THE WIRELESS INDUSTRY: REVISITING SPECTRUM, THE ESSENTIAL ENGINE OF US ECONOMIC GROWTH

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EXECUTIVE SUMMARY

The wireless industry is making a greater impact on America than ever before. The world is becoming hyper-connected, with smart phones, smart meters, smart houses, smart cities, smart businesses and smart people all relying on the fast connections that the wireless industry provides. In just four years, the wireless industry's contributions have grown dramatically. For example:

- In 2014, the wireless industry generated $194.8 billion of domestic economic value (excluding imports and exports) in the US, up 34% from 2011.
- In 2014, the US wireless industry generated $282.1 billion in US GDP, up 44% from $195.5 billion in 2011.
- The industry's global economic impact has grown at a breakneck speed to $332.9 billion, an expansion of 71% since our last report.

This report looks at the effect of the US wireless industry on the US and global economies and provides a hint of the developments we'll soon see if the government continues to provide additional spectrum. We also examine the current consumer surplus, its significance and the historical trends. The overall annual wireless consumer surplus in the US today—measured across voice minutes of use, SMS, and data usage—is $640.9 billion.

Underscoring its essential place in today's society, the wireless industry is now larger than the computer systems design industry, legal, publishing (including software), agriculture, petroleum and coal production, and other storied sectors which themselves are benefiting from wireless.

As the wireless industry has grown, it has become the midwife of countless new businesses—conceived from the fertile minds of American entrepreneurs—that sprouted where nothing existed a few short years earlier. Apps, which were a $10 billion phenomenon in 2011, became a $36 billion juggernaut in 2014. But apps haven't gotten there entirely by themselves. Wireless operators are more indispensable than ever because without the connectivity they provide none of this would be possible.

That constant wireless network connection makes smart phones and the fast-growing app economy soar. Think for a moment about mobile health apps, which make a daily, if not hourly, difference in the lives of millions of people. That would not be possible without a constant wireless connection and available spectrum.

The most remarkable thing about the wireless industry is that even after the amazing growth we chronicled between 2011 and 2014, the industry is still only on the threshold of what's possible with the marriage of high-quality, super-fast mobile connections and billions of devices.

In the not-too-distant future, 5G will usher in a new era of even faster wireless broadband connections everywhere, anytime. Video will be even easier to access, smart vehicles and transportation will be revolutionized, virtual reality will expand beyond theory and gaming to commercial applications, and the Internet of Things will fundamentally transform entire industries like shipping, health, transportation, insurance and more. The ability to control critical devices from anywhere and improve our quality of life will be nothing short of amazing. IoT will have societal impacts that will exceed the current impact of social media.

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THE GLOBAL IMPACT OF THE US WIRELESS INDUSTRY

Key Points

- The US wireless industry generated $194.8 billion in domestic GDP, which excludes exports
- The US wireless industry contribution to the global economy is $332.9 billion

Mapping out the competitors

There's a common saying that mobile is everywhere. That's intriguing, but we go a step further. Not only is mobile everywhere, but soon it will be *in everything* because almost everything is more powerful when it is connected wirelessly.

The reach and economic impact of the wireless industry is positive, powerful, profound and continues to grow. Using publicly available information from 2014, we investigated each component of the US wireless industry and calculated how much value each generated in the US, and how much stays in the US. The picture that emerges is one that underscores the broad and deep impact the industry has on the US economy.

Recon Analytics conducted similar reviews in 2005, 2008 and 2012. In the earlier reports, we saw a growing industry that supported millions of jobs, paid hundreds of billions of dollars in taxes and fees to the US and state governments, and was the genesis of the app economy. Since 2012, the wireless ecosystem has clearly evolved into a multi-polar world with independent but related businesses.

In 2014, the wireless industry had six distinct groups of players:

- Device manufacturers that create, engineer and manufacture the devices
- Wireless operators that sell and deliver services to users
- Retailers and third-party dealers that bring products to the public
- Ad agencies and channels that market products and services
- Suppliers of equipment and services that provide hardware and know-how
- App providers that create a variety of apps engineered just for mobile devices

We now see the emergence of a seventh industry participant: the on-demand economy.

Wireless industry value chain

Fast innovation, record growth, significant expansion

In 2014, the wireless industry generated $194.8 billion of economic value in the US—34% more than in 2011. Even more astoundingly, the industry's global economic impact has grown at breakneck speed to $332.9 billion, an expansion of 71% since 2011 (a compounded annual growth rate (CAGR) of 14.2%).[1]

The value chain for the wireless industry has expanded significantly since our 2012 report, with some segments seeing breathtaking growth. In 2012, we pegged the wireless industry's GDP contribution (the revenue, wages and profit that remain in the US) at $146.2 billion. With the additional $49.3 billion generated by operations outside the United States the industry generated $195.5 billion in gross world product in 2011. These foreign operations consist of network infrastructure providers such as Ericsson and Nokia (which now includes Alcatel-Lucent) and billing providers such as Amdocs. They also include handset manufacturers ranging from Samsung, LG and HTC to Motorola (now owned by Lenovo) as well as a large number of foreign-based companies that support the US wireless ecosystem.

The value chain now includes 18 types of players, two of which didn't exist at the time of our last report in 2012 (we have color-coded and grouped the sectors: **maroon** for device-related, **blue** for carrier-related, **purple** for retail, **black** for ad-related, **salmon** for network and suppliers, **light green** for apps, and **dark green** for the burgeoning on-demand economy):

- **Device and Accessories Manufacturers**
- **Device Component Suppliers**
- **Device Trade-in Programs**
- **Wireless Operators**
- **Wireline Operators**
- **MVNOs**
- **Retailers and Third Party Dealers**
- **Advertising Agencies**
- **TV, Radio, Print, Internet Ad Channels**
- **Network Equipment Suppliers**
- **Other Suppliers of Capital Equipment**
- **Professional Services**
- **Platform and Component Suppliers**
- **App and Content Stores**
- **Content**
- **App Developers**
- **Mobile Advertising Networks**
- **On-Demand Economy**

Apps have grown to $36 billion from $10 billion four years ago (a 37% CAGR) and almost zero 10 years ago. Apps ride atop wireless networks but now generate that $36 billion in revenue directly from the customer, independent of the operators.

The burgeoning on-demand economy has sprouted in the past two years from nonexistent to a $4.4 billion segment. This new phenomenon, which is built on the back of wireless services and relies on wireless broadband networks, has enabled previously unimagined, or even impossible, innovations to become part of daily life in a very short amount of time.

The changing shape of the wireless industry is delivering increased value to new entrants, traditional providers, and consumers alike. For example, device trade-in programs have become an integral part of the device purchase process that allows customers to monetize devices. Device trade-in programs generate $4.6 billion in revenues and return $3.2 billion to customers' wallets. Wireless operators alone retain in the US $87 billion of the value they generate, up 68% from $51.8 billion in 2011—which provides tremendous economic benefit to the US. Content providers retain $14.1 billion, up 220% from only $4.4 billion in 2011, highlighting how we consume movies, TV shows and music everywhere has been transformed by mobile devices.

Device and accessories manufacturers retain $106.2 billion, a seven-fold increase since 2011, demonstrating the success of devices imagined, conceived, designed, engineered and driven by the preferences and ingenuity of Americans.

Key Points

- The app sector grew to $36 billion in 2014
- Customers now pay a smaller share than ever of the revenue apps generate because of advertising
- In-app advertising grew to $9.2 billion in 2014

Mobile apps and content experiences take shape

Entirely new business sectors level the playing field and create enormous value

The world used to run on regular time. Then Internet time came along, which was faster than normal. Now we all run on mobile time, which has increased the speed of innovation and shortened the length of time products, services and entire companies remain relevant. Products, services and entire companies that were once integral to daily lives have been quickly outmoded by the speed of innovation that runs at mobile time. At the same time, new products, services and companies have sprouted up because they understand the new mobile world and provide users with what they want.

Few industries have evolved as much as wireless has in such a short time. Ubiquitous, wireless, always-on connectivity has gone from the stuff of science fiction to a nice-to-have and now to a seemingly indispensable and perpetual extension of a person—the ubiquitous camera is an example. Cameras are everywhere. They're not the low-resolution cell phone cameras of old. Now these devices are on the forefront of the shift to ultra-high-definition technology. Only 20 of Sony's 40 motion pictures in 2014 and 2015 were released in 4K, yet tens of millions of consumers now have 4K movie cameras in their pockets, shoot videos on a daily basis and immediately distribute those ultra-high-definition movies wirelessly to friends, family and colleagues around the world.

Not long ago, a GPS device was a standalone unit—think Garmin or TomTom—that sat suction-cupped to your dashboard. It was usually out of date quickly, required awkward firmware updates to stay current, and was not connected to the wireless network. So if there was unexpected traffic, it was nearly impossible for it to find an alternate route. Now, the smartphone, with its location-awareness software, has become the GPS device of choice because it offers so much more than dumb directions. Because of the constant wireless connection, people not only get where they want to go, but they can also dynamically avoid heavy traffic, figure out what to do when they get there and even know when their friends are nearby. The wireless connection creates the necessary context for it to all work seamlessly together.

