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Current research related to digitalization**Defining and Measuring the Digital Economy****Prepared by the United States Bureau of Economic Analysis¹***Summary*

This paper, made possible by support from the Commerce Department's National Telecommunications and Information Administration (NTIA), describes the work of the Bureau of Economic Analysis (BEA) to develop estimates of a new digital economy satellite account. BEA's statistics on gross domestic product (GDP) include economic activity associated with the digital economy, but they do not allow data users to separately identify the contribution of the digital economy to economic growth. These new estimates complement the official statistics by providing a targeted picture of the role of the digital economy in the overall U.S. economy.

This report presents BEA's initial work to lay the foundation for a digital economy satellite account. At this stage, the preliminary estimates are based on goods and services that are primarily digital. The report also describes the challenges to estimating the economic contribution of "partially-digital" goods and services and the opportunities for future research to expand these early estimates into a complete digital economy satellite account.

From 2006 to 2016, BEA estimates that digital economy real value added grew at an average annual rate of 5.6 percent, outpacing the average annual rate of growth for the overall economy of 1.5 percent. In 2016, the digital economy was a notable contributor to the overall economy—it accounted for 6.5 percent of current-dollar GDP, 6.2 percent of current-dollar gross output, 3.9 percent of employment, and 6.7 percent of employee compensation.

¹ Prepared by Kevin Barefoot, Dave Curtis, William Jolliff, Jessica R. Nicholson, Robert Omohundro. This document is a working paper and shares preliminary knowledge and statistics. The goal of the paper is to elicit feedback. The views expressed in this presentation are those of the authors and do not necessarily reflect the opinions of BEA or NTIA.

I. Introduction

1. With the rapid growth of the internet starting in the mid-1990s, the digital landscape has expanded and changed how businesses operate and how consumers engage in transactions with businesses and with each other. Computers are now ubiquitous, and the economy relies on digital and internet technologies in ways that people could not have anticipated even a few years ago. The National Telecommunications and Information Administration (NTIA) reports that 75 percent of Americans reported using the internet in 2015 compared with only 44 percent in 2000.² These technologies continue to change how people work, communicate, purchase goods and services, and perform everyday tasks. There is little doubt as to the importance of digital technology in American business and its role in fostering national economic growth and competitiveness. Measuring the impact of the digital economy is essential for understanding the overall economy given the increasing reliance of businesses and consumers on digital products and services.

2. Studying the impact of digitization on the economy is not a new idea. The Bureau of Economic Analysis (BEA), other agencies in the Department of Commerce, and other organizations have been researching and publishing reports measuring the impact of the “digital economy,” the “internet economy,” or the “new economy” for nearly two decades. The Economics and Statistics Administration has reports on measuring the emerging digital economy as far back as 1998. In 2001, the U.S. Census Bureau issued a report citing the same rationale used by advocates of digital economy measurement today. In 2016, the U.S. Department of Commerce formed the inaugural Digital Economy Board of Advisors (DEBA) made up of distinguished leaders from industry and academia. The DEBA members bring a wide range of experience and knowledge on the digital economy and how it relates to businesses and economic policy. In their first report, the DEBA recommended developing measures of the impact of digitization on economic indicators such as gross domestic product (GDP) and productivity, as well as the extent of digitization across various sectors of the economy.³

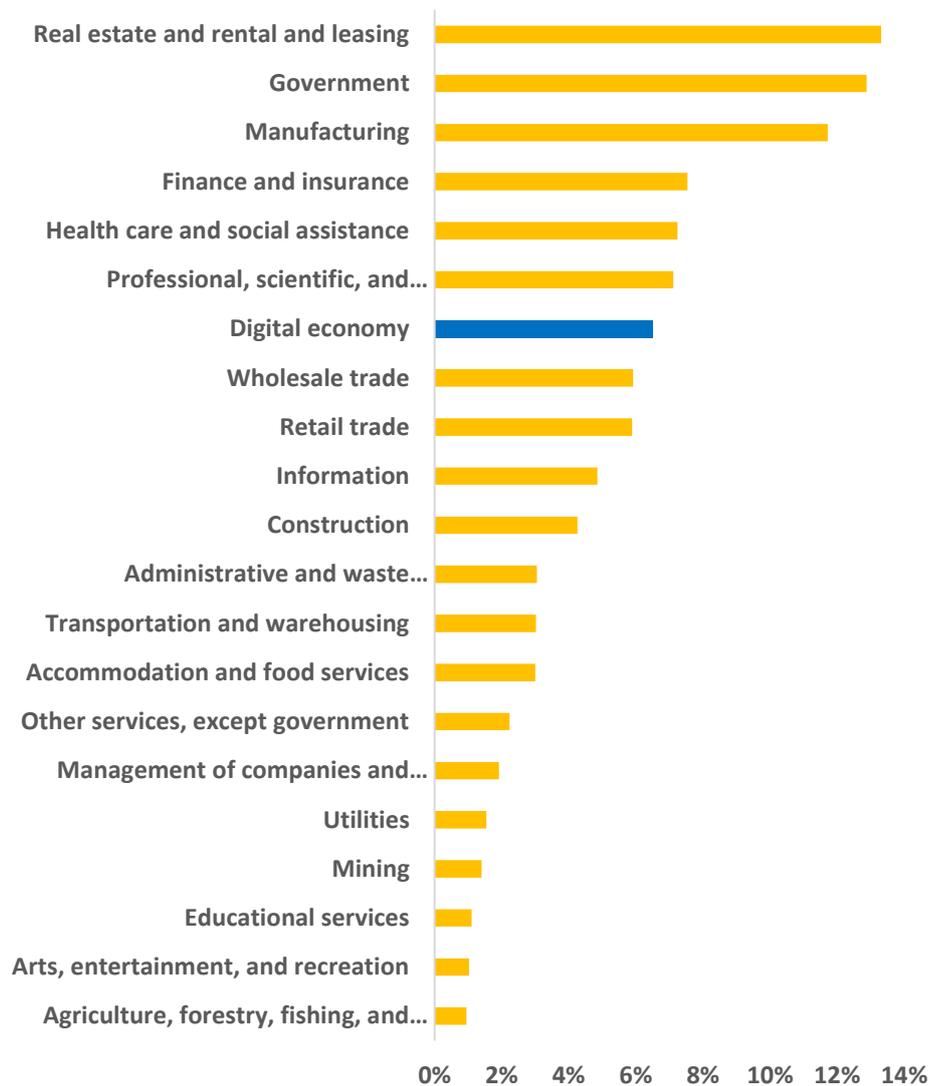
3. This report offers BEA’s first digital economy estimates within the framework of the national accounts. These new statistics provide a deeper understanding of the size and economic importance of the digital economy so that policymakers, businesses, and other stakeholders can make informed decisions. They identify and highlight digital activities that are currently embedded in BEA’s gross domestic product statistics. The data can be used by businesses, researchers and others. This report represents an important step toward BEA’s development of a digital economy satellite account.

