and consume them online. They can share news about their purchases and opinions and review products and services on social media.

12.6 Conclusion

There is little news in the observation that the internet has impacted contemporary life like no other technical product in living memory. With this report and its two predecessors we have tried to go further and quantify its impact at three points in time. We hope that by deepening the understanding of the internet's role in the economy and its structure, we have provided data and analysis that will advance the discussion of policy choices as the advertising-supported internet economy continues to extend its reach and become a larger and more integrated part of the U.S. economy.

About the Authors

John Deighton is a Baker Foundation Professor of Business Administration at Harvard Business School. The focus of his research is on digital and database marketing. The research has been published in a variety of journals including *Journal of Consumer Research*, *Journal of Marketing Research*, *Journal of Marketing*, *Journal of Interactive Marketing*, *Organizational Behavior and Human Decision Processes*, and *Harvard Business Review*. It has received a number of commendations, including the American Marketing Association's Best Article Award for an article in *Journal of Marketing* and an honorable mention from *Journal of Interactive Marketing*.

He was founding editor of *Journal of Interactive Marketing* and a two-term editor of *Journal of Consumer Research*. He has been a visiting scholar at the University of Tokyo, Duke University's Fuqua School of Business, Cambridge University's Judge School of Business, and Oxford University's Saïd Business School. He is a past Executive Director of the Marketing Science Institute, a member of the Chairman's Advisory Council of Marketing Edge, and a Director of the Berkman Klein Center for Internet and Society at Harvard University.

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