For many, the wireless connection is like the air we breathe. Constant communication with business associates, friends and family is an essential part of modern life and the more transparent (or uninterrupted) the connectivity is, the more powerful it is to a customer's life. If that constant connection is severed, it evokes dramatic feelings of a disconnection from

civilization. Just as wireless has transformed the lives of consumers, it comes as no surprise that it has become an integral yet increasingly invisible part of the US economy.

Moreover, as the wireless industry has grown, it has become the midwife of countless new businesses—conceived from the fertile minds of American entrepreneurs—that sprouted where nothing existed a few short years ago. We wrote a similar sentence in 2012, when we opened up our discussion of the how the wireless industry had fostered the creation of the app sector, which had grown to $10 billion from its humble beginnings as a rounding error less than 10 years earlier. In 2014, it became a $36 billion industry—but it hasn't gotten there entirely by itself. Wireless operators are more indispensable than ever because without the connectivity they provide—and that we take for granted—none of this would be possible. To foster innovation and help wireless become more valuable to customers, a number of operators have launched innovation centers and foundry operations that lower the barriers to entry to enable these start-up businesses to flourish.

The app success story continues in 2015, with apps already accounting for $36 billion of GDP—split between mobile advertising networks ($9.2 billion), content ($14.1 billion), application and content stores ($1.1 billion) and app developers ($11.6 billion). As apps grew in popularity, an interesting phenomenon arose: Because of ad-supported apps, the financial burden has shifted from customers to advertisers. Many apps that were once sustained by user fees are now ad-supported and get the bulk of their revenue that way. At the same time, customers get an equivalent experience without paying.

We can't overplay the importance of the mobile app phenomenon in 2015. A vibrant part of the wireless economy, apps are not just for games anymore. With the rise of tablets, smart watches and wearables—which permeate and enhance every aspect of our lives—developers are increasingly designing apps for enterprise use. Companies now deploy apps on their networks to help colleagues communicate, facilitate huge financial transactions, and open up previously unimagined opportunities. With the rise of the Internet of Things, apps have only just scratched the surface, even at $36 billion in 2014.

In the past few years, the on-demand economy sprung up from nothing. Companies like Uber and Lyft have fundamentally disrupted an entrenched industry with a simple, frictionless way to get a ride from Point A to Point B. Controversy aside, one thing is clear: Uber and Lyft are changing how we move people around while supporting income for more the than 100,000 people who work as drivers.

Such innovations always seem obvious after the fact. However, it took the combination of a mobile device with a fast network and constant location updates to make Uber and Lyft a reality. Hailing a cab in a big city usually involved waiting and then hoping the cab you spotted would stop and be able to take you to your destination. With the on-demand economy, a customer can open an app and input the destination. Using mobile technology, within minutes a car arrives and shuttles the customer. At the end of the trip, there's no fumbling for money because an app on a smartphone handles the financial transaction—from start to finish. This was hardly imaginable a decade ago.

Uber and Lyft are merely two examples of the companies that ushered in the on-demand economy. AirBnB, which has disrupted the long-staid lodging business, reports that 20% of its bookings are made with mobile devices. OpenTable, which has simplified the task of getting restaurant reservations, has forever changed that business and has significant on-the-go usage on mobile devices.

The on-demand economy, now woven so tightly into many people's lives, has changed our behavior. Decisions that once required planning can now be made on the spur of the moment—all made possible by the wireless industry.

Let's look at Exhibit 1. Column one shows the sectors that are active in the wireless economy. Column two represents the value retained from domestic US activities in each sector. Simply put, it's the sum of all economic activity generated by US consumers and companies that is retained by American businesses in the US. This amounts to $194.8 billion (see Exhibit 2 for a visual representation of all the components). Column three represents the global economic activity (including all imports and exports) for each sector (totaling $332.9 billion). See Exhibit 3 for a visual representation of all the components. Column four represents the value retained in the US as a result of that global activity ($282.1 billion). See Exhibit 4 for a visual representation of all the components.

Exhibit 1: Wireless Industry Value-Add
(currency values in billions of US$)

Sector	Value Retained from Domestic Activities	Global Economic Activity	Value Retained in the US
Device and Accessories Manufacturers	$14.9	$106.2	$83.9
Device Component Suppliers	$1.6	$5.3	$1.6
Device Trade-in Programs	$1.4	$1.4	$1.4
Wireless Operators	$87.0	$91.6	$87.0
Wireline Operators	$2.1	$2.1	$2.1
MVNOs	$0.9	$1.2	$0.9
Retailers & Third Party Dealers	$8.1	$8.1	$8.1
Advertising Agencies, PR, and Related	$0.6	$0.8	$0.6
TV, Radio, Print, Internet Ad Channels	$5.4	$5.4	$5.4
Network Equipment Suppliers	$1.0	$3.4	$1.0
Other suppliers of capital equipment	$2.5	$4.1	$2.5
Professional Services	$27.3	$39.0	$27.3
Platform and Component Suppliers	$1.6	$2.7	$1.6
Application and Content Stores	$1.1	$9.9	$9.9
Content	$14.1	$15.7	$14.1
App Developers	$11.6	$12.9	$11.6
Mobile Advertising Networks	$9.2	$18.7	$18.7
On-Demand Economy	$4.4	$4.4	$4.4
Total	$194.8	$332.9	$282.1

Source: US Bureau of Economic Analysis, Recon Analytics analysis, 2015

Wireless grows leaps and bounds

Key Points

- US wireless operators have significantly advanced their network coverage and speed, making wireless even more useful and universal and enabling previously unimaginable innovations
- At the end of 2014, all four nationwide US wireless carriers had at least 270 million Americans with LTE, with the leaders providing LTE coverage to more than 300 million Americans
- Emerging wireless players such as Apple, Microsoft and Google retain significant value from every app transaction around the globe

A vibrant, growing marketplace

We have translated the numbers from the table in Exhibit 2 into a visual representation that shows the impact of the wireless industry on the US economy (see Exhibit 3 for the domestic components of the value chain, Exhibit 4 for the international inflows and Exhibit 5 for the global components of the value chain). In 2014, the wireless industry GDP contribution was $194.8 billion, underscoring the importance of the wireless sector to the US economy, almost as large as the wireless gross world product in 2011 ($195.5 billion).

By the end of 2014, the industry was completely transformed, with segments that weren't even conceived of when we wrote our last report in 2012. The US is now the undisputed global leader in wireless mobility. Operators have advanced their network coverage and speed significantly. As a result, wireless is even more useful and universal. All four wireless carriers provide at least 270 million Americans with LTE coverage, with the leaders covering more than 300 million.

Back in 2012, and in previous reports, the value chain was centered on the wireless operators, with device and accessories manufacturers growing in stature and the app segments coming on fast. This development is significant and all the more intriguing because we have used the same methodology for all of our reports—so these are apples-to-apples comparisons.

In addition, the value chain used to be based on simple transactions, capital and service. An end user would buy a device and pay the operator, dealer or reseller. The value flowed fairly simply from there—to handset suppliers, support providers, wireline carriers and network equipment providers. In 2012, we documented the rise of apps, but the operators were still the largest economic force in the ecosystem. Now, device manufacturers represent the second largest pool of companies generating economic value across the mobile value chain in the US—almost on par with wireless operators. This demonstrates the more distributed nature of the wireless ecosystem's contribution to the economy and indicates that network operators are neither gatekeepers nor barriers to innovation. Rather, they are enablers of innovation, competition and value generation. Device manufacturers and OS providers (i.e., Apple, Google and Microsoft) all generate significant value add, both domestically and internationally. The US wireless customer sits at the hub of this dynamic set of business relationships. Every player caters to the customer's wants and needs. Therefore, the customer drives the global trends in mobile innovation at the network, device and application layers. This dynamic relationship signifies the multi-polar nature of the wireless ecosystem today. It's the proof point of the global nature and drive of American

device and app companies and how far they have come—all built on an American foundation. The rest of the world benefits from the hyper-competitive nature of the American wireless marketplace that is the leader in next-generation network deployment and devices that take advantage of those networks. The wireless experience that consists of the harmonious relationship between networks, devices and applications created for customers in Kansas, Georgia and Oregon are the same devices craved by customers around the world—from China to Zambia.

The US is now truly the global center of wireless mobility, just as customers are at the center of the wireless ecosystem (see Exhibit 2 for a graphic representation of the customer's central role).

As a result, Apple, Google and Microsoft are able to create a value stream from the ingenuity of American engineers by satisfying the need of a global customer base. As late as 2011, the amount of US wireless products and services was very modest because we were at the very beginning of the success of the smartphone revolution. In fact, the US was using a significant amount of products and services from internationally domiciled and owned companies. Now, the tables have turned. Think for a moment about the $750 iPhone. It costs $200 to make the phone and less than $50 to distribute. The $500 difference is all value-add that is attributable to the slogan on the back of the phone: "Designed by Apple in California." In addition, the app economy means that companies like Apple, Google and Microsoft that are so woven into the distribution of apps retain significant value from every app transaction. An app designed in India and downloaded in Latvia will result in a 30% share of that revenue going to Apple, Microsoft or Google in the US. Pick the countries, anywhere in the world, and the results are the same: The US economy benefits from the global impact of American ingenuity.

To reflect this dramatic economic expansion, we have added a third value chain chart—one that covers the significant infusions created in America (see Exhibit 3).