4. BEA’s initial estimates show that the digital economy has been a bright spot in the U.S. economy, growing at an average annual rate of 5.6 percent per year from 2006 to 2016 compared to 1.5 percent growth in the overall economy. The digital economy accounted for 6.5 percent (\$1,209.2 billion) of current-dollar GDP (\$18,624.5 billion) in 2016. When compared with traditional U.S. industries or sectors, the digital economy ranked just below professional, scientific, and technical services, which accounted for 7.1 percent (\$1,326.3 billion) of current-dollar GDP, and just above wholesale trade, which accounted for 5.9 percent (\$1,102.6 billion) of current-dollar GDP (chart 1).

² See the National Telecommunications and Information Administration’s Digital National Data Explorer at <https://www.ntia.doc.gov/data/digital-nation-data-explorer#sel=internetUser&disp=map>.

³ See U.S. Department of Commerce. “First Report of the Digital Economy Board of Advisors.” (2016) Available at https://www.ntia.doc.gov/files/ntia/publications/deba_first_year_report_dec_2016.pdf.

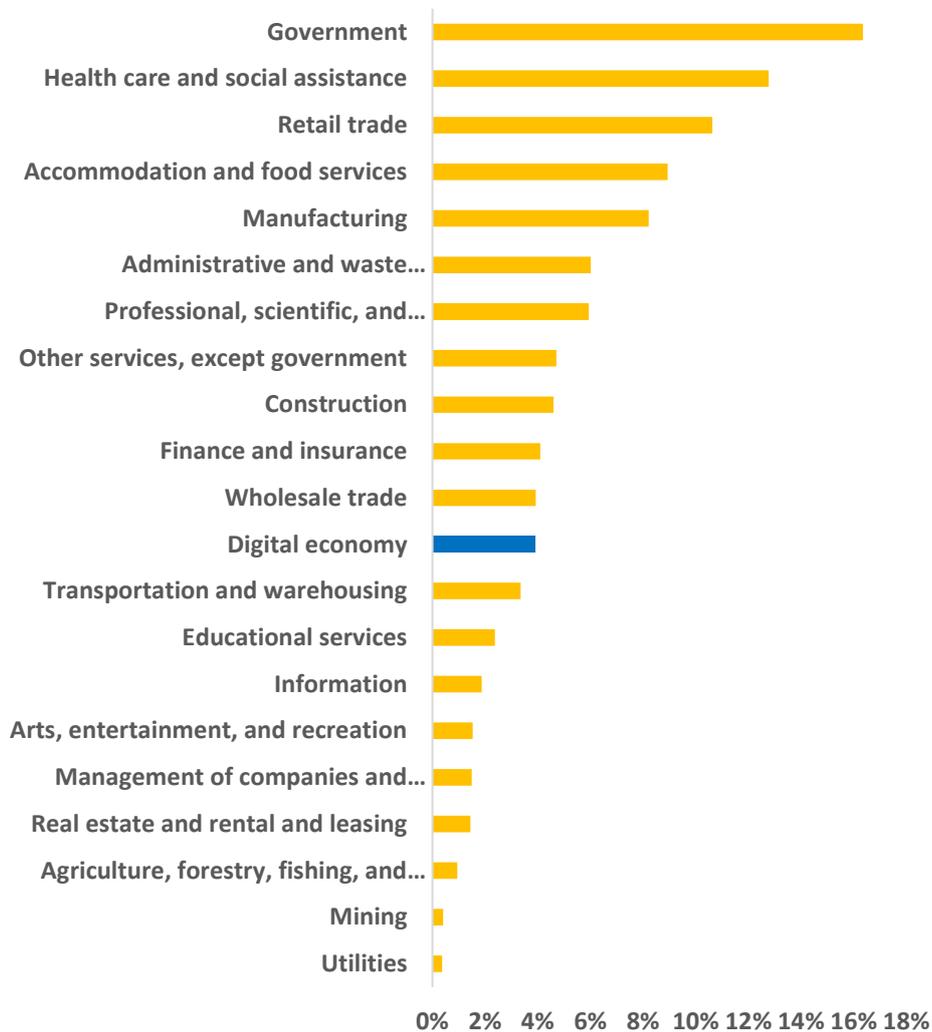
Chart 1

Digital Economy and Industry Share of Total Gross Domestic Product, 2016

Source: U.S. Bureau of Economic Analysis

5. That same year, the digital economy supported 5.9 million jobs, which accounted for 3.9 percent of total U.S. employment (150.3 million), similar to industries like finance and insurance, wholesale trade, and transportation and warehousing (chart 2). Employees working in the digital economy earned \$114,275 in average annual compensation compared to \$66,498 average annual compensation per worker for the total U.S. economy.

Chart 2
Digital economy and industry share of total employment, 2016



Source: U.S. Bureau of Economic Analysis

6. The remainder of this report comprises three sections. The first section discusses the estimation methodology in more detail. The second section presents preliminary digital economy estimates. The report concludes by noting potential areas for research to advance measurement of the digital economy toward the construction of a comprehensive satellite account.

II. Methodology

7. BEA prepared these statistics within the supply-use framework, following methodology used in the production of other BEA satellite accounts, including those on travel and tourism, arts and cultural production, and outdoor recreation.⁴

8. The estimation process includes three main steps:

- (a) Develop a conceptual definition of the digital economy;
- (b) Identify goods and services within the supply-use framework relevant for measuring the digital economy defined in the first step; and
- (c) Use the supply-use framework to identify the industries responsible for producing these goods and services, and estimate the output, value added, employment, compensation and other variables associated with this activity

9. During the second step of this process, BEA reviewed the detailed goods and services categories from the supply-use framework to identify those goods and services that are part of the digital economy.⁵ Some goods and services categories include a mix of both digital and non-digital goods and services. For example, the goods category electronic toys and games, including home video games (excluding cartridges, disks, and tapes) includes both digital video games and non-digital electronic toys. Conceptually, measures of the digital economy should include digital video games; however, due to data and resource constraints, the estimates presented here include the goods and services categories that BEA considers primarily digital.

A. Define the digital economy

10. Just as the idea of measuring the digital economy has been around for many years, so have the challenges associated with its measurement. One of the most fundamental challenges is the lack of a precise and universal definition that clarifies which activities should be included when measuring the digital economy. Part of what makes defining the digital economy difficult is the rapidly changing nature of technology. What is relevant one day might be obsolete the next as businesses and consumers adopt new technologies to perform tasks and communicate. Ideally, the definition of the digital economy would allow for the changing nature of what it encompasses over time.

11. In this paper, BEA defines the digital economy primarily in terms of the Internet and related information and communications technologies (ICT). To develop a definition, BEA relied on analyst expertise and existing literature and statistics on the digital economy. BEA's ICT sector served as a starting point for BEA's definition of the digital economy.⁶ While not

⁴ For more information on the methodology and satellite accounts, see BEA's "Measuring the Nation's Economy: An Industry Perspective. A Primer on BEA's Industry Accounts." Available at https://www.bea.gov/industry/pdf/industry_primer.pdf. The industry accounts are one component of the U.S. economic accounts that provide information on the value and composition of output produced in the United States and on the types of income generated by that production. The national accounting framework excludes goods and services provided at zero cost.

⁵ BEA classifies goods and services using a system based on the North American Industrial Classification System (NAICS).

⁶ The BEA ICT sector consists of computer and electronic product manufacturing (excluding navigational, measuring, electromedical, and control instruments manufacturing); software publishers; broadcasting and telecommunications; data processing, hosting and related services; internet publishing and broadcasting and web search portals; and computer systems design and related

all ICT goods and services are fully in scope, the ICT sector and the digital economy largely overlap. The estimates presented in this report include BEA's ICT sector as well as additional goods and services determined to be in scope for the digital economy. As in the past when BEA developed statistics on the ICT sector, BEA referenced the Organization for Economic Cooperation and Development's (OECD) digital economy measurement literature.⁷ BEA includes in its definition (1) the digital-enabling infrastructure needed for a computer network to exist and operate, (2) the digital transactions that take place using that system ("e-commerce"), and (3) the content that digital economy users create and access ("digital media").

1. Digital-enabling infrastructure

12. Computer networks, such as the internet, are the foundation of the digital economy. Digital-enabling infrastructure is comprised of the basic physical materials and organizational arrangements that support the existence and use of computer networks and the digital economy, these include:

- Computer hardware: The manufactured physical elements that constitute a computer system including, but not limited to, monitors, hard drives, semiconductors, wireless communications products, and audio and visual equipment products.
- Software: The programs and other operating information used by devices such as personal computers and commercial servers, including both commercial software and software developed in-house by firms for their own use.
- Telecommunications equipment and services: The equipment and services required for the digital transmission of information over a distance by cable, telegraph, telephone, broadcasting, or satellite.
- Structures: This includes the construction of buildings where digital economy producers create digital economy goods or supply digital economy services. The structures category also includes buildings that provide support services to digital products. This includes the construction of data centers, semiconductor fabrication plants, the installations of fiber optic cables, switches, repeaters, etc.
- The Internet of Things (IoT): Internet-enabled devices like appliances, machinery, and cars with embedded hardware allowing them to communicate with each other and connect to the Internet.
- Support services: Services necessary for the function of digital infrastructure such as digital consulting services and computer repair services.

2. E-commerce

13. BEA uses the term "e-commerce" to describe, broadly, all purchases and sales of goods and services that occur over computer networks. E-commerce reflects the nature of a transaction for goods or services. BEA considers e-commerce to include digitally-ordered, digitally-delivered, or platform-enabled transactions. These transactions include:

- Business-to-business (B2B) e-commerce: E-commerce that utilizes the internet or other electronic means to conduct transactions of goods and services by businesses to other businesses. Manufacturers, wholesalers, and other industries engage in both

services. BEA's definition is generally consistent with the internationally accepted definition of the ICT sector used and developed by the statistical offices of the OECD and United Nations.

⁷ For information on the OECD's digital economy measurement work, see <http://www.oecd.org/sti/ieconomy/>. BEA also participates in the OECD working group on Measuring GDP in a Digitalized Economy.

interfirm and intrafirm e-commerce to produce goods and services for final consumption.

- Business-to-consumer (B2C) e-commerce: E-commerce that utilizes the Internet or other electronic means to conduct the sale of goods and services by businesses to consumers, or retail e-commerce.
- Peer-to-peer (P2P) e-commerce: The “sharing” economy, also known as platform-enabled e-commerce, involves the exchange of goods and services between consumers facilitated through a digital application. These include, but are not limited to, ride dispatching, accommodation rentals, delivery and courier services, landscaping, food preparation, consumer goods rentals, laundry services, and janitorial services.

3. Digital media

14. The third component of the digital economy is digital media. Increasingly, consumers forgo the physical purchase or rental of products like books, newspapers, music, and videos, opting instead to access these products online in a digital format. BEA defines digital media as the content that people create, access, store, or view on digital devices, specifically:

- Direct sale digital media: Businesses may sell digital products directly to consumers in exchange for a fee, either on an item-by-item basis or through a subscription service.
- Free digital media: Some companies offer digital media to consumers at no cost, such as YouTube or Facebook. Typically, businesses offering these services earn revenue by selling advertising space on the margins of the digital product, like the model followed by many print media or broadcast television outlets. In addition, some consumers create original online content for peer consumption, known as P2P digital media.
- Big data: Some companies generate large data sets as part of their normal operations. This could also include the use of digital media as a mechanism for gathering information about consumer behavior or preferences. These companies may earn revenue by selling this information, sometimes referred to as “big data,” or leveraging it in other ways.

B. Identify digital economy goods and services

15. Using this definition and the existing detailed data from the supply-use tables, BEA identified goods and services for inclusion in the initial digital economy estimates. BEA classifies data in the supply-use tables using a NAICS-based framework that includes about 5,000 categories of goods and services.⁸ (See Box 1 on BEA Methodology for Estimating Supply-Use Tables). BEA relied on analyst expertise and outside research to select over 200 goods and services categories for inclusion in the preliminary estimates presented in this report.⁹ The remainder of this section discusses some of the differences between the goods and services identified in the conceptual definition of the digital economy and the goods and services BEA included in the initial estimates.

16. As noted in the introduction, some NAICS-based goods and services categories include digital goods and services as well as non-digital goods and services. While BEA’s

⁸ At the time of this report, the 2007 benchmark tables contained the latest benchmark data available and used a commodity classification system based on the 2007 NAICS.

⁹ See Appendix Table.

conceptual definition of the digital economy includes all digital goods and services, BEA did not attempt to include the digital portion of those goods and services categories that include both digital and non-digital components in the preliminary estimates, choosing instead to focus only on goods and services categories that are exclusively or primarily digital. Splitting the output of “partially-digital” categories into digital and non-digital portions will require additional source data and other resources to accurately identify the share of output that is in scope for the digital economy, as will be discussed in the last section of this report.

17. Following this approach, BEA included a near-comprehensive list of digital economy hardware, software, support services, and telecommunications goods and services in the infrastructure portion of the digital economy estimates. BEA did not include structures and IoT infrastructure in the initial estimates because of the difficulty in determining the proper allocation of these categories into digital and non-digital components.

18. For both structures and IoT infrastructure, BEA does not have data available to separate digital economy activity from all other activity. The case of IoT infrastructure presents additional challenges. For example, the connectivity of an internet-enabled refrigerator may allow the owner to track and purchase food items when they are running low or record usage of the appliance. However, the primary function of the refrigerator is to keep food cold, output which BEA would not classify as being part of the digital economy.

19. E-commerce output is generally measured as the wholesale or retail trade margin on “digitally ordered” goods and services sold over the Internet or through some other electronic market. The margin is equal to total revenue earned from online sales less the producer cost of the goods and services. For this report, BEA included in the estimates the margins for both B2B wholesale and B2C retail transactions from electronic market establishments. BEA also included some non-margin output in the form of fees for brokers that connect buyers and sellers. BEA did not explicitly include the value of P2P or “platform-enabled” transactions because of a lack of data on the value of these transactions. BEA captures in the supply-use tables the value of P2P activities such as ride dispatching and accommodation, but it is unclear what value from these activities BEA should attribute to the digital economy. More information on the challenges of measuring the output of P2P transaction is included later in the section of this report on areas for future study.