Exhibit 2: Domestic Inflows of the US Wireless Value Chain in 2015

Source: Publicly available data, Recon Analytics analysis, 2015

What the three pictures have in common

Key Points

- The wireless sector shows what the engine of innovation and investment looks like. Customer demand drives network upgrades which, in turn, enable more device innovation and catalyze more innovation at the app layer
- Wireless operators spent $21.4 billion on network equipment and associated services
- Wireless operators, separately, spent an additional $27.1 billion on professional services
- Device and accessories manufacturers realize $36.3 billion in revenue from wireless operators and in turn spend $25.4 billion with device component suppliers
- Customers spent $24.6 billion with app and content stores

Understanding the Value Chain

Let's start at the center of Exhibit 2: Mobile customers are responsible for $265.7 billion of economic activity in the US. Customers spent $179.3 billion on services, devices and accessories directly with US wireless operators; they also spent $40.8 billion with retailers and third-parties, and $2.2 billion with MVNOs for service and devices, another $4.4 billion for on-demand services, and $24.6 billion for apps, movies, music and other content through app and content stores. Those retailers and third-party dealers then conveyed $5.3 billion to MVNOs (via websites, automatic payments, etc.), $12.3 billion to wireless operators, and $15.1 billion to device and accessories manufacturers (when a customer purchases directly from a manufacturer). Retailers retained $8.1 billion, which is composed of profits and supports the direct jobs outlined in Exhibit 8. Customers also realized $3.2 billion in value from trade-in programs.

So, how do US wireless operators expand value generation? They start with network design and keep building. Wireless operators spent $4.7 billion in 2014 for wireline services. This figure includes not only payments for backhaul but also payments for a myriad of other services that include the mobile carriers' interoffice networks. It includes payments for connecting mobile switching networks, providing the synchronization of call record databases and other databases to a wide range of organizations including telecom providers, cable providers, electric utilities, railroads and other organizations that provide private fiber or microwave transport networks and associated services. Wireline operators turn around and spend $2.5 billion of their budgets with network equipment suppliers to fulfill the demands of the wireless operators.

The US wireless operators also spent $21.4 billion with network equipment suppliers on base stations, antennas, core network equipment and associated services. In turn, network equipment suppliers spent $8.6 billion with platform and component suppliers on the various pieces that make up the equipment they sold to the wireless operators and an additional $11.9 billion on professional services.

In 2014, wireless operators also spent billions on professional services, in this case, $27.1 billion for a variety of needs. Moving to the right on the value chain, wireless operators also spent $10.7 billion with other suppliers of capital equipment for needs as diverse as laptops for employees to servers in corporate offices. Wireless operators spent $4.2 billion on marketing and advertising while device manufacturers spent $2.0 billion, for a combined $6.2 billion, filtered through ad

agencies, which retained $0.6 billion and passed on $5.4 billion in the form of TV, radio, print, and internet advertising.[2] Device and accessories manufacturers received $36.3 billion from US wireless operators in the form of direct payments and then spent $25.4 billion with the device component suppliers for the parts that make up their devices.

The most profound change in the value chain in 2014 is the way the customer deals with apps. In the past, the value chain ran directly through the wireless operators. They controlled which apps a customer could see, and which ones they could purchase.

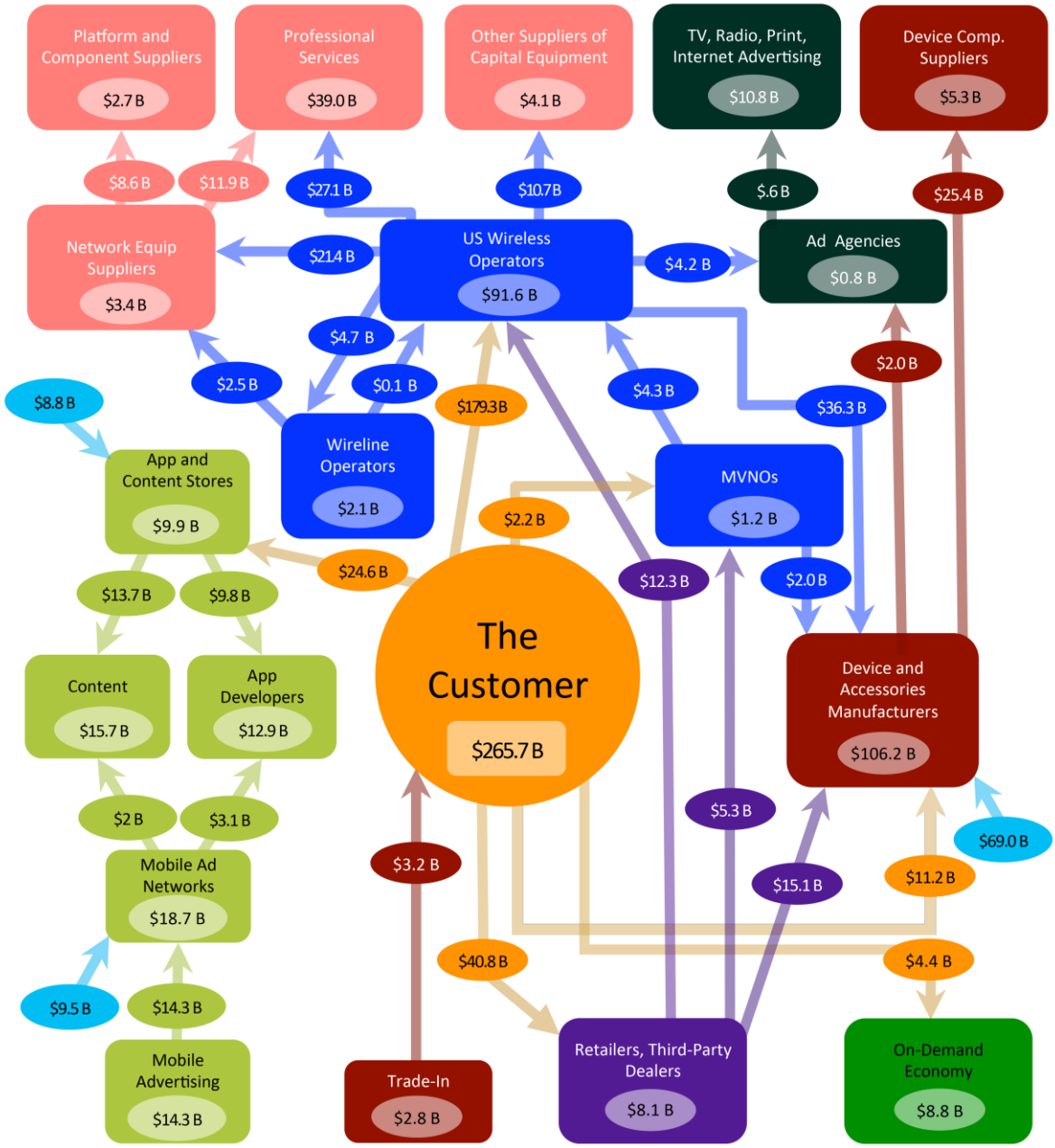
That model has been upended.

In 2014, the customer bypassed the operators and spent $24.6 billion directly with app developers and app stores (which retained $1.1 billion in value). The app and content stores then passed on $13.7 billion to content developers, and $9.8 billion to app developers. Content and app developers are at the center of the app ecosystem and they both also benefit from inflows that start with mobile advertising, which poured $14.3 billion into mobile ad networks in 2014. Those mobile ad networks then sent $2 billion to content and $3.1 billion to app developers.

Exhibit 3: International Inflows of the US Wireless Value Chain in 2015

Source: Publicly available data, Recon Analytics analysis, 2015

Exhibit 4: Global Impact of the US Wireless Value Chain in 2015



Source: Publicly available data, Recon Analytics analysis, 2015

In Exhibits 3 and 4, to get a clear picture of the exports, we have included (in **aquamarine**) the export value add coming back to the US for the following: $69 billion from international device sales, $9.5 billion in international advertising and $8.8 billion in international app store sales.

What the value chain numbers mean

Key Points

- Customers have more choices than ever
- The industry is focused on unanticipated needs and wants
- Americans rely on and trust the wireless industry
- The number of wireless-only households continue to rise, with 47.4% of households cutting the wire, according to the CDC
- Customers now use their devices for so much more than just phone calls

In 2014, we saw a trend we identified in 2011 reaching new heights. The wireless industry continues to push functionality of devices beyond imagination. Apps are engaging customers and providing invaluable services. The industry is clearly no longer in the phone business alone. It has its sights set on the customer's unanticipated needs and wants. In 2015, wireless services have become even more essential to our daily lives, and the customer is the central player in the value chain.