20. As mentioned above, digital media is the content that digital economy users create and access. From this category, the estimates in this report include data streaming services, internet publishing, and internet broadcasting. Streaming and download services includes both subscription-based services that allow unlimited access to digital content as well as one-time purchases of content, such as renting and streaming a single movie or purchasing one song for download. Internet publishing captures fees collected from consumers for access to digital content such as online newspapers or magazines. Internet broadcasting captures fees consumers pay for subscriptions to internet radio, webcasts, or “simulcasts” where large televisions broadcasters simultaneously broadcast over the Internet. The estimates include internet publishing and broadcast licensing which is the revenue publishers receive by licensing use of their content to other platforms. For example, a website may host another publisher’s content. The hosting website may be required to pay a licensing fee to the original publisher for rights to host the content.

21. Other websites offer free digital media to consumers but collect revenue through advertising. While BEA’s national accounts do capture this advertising revenue, the estimates in this report do not include this revenue. BEA currently does not have the data needed to identify what portion of advertising revenue is associated with these websites.

Box 1

Bureau of Economic Analysis Methodology for Estimating Supply-Use Tables

The supply-use tables are an integral and essential element of the U.S. economic accounts. First, they are the building blocks for other economic accounts. Prominent among these are the BEA's national income and product accounts (NIPAs), which feature the estimates of expenditure-based GDP. Second, the supply-use tables show how industries interact; specifically, they show how industries provide input to, and use output from, each other to produce GDP. They are a complete, balanced set of economic statistics, and they present a full accounting of industry and final-use transactions.

The core of the supply-use tables consists of two basic national-accounting tables—a “supply” table and a “use” table. The supply table shows the commodities that are available for domestic consumption. The use table shows the inputs to industry production (intermediate inputs) and the commodities that final users consume. The use table is the most frequently requested table because of its applications to the estimates of GDP.

The BEA uses the North American Industry Classification System (NAICS) to classify industries. The United States, Canada, and Mexico jointly developed this classification system with the aim of improving the comparability of their economic statistics. NAICS classifies industries based on their production processes. The NAICS codes comprise six digits, which reading from left to right, indicate the general sector down to a detailed industry.

The U.S. statistical system does not currently have a separate classification system for commodities, which are groups of similar products defined by the characteristics of the product (commodity) itself rather than by the production process. At present, BEA uses a commodity classification system to assign each commodity the code of the industry in which the commodity is the primary product. The foundation for this commodity classification system is the six-digit NAICS code.

BEA prepares benchmark supply-use tables roughly every five years based on the highest quality source data, notably the U.S. Census Bureau's Economic Censuses. Largely because of their rich source data, the benchmark supply-use tables are the most important statistical source of information for comprehensive updates of the NIPAs and are widely used by other statistical agencies. BEA released the most recent benchmark supply-use tables in 2015. These accounts cover 2007 and use the 2007 NAICS for classification. At the time of this publication, BEA is preparing the 2012 benchmark and comprehensive update of the accounts using the 2012 NAICS, with a planned release date of late 2018.

For more information on the definitions and conventions used in the U.S. supply-use tables, please refer to "Supply-Use Tables for the United States," SURVEY OF CURRENT BUSINESS (September 2015).

C. Identify digital economy industries and prepare results

22. BEA estimated nominal value added, output, compensation and employment by industry for the digital economy. After identifying the goods and services included in the digital economy, BEA identified the industries that produce those goods and services using the supply table. Digital economy gross output by industry represents the total value of in-scope gross output produced by each industry across all digital economy goods and services. Value added for the digital economy is derived from the relationship between the industry output for the digital economy and total industry output. This means the ratio of intermediate consumption associated with the industry output for the digital economy is assumed to be the same as the ratio of total industry intermediate consumption to total industry output. Compensation and employment for the digital economy are derived through the same procedure as value added. Specifically, the ratio of an industry's digital economy output to total output is applied to total employment and compensation for the industry.

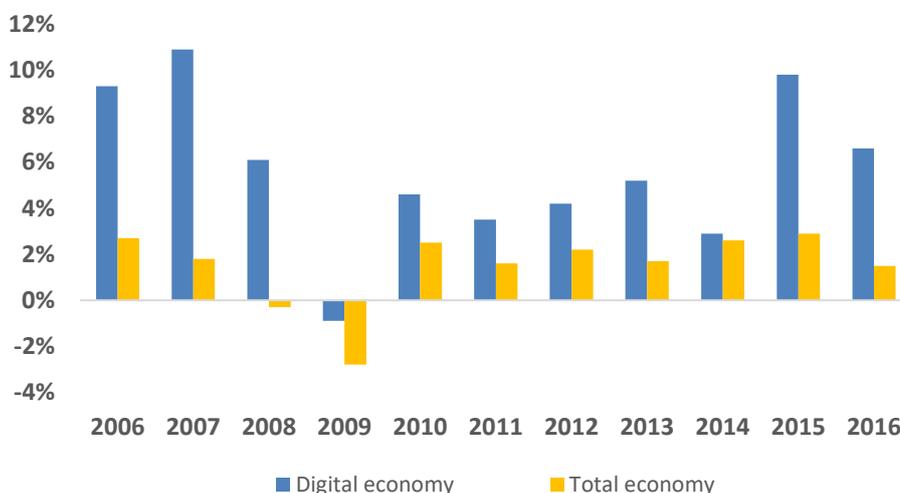
23. BEA prepared price and quantity indexes for digital economy gross output and value added in three steps. First, gross output indexes are derived by deflating each digital good and service produced by an industry that is included as part of its gross output from the supply table. Second, BEA derived indexes for intermediate inputs by deflating all commodities from the use table that are consumed by the industry as intermediate inputs in the production of digital goods and services. Domestic and international sources of intermediate inputs are deflated separately by using the import proportionality, or comparability, assumption. Third, BEA calculated indexes for value added by industry using the double-deflation method in which real value added is computed as the difference between real gross output and real intermediate inputs within a Fisher index-number framework.

III. Results

A. Gross domestic product or value added

24. GDP is the value of the goods and services produced by the nation's economy less the value of the goods and services used up in production. GDP by industry, or value added, is a measure of an industry's contribution to overall GDP. According to the initial estimates, the digital economy was an engine of GDP growth throughout the period covered by these statistics. In 2016, digital economy real (inflation-adjusted) value added totaled \$1,302.2 billion, 82.2 percent larger than it was in 2005. From 2006 to 2016, real value added for the digital economy outpaced overall growth in the economy each year and mitigated the downturn in GDP during the recession in 2008 and 2009 (chart 3). In five of those years, including 2015 and 2016, the two most recent of the series, the digital economy grew over 6 percent.

Chart 3

Digital economy real value added and total economy real gross domestic product: percentage change from previous year

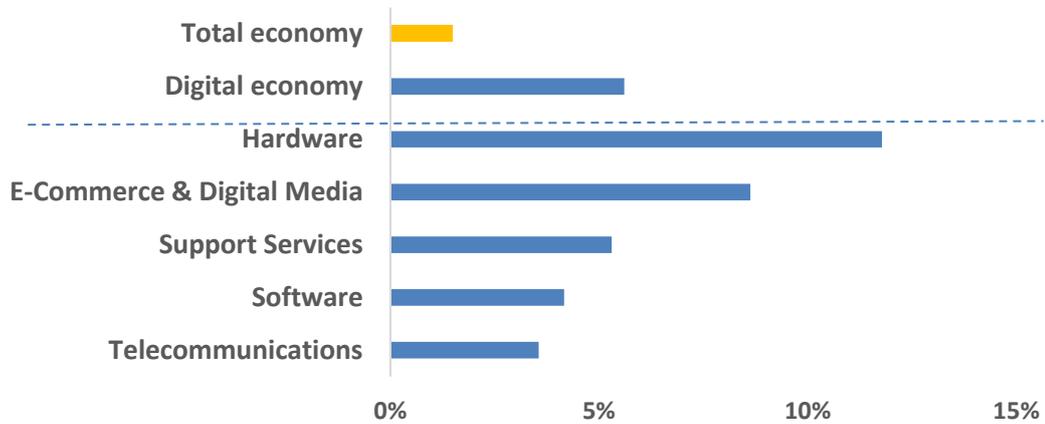
Source: U.S. Bureau of Economic Analysis

25. The relative strength of the real digital economy led it to consistently contribute more to economic growth than its share of the economy. For example, in 2016, the real digital economy's growth of 6.6 percent accounted for 28 percent, or 0.41 percentage point, of the total 1.5 percent growth in real GDP.

26. From 2006 to 2016, the real digital economy grew at an average annual rate of 5.6 percent, while real GDP grew at just 1.5 percent (chart 4). Within the digital economy, hardware and the category of e-commerce and digital media grew faster than the other components, on average, at 11.8 percent and 8.6 percent annually, respectively. Telecommunications grew the slowest of the components, on average averaging 3.6 percent per year. Overall, average annual growth in real value added of digital goods, at 9.1 percent, outpaced digital services at 5.0 percent.

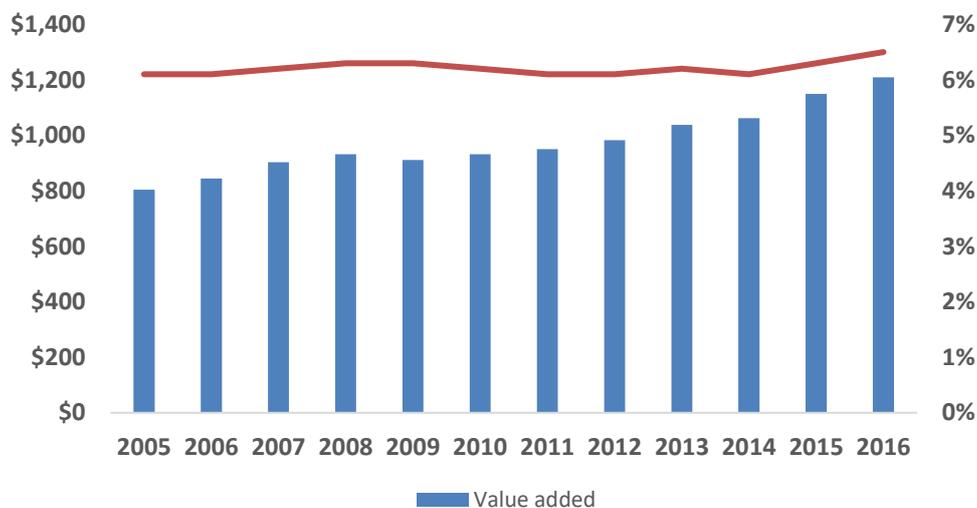
27. From 2005 to 2016, digital economy current-dollar value added accounted for an average 6.2 percent of total U.S. current-dollar GDP each year. In 2016, digital economy current-dollar GDP totaled \$1,209.2 billion, or 6.5 percent of total U.S. current-dollar GDP (\$18,624.5 billion) (chart 5).

Chart 4
Components of the digital economy: real value added average annual growth, 2006-2016



Source: U.S. Bureau of Economic Analysis

Chart 5
Digital economy current-dollar value added (billions) and share of total current-dollar gross domestic product (percentage)



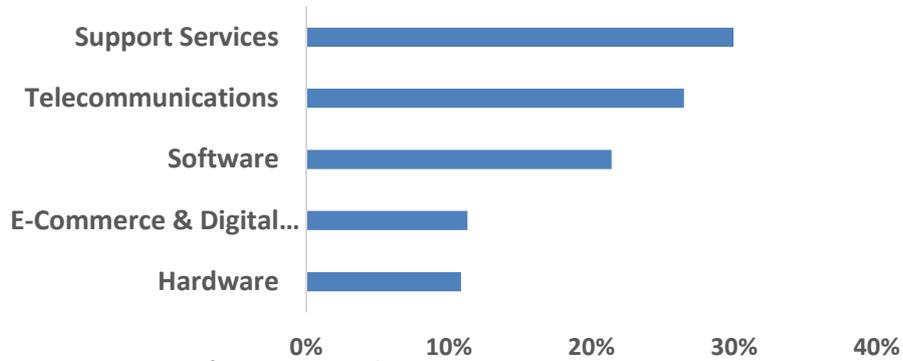
Source: U.S. Bureau of Economic Analysis

28. In 2016, digital-enabling infrastructure, or the hardware, software, telecommunications and support services that allow the digital economy to exist, accounted for \$1,072.6 billion (88.7 percent) of the total estimated \$1,209.2 billion in digital economy current-dollar value added. Digital economy support services totaled \$362.2 billion (30.0 percent) of the total digital economy, telecommunications totaled \$320.4 billion (26 percent), software totaled \$258.8 billion (21.4 percent), and hardware totaled \$131.3 billion (10.9 percent) (chart 6). E-commerce and digital media accounted for the remaining \$136.5 billion (11.3 percent) of the total digital economy current-dollar value added. Services dominated

the digital economy, relative to goods, accounting for 87.5 percent of total digital economy current-dollar value added.

Chart 6

Components of the digital economy: current-dollar value added share of total, 2016



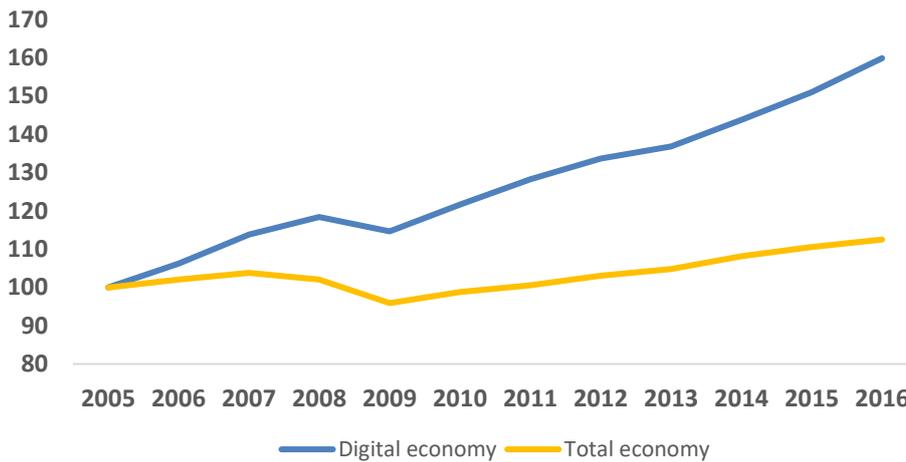
Source: U.S. Bureau of Economic Analysis

B. Gross output

29. Gross output is a measure of sales or revenue from production for most industries. Real gross output for the digital economy grew at an annual rate of 4.4 percent from 2006 to 2016, faster than the total economy, which grew at an average annual rate of 1.1 percent over this period. The compound effect of the faster output growth in the digital economy relative to the overall economy is clearly seen when output is indexed to a base year (chart 7). Since 2010, digital economy real gross output growth averaged 4.9 percent per year and outpaced average annual real gross output growth of 2.3 percent in the U.S. economy, overall, widening the distance between the gross output indexes displayed in chart 7.