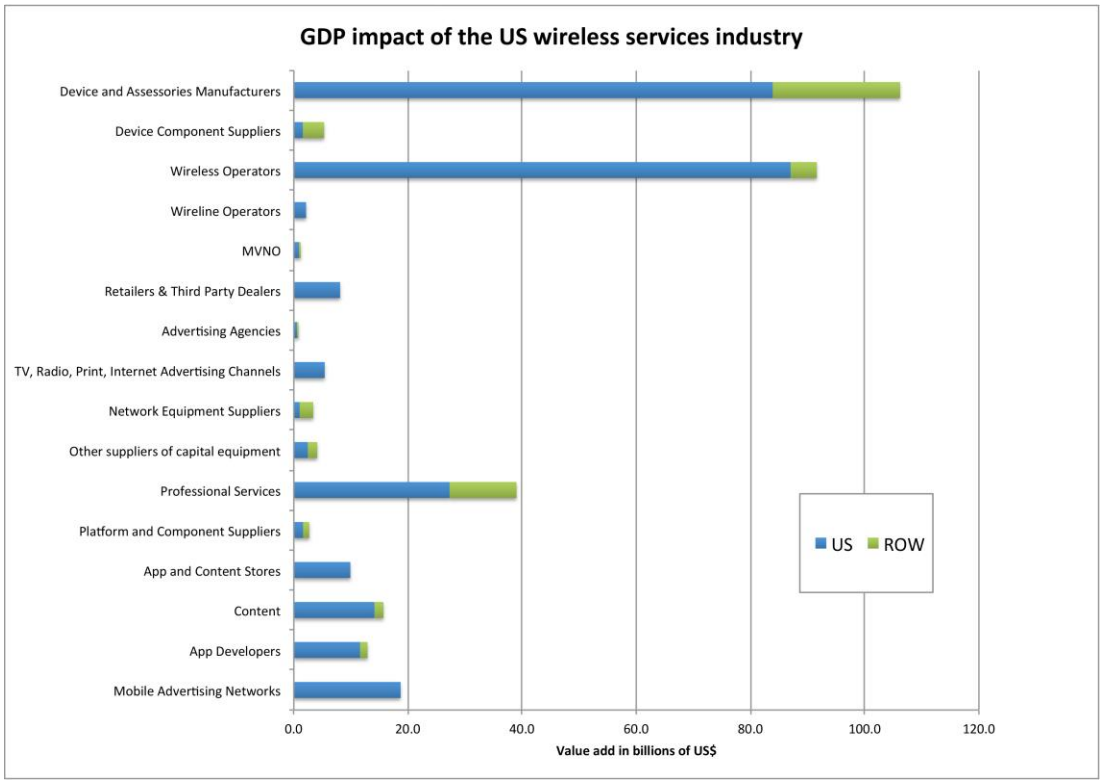
Using a device to make a phone call obviously remains a core capability. In fact, the number of households without a landline indicates that the ability to use a device to make a call is critically important, if often overlooked. And the number of wireless minutes is near an all-time high. According to a CDC survey released in December 2015,[3] 47.4% of American households have "cut the wire" and are wireless-only. The CDC notes that this was a 3.4 percentage-point increase since 2014. At this rate, cord-cutters will be a majority in a very short time.

Phone calls remain important, but customers now want much more from their devices. Texting, location-based services, mobile payments, entertainment, social media, creating and distributing video, real-time video conference calling are a short list of what consumers demand. In its effort to meet and surpass this demand, network operators generate tremendous levels of economic value for entire classes of companies.

The proof is clear in Exhibits 2, 3 and 4. The wireless industry—a customer-centered, connected, cooperative, and competitive ecosystem—provides revenue opportunities for a wide swath of American enterprises, businesses and entrepreneurs alike. Entire new business segments that utilize high-speed wireless connectivity combined with lightning-fast innovations have led to new transformative companies that spring up seemingly overnight and out of nowhere, generating billions of dollars of value in the process. And the customers get what they want (and even sometimes what they didn't know they wanted).

For additional views of this, we provide Exhibit 5, which shows the US GDP distributed between the USA and the rest of the world, and Exhibit 6, which compares the US wireless industry with other industries.

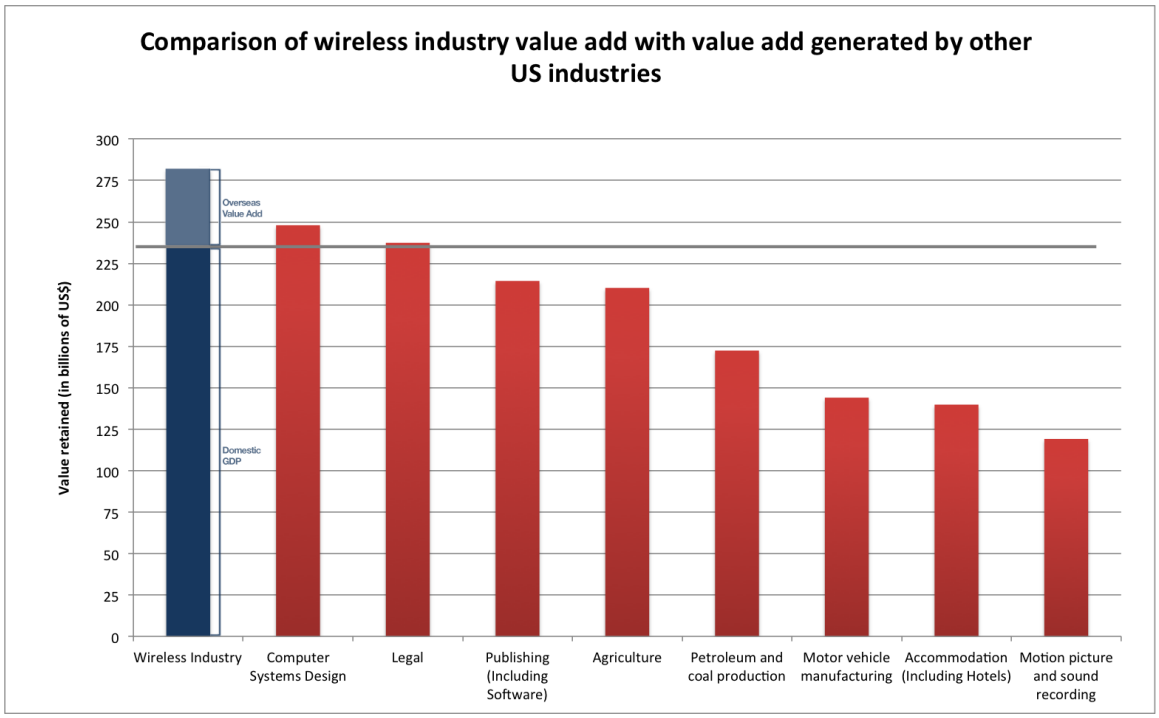
Exhibit 5: GDP impact of the wireless industry



Source: US Bureau of Labor Statistics, Recon Analytics analysis, 2015

Let's look at some key points from Exhibit 5: Device and accessories manufacturers retain $83.9 billion in value, with a large percentage coming from American device manufacturers such as Apple. The remaining $22.3 billion is derived by companies based in other countries (such as Samsung, Lenovo/Motorola and HTC) for a total of $106.2 billion. Wireless operators retain $87 billion in value in the US, with $4.6 in value overseas for a total value add of $91.6 billion. Professional services retains $27.3 billion in the US with $11.7 billion in value overseas due to an increasing number of international professional services providers, such as Nokia and Tech Mahindra, for a total value add of $39.0 billion.

Exhibit 6: Comparing wireless industry value add to other industries



Source: US Bureau of Economic Analysis[3], Recon Analytics analysis, 2015

Underscoring its essential place in today's society, the wireless industry is now larger than the computer systems design industry, legal, publishing (including software), agriculture, petroleum and coal production, and other storied sectors.

Wireless industry employment effects

Key Points

- The industry accounts directly for more than 4.6 million jobs
- Induced employment (using the multiplier effect) is more than 7.0 million

An already broad employment base continues exponential growth

The US wireless industry employs millions of people directly and indirectly (see Exhibit 8). Wireless operators alone account for 1,534,065 direct, support and indirect jobs in the US.

The next biggest sectors are Device and Accessories Manufacturers adding 1,341,992, Professional Services Organizations adding 474,910, Mobile Advertising Networks adding 289,727 and Content adding 262,674.

All sectors together (accounting for the multiplier that we define and explain on the next two pages) account for 4,688,119 direct, support and indirect jobs in the US.

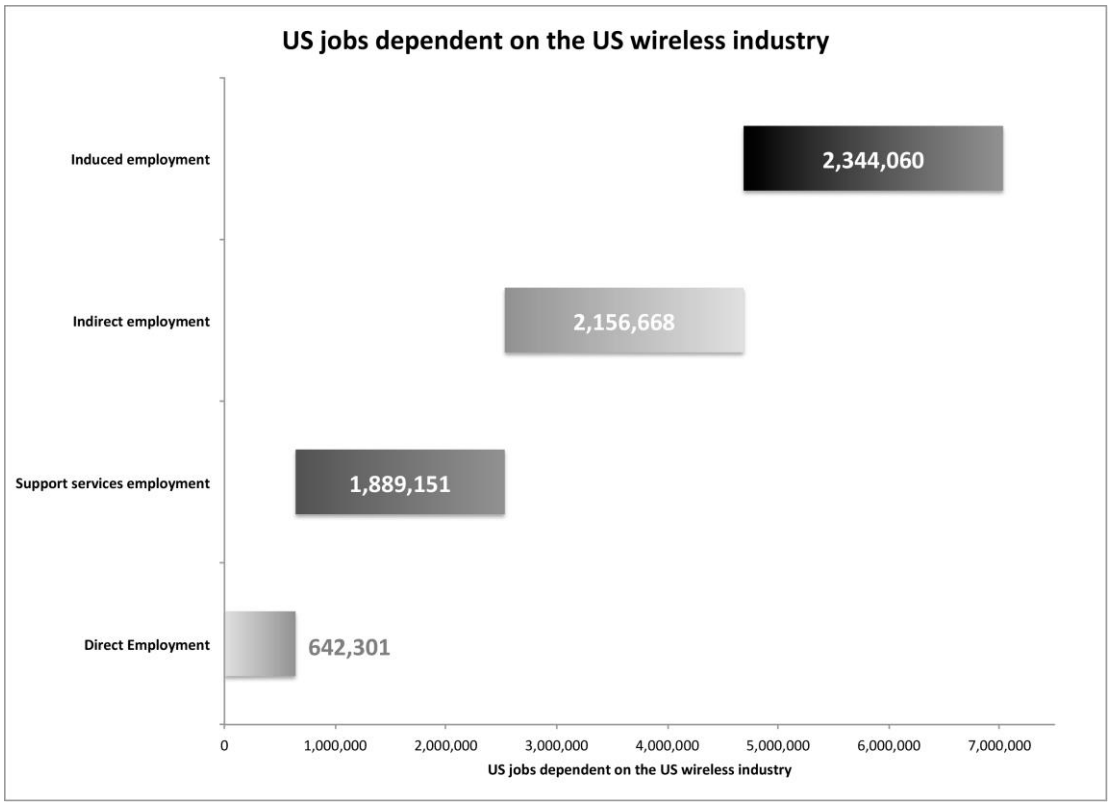
Exhibit 7 shows the direct, support and indirect jobs in the wireless industry; we provide an overall visual summary of our calculations in Exhibit 8.