Chart 7

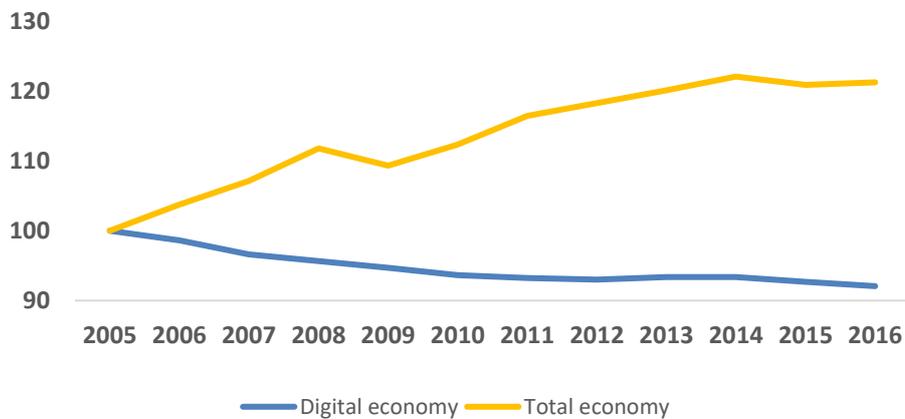
Real gross output index (2005=100)



Source: U.S. Bureau of Economic Analysis

30. During this economic recovery, prices for digital economy good and services decreased at an average annual rate of 0.4 percent (chart 8). Prices for all goods and services in the economy increased at an average annual rate of 1.5 percent.

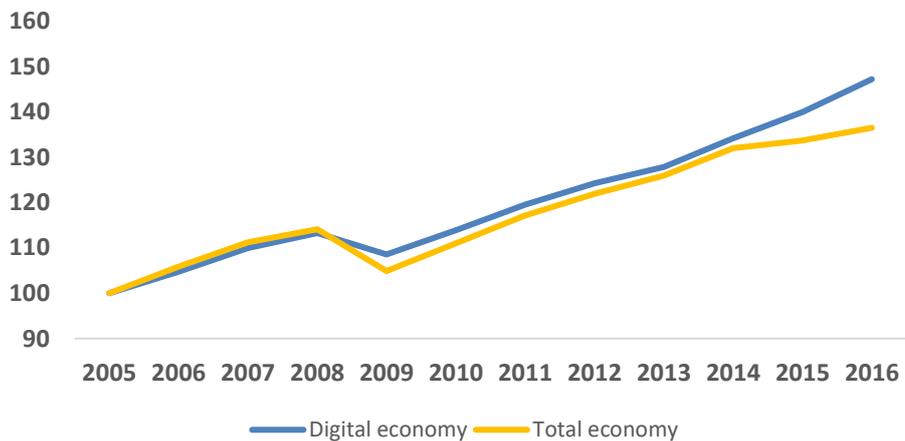
Chart 8
Gross output price index (2005=100)



Source: U.S. Bureau of Economic Analysis

31. Although real output in the digital economy accelerated faster than real output for the economy overall, the falling prices of digital goods and services caused current-dollar gross output growth in the digital economy and the overall economy to be roughly equal until 2014 (chart 9). In 2015 and 2016, total economy current-dollar gross output growth decelerated while growth in the digital economy accelerated slightly (from 4.3 percent average annual growth over the 2006 to 2014 period to 4.7 percent from 2015 to 2016). Digital economy nominal gross output reached \$1.97 trillion in 2016, totaling 6.2 percent of total U.S. nominal gross output.

Chart 9
Nominal gross output index (2005=100)



Source: U.S. Bureau of Economic Analysis

Box 2

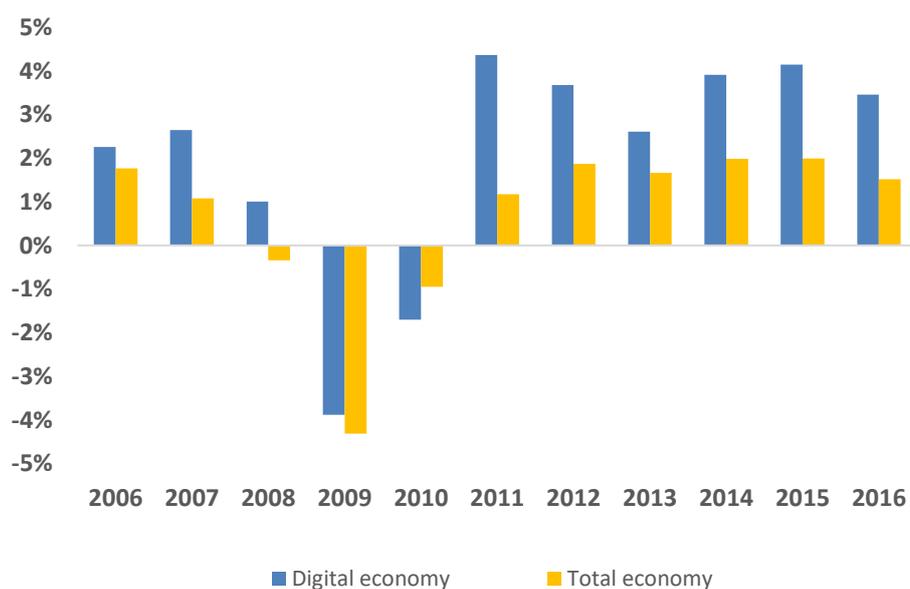
Data availability

The entire time series of digital economy estimates (2005-2016) are available on the digital economy page on BEA's website (<http://www.bea.gov/data/special-topics/digital-economy>). Data include real, current-dollar, and price data for value added and gross output by industry and by commodity. Data are also available on digital economy employment and compensation by industry.

C. Employment and compensation

32. In 2016, the digital economy employed 5.9 million workers, representing 3.9 percent of total employment. Of all digital economy workers, 88.2 percent worked in service-providing industries, most notably computer systems design and related services (1,870,000 employees), other retail (984,000 employees, working primarily in e-commerce), and broadcasting and telecommunications (869,000 employees). On the goods-producing side, the computer and electronic products manufacturing industry supported the most digital economy jobs (572,000). From 2011 to 2016, employment in the digital economy grew at an average annual rate of 3.7 percent compared to an average annual rate of 1.7 percent for the overall economy (chart 10).

Chart 10

Employment: percentage change from previous year

Source: U.S. Bureau of Economic Analysis

33. In 2016, total compensation, including wages and benefits, for these workers was \$674.0 billion, or 6.8 percent of total industry compensation. Workers in the digital economy earned average annual compensation of \$114,275 compared to the economy-wide average of \$66,498.