Exhibit 7: Employment in the US generated by wireless services

Sector	Direct Jobs	Support Jobs	Indirect Jobs	Total Jobs
Device and Accessories Manufacturers	60,307	67,457	1,214,228	1,341,992
Device Component Suppliers	21,027	16,833	8,977	46,837
Wireless Operators	153,180	915,418	465,467	1,534,065
Wireline Operators	24,459	7,258	2,041	33,758
MVNOs	9,121	6,860	1,524	17,506
Retailers & Third Party Dealers	100,620	48,020	15,435	164,075
Advertising Agencies, PR, and Related		7,201	3,811	11,012
TV, Radio, Print, Internet Ad Channels		63,380	34,300	97,681
Network Equipment Suppliers	12,199	8,639	360	21,197
Other Suppliers of Capital Equipment	12,902	8,681	15,626	37,209
Professional Services	30,150	386,957	57,802	474,910
Platform and Component Suppliers	5,355	4,288	5,145	14,788
App and Content Stores	20,396	41,923	83,845	146,164
Content		212,811	49,862	262,674
App Developers	29,899	28,679	8,194	66,771
Mobile Advertising Networks	44,247	55,431	190,049	289,727
On-Demand Economy	118,438	9,316		127,754
Total	642,301	1,889,151	2,156,668	4,688,119
			Multiplier	1.5
			Grand Total	7,032,179

Source: US Bureau of Labor Statistics, Recon Analytics analysis, 2015

Exhibit 8: Employment in the US generated by wireless services



Source: US Bureau of Labor Statistics, Recon Analytics analysis, 2015

Arriving at the employment numbers

The effect multiplies

Each component of the sectors outlined above has three pieces: direct jobs, support jobs, and indirect jobs. The direct jobs are positions that work directly for the companies. The overall wireless industry supported 417,339 such jobs in 2011. In 2014, that number grew to 642,301. In 2011, support jobs in the wireless industry amounted to an additional 1,389,402 positions; in 2014, the figure grew to 1,889,151. Indirect jobs that rely on the wireless industry added up to 716,788 jobs in 2011. In 2014, there were 2,156,668 indirect jobs.

We arrived at the estimates outlined in Exhibit 8 by dividing the value added for the US by the corresponding hourly wage rates, a calculation we show in detail in Exhibit 10. To get a complete picture, we then applied a multiplier. The multiplier effect, an accepted economic principle, results in additional induced employment. Let's explain the term a bit. Induced employment means jobs that, while not directly related to the wireless industry, exist because of the spending power of the millions of people the industry employs directly or indirectly. The effect is fairly straightforward to understand.

For example, the 4,688,119 people in the US with jobs that depend directly or indirectly on the US wireless industry don't hoard their paychecks. The effects of the salaries they receive spread

beyond the wireless sector into the neighborhoods where they live, the stores where they shop, the services they use, and many other parts of the economy. Like everyone, people with jobs that rely on the wireless industry spend money on restaurants, vacations, clothing, food, etc., which all supports additional employment.

Arriving at an accurate multiplier requires some important considerations. It's not an arbitrarily inflated figure that one pulls out of the air, just as it should not be kept artificially low. So to ensure we use the right multiplier, we consulted a number of sources:

- **The Internet Association**, in a report published in December 2015, noted that the US Bureau of Economic Analysis does not provide national multipliers. The IA report used RIMS II values from state multipliers weighted by state employment levels in a particular industry. This produced multipliers for the top 5 states that ranged from 7.8 to 10.08 (implying that for every direct job created an additional 6.8 to 9.08 jobs were created).[4]
- **The Bay Area Council**, in 2012, noted that high-tech jobs have a 5.3 multiplier (i.e., for every high-tech job created an additional 4.3 jobs were created in the local goods and services economy).[5]
- **The Software & Information Industry Association,** in 2012, reported a 1.5 multiplier (i.e., .5 additional jobs for every software job created).[6]
- The **California Department of Labor**, in 2002, assumed a 4.63 multiplier for telecommunications jobs[7] (i.e., 3.63 additional jobs for every one job created).
- **The Scottish Government**, in 2007, assumed a 2.02 employment multiplier[8] (i.e., 1.02 additional jobs for every one job created).
- **The Employment Policy Institute**, in 2011, assumed a multiplier of 1.5 when estimating these effects[9] (i.e., .5 additional jobs for every one job created).

There are other calculations in similar industries that push the multiplier even higher than the Bay Area Council's 5.3 multiplier or the range found in the Internet Association's report. We are certainly sympathetic to that point of view. It's fairly easy to argue that the wireless industry holds such a commanding presence in our society that a majority of *all* jobs and people depend on it.

But we will hold off on that for the purposes of this report because we remain focused on employees with a direct or indirect reliance on the wireless industry.

As a result, we use the conservative 1.5 multiplier, which matches the multiplier we used for our reports in 2011, 2008 and 2005. By sticking to this formula, the methodology remains the same and we can make apples-to-apples comparisons. Perhaps more importantly, we don't risk overstating the benefits. Using the 1.5 multiplier, the number of jobs dependent on the US wireless services industry increases from 4,688,119 to 7,032,179.[10]

The calculation we use to arrive at that figure is fairly simple, as illustrated below.

How the multiplier works

We take the number of direct, indirect and support jobs:	4,688,119
	x
Use the multiplier:	1.5

Arrive at the number of total jobs, including induced jobs	7,032,179

To keep things straightforward, we have applied the multiplier to the top line number (i.e., 4,688,119) but have not included calculations for induced employment for all the numbers of direct, support and indirect jobs.

For example, when we discuss the total number of jobs that sit within wireless operators (1,534,065), we do not include the multiplier. Adding the multiplier would bring that number from 1,534,065 to 2,301,098. But for the sake of clarity, we only discuss induced employment in the context of the overall number (i.e., 4,688,119 x 1.5 = 7,032,179).

Looking closely at the employment numbers

Key Points

- The industry has gained jobs in every sector
- Jobs that depend on the wireless industry grew from 2,523,579 in 2011 to 4,688,119 in 2014. Using the 1.5 employment multiplier, the number of jobs dependent on the wireless industry grows to 7,032,179—over 3.2 million more jobs than in 2011
- Direct jobs grew to 642,301—a 64.0% increase since 2011
- Device and accessories manufacturers' direct jobs grew to 60,307—up 87.6% from 2011

The significant expansion continues

In 2015, overall wireless operator jobs reached 1,534,065, up from 1,044,123. In 2015, the growth in wireless operator jobs came in the form of support jobs, which expanded to 915,418 from 647,067.

What's behind this ongoing shift? Outsourcing deals continue to move jobs from one balance sheet to another—from direct employment for wireless operators to professional services. The duties, job functions and day-to-day responsibilities of the people in those positions remain the same.

The porting of these jobs requires a completely different view of the overall employment numbers. Instead of looking at the individual components (which may go up or may go down slightly over time), it is instructive to look at the big picture.

Comparing the numbers from 2011 with those from 2015, the industry has gained employees in each sector. In 2011, the industry had lost about 71,000 direct and support jobs and gained

189,000 indirect jobs. In 2015, the gains are striking across the board—from 417,339 direct jobs in 2011 to 642,301 in 2015, with big gains for Device and Accessories Manufacturers (from 32,147 in 2011 to 60,307 in 2015) and Professional Services (from 0 in 2011 to 30,153 in 2015) In 2015, an entirely new segment, the On-Demand Economy, sprouted from nothing a few years ago to 118,438 direct jobs.

For this report, we looked at 17 employment sectors related to the wireless industry, compared with 16 in 2011 and 10 in 2008. We did this because, as we noted earlier, entirely new areas have cropped up. Apples-to-apples comparisons are not always possible in this rapidly changing marketplace. But one thing cannot be disputed—in the past four years, the number of jobs that depend on the wireless industry has grown from 2,523,579 to 4,688,119. Using the 1.5 employment multiplier, that figure grows to 7,032,179—more than 3.2 million more jobs than in 2011.

For a full picture of the employment situation in the wireless industry we considered a number of different factors in our calculations across the 17 sectors we investigated. First, we considered the value add for each sector, then we calculated (1) the wage cost, (2) other OPEX costs, (3) and taxes, profit and interest.

Based on those factors, we arrived at a wage cost percentage for each of the three categories, an average wage for each category, and the percent of the value of those salaries that is retained in the US. Finally, using BLS data,[11] we arrived at the number of employees in each of the categories.

Exhibit 9: Estimating employment from wireless broadband services industry in the US

Sector	Value Add		Wage Cost	Average Salary	In US	Employees
Device and Accessories Manufacturers	106.2	Wage Cost	25%	$88,050	20%	60,307
		Other Opex	15%	$47,230	20%	67,457
		Taxes, profit, interest	60%	$47,230	90%	1,214,228
Device Component Suppliers	5.3	Wage Cost	50%	$75,617	60%	21,027
		Other Opex	30%	$47,230	50%	16,833
		Taxes, profit, interest	20%	$47,230	40%	8,977
Wireless Operators	91.6	Wage Cost	11%	$65,779	100%	153,180
		Other Opex	59%	$47,230	80%	915,418
		Taxes, profit, interest	30%	$47,230	80%	465,467
Wireline Operators	2.1	Wage Cost	75%	$65,692	100%	24,459
		Other Opex	20%	$47,230	80%	7,258
		Taxes, profit, interest	5%	$47,230	90%	2,041
MVNOs	1.2	Wage Cost	50%	$65,779	100%	9,121
		Other Opex	30%	$47,230	90%	6,860
		Taxes, profit, interest	20%	$47,230	30%	1,524
Retailers & Third Party Dealers	8.1	Wage Cost	55%	$44,276	100%	100,620
		Other Opex	35%	$47,230	80%	48,020
		Taxes, profit, interest	10%	$47,230	90%	15,435
Advertising Agencies, PR, and Related	0.8	Wage Cost	60%	$67,620	100%	7,099
		Other Opex	10%	$47,230	75%	1,270
		Taxes, profit, interest	30%	$47,230	75%	3,811
TV, Radio, Print, Internet Ad Channels	5.4	Wage Cost	30%	$55,708	100%	29,080
		Other Opex	40%	$47,230	75%	34,300
		Taxes, profit, interest	30%	$47,230	100%	34,300
Network Equipment Suppliers	3.4	Wage Cost	65%	$54,350	30%	12,199
		Other Opex	30%	$47,230	40%	8,639
		Taxes, profit, interest	5%	$47,230	10%	360
Other suppliers of capital equipment	4.1	Wage Cost	50%	$95,332	60%	12,902
		Other Opex	20%	$47,230	50%	8,681
		Taxes, profit, interest	30%	$47,230	60%	15,626
Professional Services	39	Wage Cost	70%	$63,382	70%	301,503
		Other Opex	20%	$47,230	70%	115,604
		Taxes, profit, interest	10%	$47,230	70%	57,802
Platform and Component Suppliers	2.7	Wage Cost	45%	$68,061	30%	5,355
		Other Opex	25%	$47,230	30%	4,288
		Taxes, profit, interest	30%	$47,230	30%	5,145
App and Content Stores	9.9	Wage Cost	25%	$97,078	80%	20,396
		Other Opex	25%	$47,230	80%	41,923
		Taxes, profit, interest	50%	$47,230	80%	83,845
Content	15.7	Wage Cost	60%	$53,112	90%	159,625
		Other Opex	20%	$47,230	80%	53,187
		Taxes, profit, interest	20%	$47,230	75%	49,862
App Developers	12.9	Wage Cost	75%	$97,078	30%	29,899
		Other Opex	15%	$47,230	70%	28,679
		Taxes, profit, interest	10%	$47,230	30%	8,194
Mobile Advertising Networks	18.7	Wage Cost	20%	$67,620	80%	44,247
		Other Opex	20%	$47,230	70%	55,431
		Taxes, profit, interest	60%	$47,230	80%	190,049
On-Demand Economy	4.4	Wage Cost	90%	$33,435	100%	118,438
		Other Opex	10%	$47,230	100%	9,316
		Taxes, profit, interest	0%	$47,230	100%	

Source: Bureau of Labor Statistics, Occupational Employment Statistics, May 2015; Recon Analytics analysis, 2015

Wireless industry revenue and tax contributions

Arriving at the contributions using two methods

In this section, we calculate the taxes that the wireless industry pays to federal, state and local governments in the US. There are two ways to arrive at this figure, which we outlined in 2011 and continued to use in 2015.

In a traditional approach, we would take the value-add and break it into the component parts, then divide it by the average salary that the Bureau of Labor Statistics data shows matches the wireless industry. As in our 2011 report, this top-down approach enabled us to come up with a very valid figure. Although this is the most common approach to solving this problem, we also decided to calculate the amount in a second way. We took the Bureau of Labor Statistics figures, then estimated how many people work in each sector. We then multiplied that out—leaving out the value-add component—to arrive at the final tax figure.

As in 2011, when we completed the separate calculations, the second calculation ended up within 5-10% of the result we got with the first calculation. This kind of congruity confirms that the figures we outline in Exhibits 7, 8 and 9 are accurate.[12]

The tax bill

Key Points

- Direct industry jobs are high paying
- Direct industry employees and employers paid nearly $1 billion in taxes in 2014
- Indirect and support workers paid more than $7.6 billion in taxes in 2014

Measuring the industry's contributions

Jobs come with taxes—for the employer and employee. And in an industry that is responsible for millions of jobs, the calculation of the taxes (including local, state, and federal income, FICA and Medicare tax) is an important measure of the industry's contribution.

So, let's start at the beginning. The wireless industry had approximately 7 million direct, support, indirect and induced employees in 2015. According to the Department of Labor's Bureau of Labor Statistics, the average wage for a direct wireless operator employee in the US was $65,779 annually. That compares with $47,230 for support and indirect positions.

In the US, the average worker paid 6.2% in FICA and Medicare taxes in 2014. Employers paid 7.1% of their employees' wages in FICA and Medicare taxes to the government. The effective Federal income tax rate was up slightly from 13.8% in 2011 to 14.1% in 2014.

Let's take a line item from Exhibit 10 apart.

The average direct employee in the device and accessories manufacturers' category earns a salary of $88,050. That employee, based on tax bracket, pays $16,522 in income tax to the federal government. According to data we collected from the BLS, there are 60,302 people in this category. Simple math shows that multiplying the number of employees by the tax each one pays arrives at $996,407,742 as the amount of federal income tax this group paid in 2014. But the story doesn't end there.

In addition to income tax, employees and employers are responsible for FICA and Medicare taxes. In the case of this direct employee group, the employers pay a total of $377,010,000 to FICA and Medicare while employees hand over another $329,220,000.

One group (indirect workers for device and accessories manufacturers) pays more than $7.6 billion in taxes. It breaks out like this: Because support employees span the entire economy, we are using the average salary of a US employee, which is $67,457. This translates into an annual tax bill of $5,345. That might not seem like much, but when one considers that there are 1,214,228 indirect workers, it adds up to $ 7,670,704,802 in annual taxes, $4,071,708,000 in employer-paid FICA and Medicare and $3,555,576,000 in employee-paid FICA and Medicare.