IV. Potential areas for future study

34. The current digital economy estimates provide insight into the impact of the digital economy on the overall U.S. economy. However, there are opportunities for BEA to expand these statistics into a comprehensive digital economy satellite account to reflect more completely the digital economy's contribution to economic growth. Potential areas for future study, discussed briefly below, are:

- Including additional digital goods and services;
- Incorporating updated statistical classifications, methodologies, and source data;
- Accurately measuring P2P transactions;
- Accounting for digital inputs to production; and
- Estimating the consumer surplus related to the digital economy.

A. Including additional digital goods and services

35. BEA would like to expand these estimates to include the value of the digital economy goods and services from those goods and services categories that include a mix of digital and non-digital components. For some categories, dividing output into digital and non-digital segments may be especially challenging due to a lack of source data or because research remains to be done regarding how to value connectivity or other digital features of a good or service. BEA may also need data to split the value of goods and services categories between different digital economy categories. Furthermore, the weights may vary from year-to-year for some goods and services categories because of the rapid pace of technological advancement in the digital economy.

B. Incorporating updated statistical classifications, methodologies, and source data

36. The rapid advancement of digital technology poses other challenges as well. The digital economy is evolving faster than U.S. and international statistical classification standards, methodologies, and source data. For example, the estimates in this report use BEA's 2007 benchmark tables and the 2007 NAICS classification system, which means that BEA estimates may not fully reflect the current state of the digital economy. This challenge may compound as technology continues to advance.

37. Additionally, the pace of technological change poses challenges for pricing digital economy goods and services. The statistical community has extensively commented and researched the issue of price change for digital products. BEA is actively engaged in research on this topic and continues to explore new data sources to measure accurately price changes for digital economy estimates and other BEA measures. BEA will continue to update the estimates using new classifications, methodologies, and data as they become available and as resources permit.

C. Accurately measuring P2P transactions

38. There are other challenges to properly measuring P2P e-commerce's contribution to the economy beyond the difficulty in separating out the value attributable to the digital economy. In the sharing economy, consumers rent their private goods and services to other consumers. Consumers' rental of their private goods, such as cars for ride-dispatching services and homes for lodging, raises questions as to how BEA should treat certain consumer

durables and whether to consider them as goods strictly for final use consumption.¹⁰ P2P transactions blur the boundary between producers and consumers and call into question how to split output from the digital economy among the standard NAICS industries.¹¹

39. Additionally, revenue sharing among business intermediaries and associated providers of goods and services may introduce measurement error. According to Airbnb, its earnings may be as low as 3 percent of any total transaction, meaning most of gross output flows to private individuals. This raises two potential measurement issues: (1) business intermediaries may differ in their reporting of revenue (gross revenue versus net revenue), and (2) operating costs and/or earnings of households may be misreported or unavailable. The presence of either issue would complicate efforts to measure P2P e-commerce.

D. Accounting for digital inputs to production

40. Digitalization has revolutionized how businesses produce, market, sell and disseminate goods and services. Businesses increasingly employ digital inputs to drive key production activities including: online procurement of intermediate inputs, management of logistical systems, online or digital advertising, internal communication systems (Voice over Internet Protocol or VoIP, online messaging, teleconferencing, etc.), and financial, operational and client management software. In the future, it may be possible for BEA to develop a new input category for digital inputs to production under the current KLEMS (K-capital, L-labor, E-energy, M-materials, and S-purchased services) production framework.¹² Information on business use of digital inputs to production would likely be useful to BEA for weighting goods and services categories that include both digital and non-digital components.

E. Estimating consumer surplus

41. This report does not measure changes in consumer surplus related to the consumption of digital economy goods and services. GDP measures the market value of the goods, services, and structures produced by the nation's economy in a period. That is, it measures the amount that households, businesses, and governments spend on final goods and services. These accounts do not measure consumer surplus, or the difference between what consumers are willing and able to pay for a good or service, and the price that they pay.

42. In today's economy, many services that in the past were available for purchase are now available free-of-charge over the internet. For example, consumers can compare quickly and easily prices for flights or lodging using travel websites and apps rather than calling a travel agent or spending the time to call each airline and hotel. Even some goods have now turned into services. Instead of purchasing a CD or a DVD, digital media allows consumers to access or download content for free or for a fee. Wikipedia and Google have changed how people learn about the world and search for information. Additionally, a single smart phone replaces a myriad of individual goods that consumers formerly individually purchased, such as a camera, a music player, a video game console, etc. There is great interest among digital economy stakeholders in determining the impact of these changes. In the future, BEA may explore ways to measure the impact the digital economy's impact on consumer welfare.

¹⁰ PWC, "The Sharing Economy", Consumer Intelligence Series.

¹¹ See Ahmad and Schreyer, 11

¹² For more on KLEMS, see https://www.bea.gov/faq/index.cfm?faq_id=192.

V. Conclusion and request for feedback

43. Digital goods and services have driven growth in GDP over the last decade. BEA will continue to monitor the production and consumption of digital goods and services as the U.S. economy transforms with the digital age. The digital economy poses measurement challenges, some new and some old, to the traditional methods of calculating GDP and other economic measures. BEA's development of these initial estimates toward a digital economy satellite account is an important step forward in providing statistics showing the impact of the digital economy on the wider U.S. economy.

44. BEA would like input from users to refine these estimates and further the effort to develop a comprehensive digital economy satellite account. Please email all comments to DigitalEconomy@bea.gov. BEA is requesting feedback on the following questions:

1. Does the definition proposed by BEA accurately define the digital economy?
2. What goods and services not captured in the current definition of the digital economy should BEA consider in scope for the digital economy satellite account? Are there goods and services currently included in the definition that should not be included?
3. What datasets could BEA use to estimate in-scope shares of partially digital goods and services?
4. Who would use these new statistics and what would they use them for (please provide specific examples)?
5. Beyond statistics on value added, output, employment, and compensation, what other types of digital economy statistics would be useful?
6. Why are these new statistics needed? What benefits would flow to users from BEA-produced statistics in this area that they couldn't get elsewhere?

VI. Acknowledgements

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Appendix

[English only]

Table A-1. Digital economy goods and services included in BEA estimates	
Digital economy	
Infrastructure	
Hardware	
	<i>Included from NAICS 333</i>
	Digital electronic prepress systems, components, and elements, including color and B/W scanners, digitizers, and recorders
	<i>Included from NAICS 334</i>
	Alarm Systems, including Electric Sirens and Horns
	Audio and Video Equipment, nsk, total
	Audio discs, records, and compact discs (CD), full-length
	Audio tapes, cassette, full-length
	Bare Printed Circuit Board Manufacturing
	Capacitors for electronic circuitry
	Computer Storage Device, nsk, total
	Computer storage devices (except parts, attachments)
	Computer system design, data and information processing and facilities management svcs - reclassified
	Computer terminals (excl. parts/attachments/accessories/etc.)
	Computer terminals, nsk, total
	Consumer audio and video equipment, including audio and video recorders and players (camcorders) and Power amplifiers, including preamplifiers
	Digital cameras
	Electron tubes and parts, excluding glass blanks
	Electronic coils, transformers, and other inductors
	Electronic Computers nsk, total
	Electronic connectors
	External modems, consumer
	Flexible magnetic discs and other recording media, including parts
	Home, Portable, and Automobile Radios and Radio-phonograph-tape Recorder-compact Disc Combinations
	Host computers, multiusers (mainframes, super computers, medium scale systems, UNIX servers, PC servers)
	Impact printers
	Input devices, all types
	Intercommunications Systems, including Inductive Paging Systems (selective paging), except Telephone and Telegraph
	Magnetic tape
	Monitors, accessories, and other peripheral equipment.
	Nonimpact printers
	Optical disks
	Optical scanning devices
	Other computer peripheral equipment, nsk, total
	Other Computers, including Array and Other Analog, Hybrid, and Special Purpose
	Other electronic component manufacturing
	Parts and attachments for point of sale terminals and fund-transfer devices
	Parts, Attachments, and Accessories for Computer Peripheral (input-output) Equipment
	Parts, Attachments, and Accessories for Computer Storage Devices
	Parts, Attachments, and Accessories for Computer Terminals (except point-of-sale and funds-transfer devices)
	Point-of-sale Terminals and Funds-Transfer Devices
	Printed circuit assemblies, loaded boards and modules (printed circuit boards with inserted electronic components)
	Printed circuit assembly (electronic assembly), nsk, total
	Public address systems, including musical instrument amplifiers
	Reproduction of audio discs, records, & compact discs
	Reproduction of audio tapes
	Reproduction of recording media, nsk
	Reproduction of video recording media
	Resistors for electronic circuitry
	Rigid magnetic disks
	Semiconductor and Related Device Manufacturing
	Single user computers, microprocessor-based, capable of supporting attached peripherals (personal computers, workstations, portable computers)
	Software Reproducing
	Speakers, including loudspeakers systems and loudspeakers sold separately, and commercial sound equipment
	Television Receivers, including Combination Models
	Vehicular and pedestrian traffic control equipment, including electric railway signals and attachments
	<i>Included from NAICS 339</i>
	Other electronic toys and games, including home video games (excluding cartridges, disks, and tapes)

Continued on next page

Table A-1. Digital economy goods and services included in BEA estimates (continued)

Software
<i>Included from NAICS 511</i>
Application software publishing (other than games)
Game software publishing
Inventory Change For Software Publishers
Licensing of rights to reproduce & distribute computer software
Software related technical support services
System software publishing
<i>Included from NAICS 541</i>
Own-Account Software
Support Services
<i>Included from NAICS 518</i>
Application service provisioning, website hosting, and other IT infrastructure provisioning services (includes collocation and streaming services) ¹
Auxiliary Data Processing Services
Business process management services (includes provision of facility)
Data management, processing, storage, and information and document transformation services
<i>Included from NAICS 541</i>
Computer Facilities Management Services
Computer Systems Design Services
Custom Computer Programming
Other Computer Related Services
<i>Included from NAICS 611</i>
Computer training schools (taxable)
Other technical & trade schools (taxable)
<i>Included from NAICS 811</i>
Communications equipment repair and maintenance
Computer & office machine repair & maintenance
Consumer electronics repair and maintenance
Telecommunications
<i>Included from NAICS 334</i>
Antenna systems, sold separately
Broadcast, studio Parts and accessories
Broadcast, studio, and related electronic equipment
Carrier Line Equipment & Nonconsumer Modems
Cellular handsets (cell phones)
Data Communications Equipment (including routers, gateways, bridges, terminal servers, and concentrators)
Other communication systems and equipment
Other Communications Equipment, nsk
Parts, components, and subassemblies for other telephone and telegraph equipment
Parts, components, and subassemblies for telephone switching equipment
Radio and TV Broadcasting and Wireless Communications Equipment, nsk
Radio station equipment including satellite, airborne and earth-based (fixed and mobile)
Telephone Apparatus, nsk
Telephone sets, including wireless phone sets, exclude cell phones
Telephone Switching Equipment
Wireless networking equipment
Wireline voice equipment
<i>Included from NAICS 335</i>
Electronic wire and cable, made of nonferrous metals (purchased wire)
Fiber optic cable for communication, nsk, total
Fiber optic cable, all other applications
Fiber optic cable, communication applications
Other communication and energy wires, nsk, total
Telephone and telegraph wire and cable, made of nonferrous metals (purchased wire)

Continued on next page

Table A-1. Digital economy goods and services included in BEA estimates (continued)
Telecommunications (continued)
<i>Included from NAICS 517</i>
Basic fixed local telephony (other than telecom resellers) - (Includes subscriber line and calling feature charges)
Basic fixed local telephony (provided by telecommunications resellers) - (Includes subscriber line and calling feature charges)
Basic fixed long distance and all distance telephony (other than telecom resellers)
Basic fixed long distance and all distance telephony (provided by telecommunications resellers)
Broadband (always on) internet access services
Carrier services (other than satellite telecom) - (Includes network access and Internet backbone services)
Force account, telephone equipment installation
Internet telephony
Licensing of rights to use intellectual property of all other telecommunications
Licensing of rights to use intellectual property of telecom resellers
Licensing of rights to use intellectual property of wired telecom carriers
Licensing of rights to use intellectual property of wireless telecom carriers
Mobile local, all distance and long distance telephony (other than telecom resellers) - (Includes mobile telephony calling feature charges)
Mobile telephony services (provided by telecommunications resellers) - (Includes mobile telephony calling feature charges)
Multichannel programming distribution services (analog and digital) (includes startup and reconnect fees)
Narrowband (dial-up) internet access services and other telecommunications services
Paging, mobile dispatch, and specialized wireless services
Private network services (other than satellite telecom)
Satellite telecommunications services - (includes carrier services and private network services of satellite telecommunications)
E-Commerce and digital media
E-Commerce
Business-to-Business
<i>Included from NAICS 425</i>
Wholesale trade margin output, Business to Business Electronic Markets
Wholesale trade nonmargin output, Business to Business Electronic Markets
Business-to-Consumer
<i>Included from NAICS 454</i>
Non-margin retail trade, Electronic Auctions
Retail Trade Margin, Electronic Shopping
Digital Media
<i>Included from NAICS 512</i>
Own account subscription TV program originals
<i>Included from NAICS 515</i>
Air-time sales for the broadcasting of radio program content
Air-time sales for the broadcasting of television program content
Licensing of rights to broadcast radio programs
Licensing of rights to broadcast television programs
Licensing of rights to distribute specialty television or audio programming content
Own account broadcast TV program originals
Public and non-commercial programming services - Radio (includes contributions, gifts, and grants)
Public and non-commercial programming services - TV (includes contributions, gifts, and grants)
<i>Included from NAICS 518</i>
Application service provisioning, website hosting, and other IT infrastructure provisioning services (includes collocation and streaming services) ¹
<i>Included from NAICS 519</i>
Internet publishing & broadcasting - subscriptions & sales
Licensing of rights to use intellectual property of internet publishers and broadcasters
nsk: not specified by kind
1. Service is allocated to both Infrastructure, Support services (90%) and Digital media (10%).
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