Exhibit 10: Wireless Tax Contributions

Sector	Type	Segment Size	Income	Federal Income Tax	Federal Taxes	Employer FICA/Medicare	Employee FICA/Medicare
Device and Accessories Manufacturers	Direct	60,307	$88,050	$16,522.37	996,407,742	$377,010,000	$329,220,000
	Support	67,457	$47,230	$6,317.35	426,150,267	$226,206,000	$197,532,000
	Indirect	1,214,228	$47,230	$6,317.35	7,670,704,802	$4,071,708,000	$3,555,576,000
Device Component Suppliers	Direct	21,027	$75,617	$13,414.03	282,058,106	$112,890,000	$98,580,000
	Support	16,833	$47,230	$6,317.35	106,336,931	$56,445,000	$49,290,000
	Indirect	8,977	$47,230	$6,317.35	56,713,030	$30,104,000	$26,288,000
Wireless Operators	Direct	153,180	$65,779	$10,954.60	1,678,021,095	$715,396,000	$624,712,000
	Support	915,418	$47,230	$6,317.35	5,783,016,954	$3,069,699,200	$2,680,582,400
	Indirect	465,467	$47,230	$6,317.35	2,940,517,095	$1,560,864,000	$1,363,008,000
Wireline Operators	Direct	24,459	$65,692	$10,932.93	267,413,785	$114,082,800	$99,621,600
	Support	7,258	$47,230	$6,317.35	45,849,809	$24,337,664	$21,252,608
	Indirect	2,041	$47,230	$6,317.35	12,895,259	$6,844,968	$5,977,296
MVNO	Direct	9,121	$65,779	$10,954.60	99,921,860	$42,600,000	$37,200,000
	Support	6,860	$47,230	$6,317.35	43,337,315	$23,004,000	$20,088,000
	Indirect	1,524	$47,230	$6,317.35	9,630,515	$5,112,000	$4,464,000
Retailers & Third Party Dealers	Direct	100,620	$44,276	$5,578.75	561,332,470	$316,305,000	$276,210,000
	Support	48,020	$47,230	$6,317.35	303,361,207	$161,028,000	$140,616,000
	Indirect	15,435	$47,230	$6,317.35	97,508,959	$51,759,000	$45,198,000
Advertising Agencies, PR, and Related	Direct	5,931	$67,620	$11,414.82	67,699,074	$28,473,867	$24,864,504
	Support	1,270	$47,230	$6,317.35	8,025,429	$4,260,000	$3,720,000
	Indirect	3,811	$47,230	$6,317.35	24,076,286	$12,780,000	$11,160,000
TV, Radio, Print, Internet Ad Channels	Direct	29,080	$55,708	$8,436.93	245,346,216	$115,020,000	$100,440,000
	Support	34,300	$47,230	$6,317.35	216,686,576	$115,020,000	$100,440,000
	Indirect	34,300	$47,230	$6,317.35	216,686,576	$115,020,000	$100,440,000
Network Equipment Suppliers	Direct	12,199	$54,350	$8,097.26	98,776,785	$47,073,000	$41,106,000
	Support	8,639	$47,230	$6,317.35	54,572,916	$28,968,000	$25,296,000
	Indirect	360	$47,230	$6,317.35	2,273,871	$1,207,000	$1,054,000
Other suppliers of capital equipment	Direct	12,902	$95,332	$18,342.89	236,664,683	$87,330,000	$76,260,000
	Support	8,681	$47,230	$6,317.35	54,840,430	$29,110,000	$25,420,000
	Indirect	15,626	$47,230	$6,317.35	98,712,774	$52,398,000	$45,756,000
Professional Services	Direct	301,503	$63,382	$10,355.46	3,122,202,748	$1,356,810,000	$1,184,820,000
	Support	115,604	$47,230	$6,317.35	730,314,017	$387,660,000	$338,520,000
	Indirect	57,802	$47,230	$6,317.35	365,157,008	$193,830,000	$169,260,000
Platform and Component Suppliers	Direct	5,355	$68,061	$11,525.07	61,722,505	$25,879,500	$22,599,000
	Support	4,288	$47,230	$6,317.35	27,085,822	$14,377,500	$12,555,000
	Indirect	5,145	$47,230	$6,317.35	32,502,986	$17,253,000	$15,066,000
Application and Content Stores	Direct	20,396	$97,078	$18,779.29	383,022,764	$140,580,000	$122,760,000
	Support	41,923	$47,230	$6,317.35	264,839,149	$140,580,000	$122,760,000
	Indirect	83,845	$47,230	$6,317.35	529,678,298	$281,160,000	$245,520,000
Content	Direct	159,625	$53,112	$7,787.86	1,243,136,007	$601,938,000	$525,636,000
	Support	53,187	$47,230	$6,317.35	335,997,950	$178,352,000	$155,744,000
	Indirect	49,862	$47,230	$6,317.35	314,998,079	$167,205,000	$146,010,000
App Developers	Direct	29,899	$97,078	$18,779.29	561,476,552	$206,077,500	$179,955,000
	Support	28,679	$47,230	$6,317.35	181,174,054	$96,169,500	$83,979,000
	Indirect	8,194	$47,230	$6,317.35	51,764,015	$27,477,000	$23,994,000
Mobile Advertising Networks	Direct	44,247	$67,620	$11,414.82	505,075,396	$212,432,000	$185,504,000
	Support	55,431	$47,230	$6,317.35	350,176,208	$185,878,000	$162,316,000
	Indirect	190,049	$47,230	$6,317.35	1,200,604,141	$637,296,000	$556,512,000
On-Demand Economy	Direct	118,438	$33,435	$2,868.68	339,759,353	$281,160,000	$245,520,000
	Support	9,316	$47,230	$6,317.35	58,853,144	$31,240,000	$27,280,000
	Indirect	-	$47,230	$6,317.35	-	$-	$-

Source: Bureau of Labor Statistics, Occupational Employment Statistics, May 2015; Recon Analytics analysis, 2015

As we all know, income taxes don't end with federal taxes. In addition to the federal taxes we have calculated here, there are additional liabilities that employees must pay. Direct, support and indirect employees of the wireless industry also pay state and local taxes, amounting to $21.6 billion in 2015, up from $18.4 billion in 2011.

The fees and surcharges

Key Points

- The wireless industry paid $4.9 billion in device equipment sales tax in 2014
- The wireless industry paid $4.7 billion in universal service fees in 2014
- The wireless industry paid $21.6 billion in state and local fees

Of course, even income taxes, FICA and Medicare, and state and local taxes don't complete the picture. That's because the wireless industry also contributes a significant amount of money in the form of fees and surcharges. See Exhibit 11 for an overview.

Exhibit 11: Taxes, fees and surcharges
(monetary units in billions of US$)

Type of Fee or Surcharge	2011 Sales	2011 Fee %	2011 Fee Amount	2014 Sales	2014 Fee %	2014 Fee Amount
Device equipment sales tax	$27.2	7.26%	$2.0	$64.6	7.57%	$4.9
Universal Service Fee	N/A	5.05%	$4.5	N/A	6.46%[13]	$4.7
State and local fees to end users	$164.5	11.21%	$10.2	$187.8	11.5%	$21.6
Totals	$191.7		$16.7	$252.4		$31.2

Source: CTIA Wireless Indices 2014, The Tax Foundation, Recon Analytics 2015

The industry is responsible for paying average federal, state and local taxes, fees and surcharges of 11.5% on $187.8 billion in wireless service sales. There have been some interesting developments in taxation across the country. Absolute state and local income taxes went down in 2014, compared with 2011, for the following states: Connecticut, Delaware, Idaho, Kansas, Maine, Massachusetts, Montana, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Vermont, and Wisconsin. In addition, taxes went down on average income and up on top income in California, while taxes went up on top incomes in Maryland, Minnesota, and Washington, DC.

Also, on average, end-users paid sales tax of 7.57% on device sales of $64.6 billion, which amounts to $4.9 billion and is significantly more than was collected in 2011. In addition, auction proceeds from Auction 96 (H Block) brought in $1.564 billion in 2014, and Auction 97 (AWS3)

brought in $41.3 billion in 2015; we do not include such revenues as a fee because they are not predictable or recurring amounts.

Key Points

- The wireless industry paid a total of **$100.1 billion in taxes and fees** in 2014
- Wireless industry employees paid $33.3 billion in income taxes in 2014
- The wireless industry paid $16.8 billion in FICA and Medicare in 2014
- Wireless industry employees paid $14.7 billion for FICA and Medicare in 2014
- The wireless industry paid **$4.0 billion in state and local income taxes** in 2014
- The wireless industry paid **$4.7 for the universal service fee** in 2014
- The wireless industry paid **$21.6 in state and local fees to end users** in 2014
- The wireless industry paid **$4.7 in state sales taxes on devices** in 2014

Fees, surcharges and taxes all told

The wireless industry contributes a large amount every year in fees, surcharges and taxes to federal, state and local authorities. To underscore this contribution, we have created Exhibit 12, which summarizes and adds up these charges.

Exhibit 12: All the contributions
(monetary units in billions of US$)

Tax or fee	2011 Amounts	2014 Amounts
Employee income taxes[14]	$23.9	$33.3
Employee FICA and Medicare	$11.6	$16.8
Employer FICA and Medicare	$10.1	$14.7
State and local income taxes	$4.6	$4.0
Universal service fee	$4.5	$4.7
State and local fees to end users	$18.4	$21.6
State sales tax on devices	$3.0	$4.7
Total	**$76.1**	**$100.1**

Source: Various publicly available sources, 2015

Adding all the contributions together (including employee income taxes, employee FICA and Medicare, Employer FICA and Medicare, state and local income taxes, universal service fee, and state sales taxes on devices) the wireless industry contributes an impressive $100.1 billion to federal, state and local governments.

The economic impact of making an additional 10 MHz of wireless spectrum available for use nationwide

The wireless industry has experienced explosive growth over the past four years and has delivered spectacular numbers. If we just examine the last four years and attribute the growth that we have seen to the additional 20 MHz[15] (20 MHz AWS1[16]) that have come on air, we observe the following.

- US GDP increases by $24.3 billion
- US employment increases by more than 1.6 million
- Government revenues in the form of taxes and fees paid by the industry and customers increase by $2.3 billion
- Wireless service provider revenues increase by $11.7 billion
- Wireless device revenues increase by $19.3 billion
- Wireless applications and content sales increase by $22.3 billion

Some could argue that the explosive growth of the past few years is not sustainable. However, these skeptics would be ignoring the still unsated hunger for more and faster connectivity by residential as well as enterprise users. This demand is manifesting itself right now with respect to the explosion of use cases for the Internet of Things. Meanwhile, the fifth-generation of wireless technology is on the horizon promising at least an order of magnitude faster speeds, an order of magnitude lower latency and with it two magnitudes more cell sites. It is easy to get carried away about the boundless opportunities and benefits that the wireless industry can enable with the right policy framework. But in our endeavor to be grounded in facts, we want to be conservative.

We calculated the 10-year average impact of an additional 10 MHz of spectrum and that impact is as follows:

- US GDP increases by $3.14 billion
- US employment increases by more than 100,000
- Government revenues increase by $590 million
- Wireless service provider revenues increase by $2.6 billion
- Wireless device revenues increase by $1.6 billion
- Wireless applications and content sales increase by $1.6 billion

Without additional spectrum, especially in the hands of licensed operators, the wireless ecosystem that has injected so much into the US economy could falter and its growth could slow.

The efficiency of spectrum use, which can be improved with certain network technologies, can take licensed operators only so far. After a point, Shannon's Limit takes over, which represents an immutable law of physics that limits how much data can be transmitted over every Hertz. Wireless operators have spent billions of dollars acquiring spectrum in the United States and will continue to earmark significant amounts for that purpose in order to satisfy customer demand. With so much at stake the operators are looking to get a positive return on their investments. In a

symbiotic relationship, wireless service providers are creating the framework within which their customers derive the greatest possible utility, either directly from the service or through the device and application marketplace that has been enabled through the existence of licensed wireless services.

At the time of the first report regarding the impact of the wireless industry on the US economy in 2004, the FCC made 196.5 MHz of spectrum available to licensed wireless operators that was deployed or in the process of being deployed. The amount of spectrum licensed and deployed or deploying increased by 311.5 MHz to 504 MHz by mid-2011. From 2011 to 2014, deployed spectrum increased by an additional 20 MHz.

Exhibit 13 shows the significant impact the additional spectrum deployments had on the US economy.

So, what would the additional 250 MHz of additional spectrum do?

The potential for the remaining 250 MHz of spectrum as promised by the government could produce great benefits.

Spectrum is the fuel on which wireless innovation and economic activity depends. If historic relationships between spectrum and GDP, employment, taxes, and industry revenues hold, we can expect that:

10-year Average Impact

- US GDP increases by up to $78.5 billion
- Support up to 2.6 million US jobs
- Government revenues increase up to $14.6 billion
- Wireless service provider revenues increase up to $63.7 billion
- Wireless device revenues increase up to $39.8 billion
- Wireless applications and content sales increase up to $40.2 billion

Exhibit 13: Impact of Additional Spectrum on the US Economy
(monetary units in billions of US$)

	2011	2014	Difference	Impact of 10 MHz incremental spectrum in last 4 years
Spectrum	504 MHz	524 MHz	20 MHz	N/A
GDP (per year)	$146.2	$194.8	$48.6	$24.3
Total Wireless Employment	3.8 million	7.0 million	3.2	1.6 million
Combined Federal, State, Local and Sales Taxes	$16.7	$31.2	$14.4	$2.3
Wireless Service	$164.5	$187.8	$23.3	$11.7
Wireless Devices	$26.1	$64.6	$38.5	$19.3
Applications and Content	$8.7	$53.2	$44.5	$22.3

Source: Recon Analytics, 2015; differences may not sum tom total due to rounding

In the three years between 2011 and 2014, the wireless industry's contribution to the US GDP increased from $146.2 billion in 2011 to reach $194.8 billion per year by 2015. This indicates that every 10 MHz of spectrum provided to operators creates an increase of $24.3 billion in additional GDP per year, on average over that three-year span. During the same time, total and induced employment derived from the wireless industry increased from 3.8 million to 7.03 million, indicating that every 10 MHz of spectrum creates more than 1.6 million jobs connected with the wireless industry.

The astounding growth in employment will likely continue as the US economy becomes more competitive through the use of advanced wireless technology and services, with apps and the on-demand economy still primed for considerable growth.

Furthermore, federal, state, local and sales taxes have increased as well. In 2011, these taxes amounted to $16.7 billion and went up $14.4 billion to $31.2 billion by 2015. Every 10 MHz that was put in the hands of wireless service providers generated $2.3 billion per year for the government. Revenues for wireless services to wireless operators and resellers increased from $164.5 billion annually in 2011 to $187.8 billion annually by 2014.

This increase translates into $11.7 billion per 10 MHz of additional spectrum. Wireless device manufacturers increased sales from $26.1 billion in 2011 to $64.6 billion by 2015 as the pace of change and innovation reached dizzying heights. The focus on devices is obvious—it's what you hold in your hands and interact with. But the iPhone and all the devices that its introduction has spawned would have been impossible without functioning, high-speed wireless connectivity.

For wireless device providers, 10 MHz of addition spectrum results in $19.3 billion of additional sales in 2014, up from $439 million in 2011. This illustrates the success of smart phones and how much they rely on spectrum. At the same time, additional spectrum, faster data speeds and device capabilities, which in 2011 allowed the wireless application and content market to start its growth, has fueled an amazing success story. Revenues increased from about $8.7 billion in 2011 to $53.2 billion per year in 2014. When we compiled an earlier version of this report in 2004, apps and content were almost a footnote—at $500 million per year. Out of that humble start, a

$53-plus billion powerhouse has been born—one with seemingly no limits on growth. Because spectrum is indirectly also the fuel that makes this all possible, every 10 MHz of spectrum created $22.3 billion in application and content revenues.

Exhibit 14: Spectrum Licensed and Deployed

Band	2004 Licensed and Deployed	Mid-2011 Licensed and Deployed	Mid-2011 Licensed	2014 Licensed and Deployed	2014 Licensed
Cellular	50	50	50	50	50
PCS	120	130	130	130	140
SMR	26.5	14	14	14	14
700 MHz		46	62	46	70
AWS		70	90	90	90
EBS		194	194	194	194
WCS					20
AWS-3					65
1670-1675					5
MSS					40
Total	196.5	504	540	524	688

Source: Recon Analytics, FCC, 2012-2014

The consumer surplus from wireless voice and data services

The Wireless Consumer Surplus is Robust

- The overall annual wireless consumer surplus – combining voice, messaging, and data services – is $640.9 billion.
- The wireless voice services consumer surplus is $435.5 billion.
- The messaging consumer surplus is $78.9 billion.
- The wireless data consumer surplus amounts to $126.5 billion.

Why is the consumer surplus important?

The US consumer wireless surplus measures the extent to which US businesses and US consumers value wireless services in excess of what they currently pay.

The consumer surplus is part of the economic canon and is a core economic concept. Economists view consumer surpluses as highly positive. But the models to measure the surplus are usually hard to build, so they are not undertaken very frequently. Our work on this subject expands the economic research about the impact of the wireless industry on the US economy and reveals the economic benefits that accrue directly to the consumer. One thing is clear: the consumer surplus gives consumers additional buying power, which is a formidable instrument.

And, the growth of the overall consumer surplus in wireless since our last report has been nothing short of breathtaking—with another $103.6 billion going back into consumers' wallets on top of the $537.0 billion we reported in 2011, for a total 2014 wireless consumer surplus—measured across voice minutes of use, SMS (or texting), and data usage—of $640.9 billion.[17]

What generates the wireless consumer surplus in the U.S.? Intense competition, significant operator capex investments, and the efficient utilization of additional spectrum create the atmosphere in which providers can offer consumers a better quality product at lower, more competitive prices.

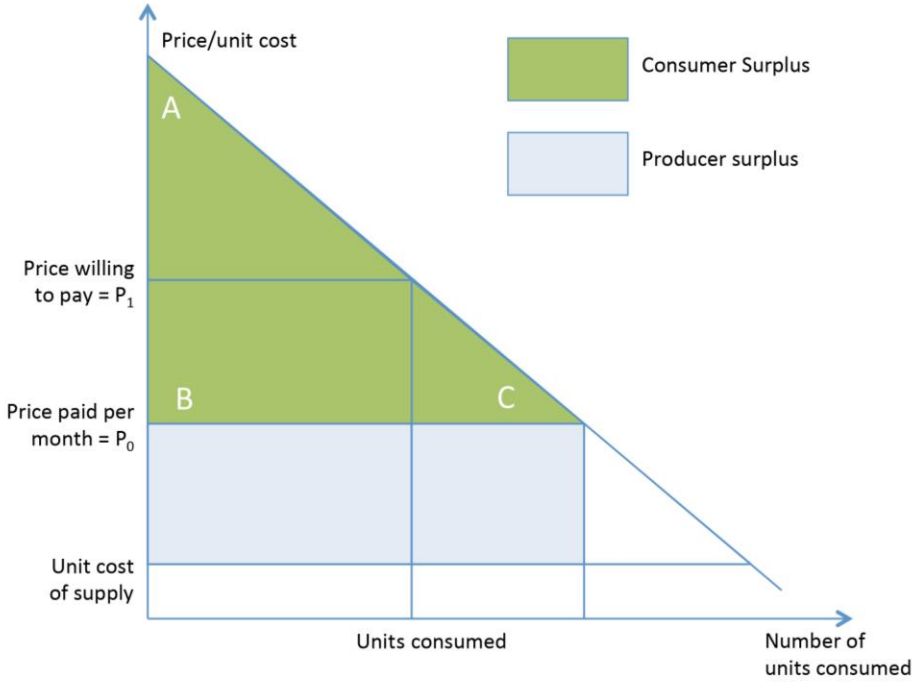
Let's break these figures into their individual components.

With 2.45 trillion minutes of use in 2014, the consumer surplus in wireless voice was $435.5 billion. Texting continues to be an essential part of the wireless marketplace, with more than 2.0 trillion texts in 2015, pushing the text consumer surplus to $78.9 billion.

With the appetite for video seemingly insatiable, data usage continues to grow without pause. Customers used more than 4.06 trillion megabytes of data in 2014. At close to a trillion megabytes higher than 2013 and almost four times the rate in 2011, the 2014 data consumer surplus sits at $126.5 billion.

We illustrate how the consumer surplus works in Exhibit 15, with A, B, and C representing the consumer surplus.

Exhibit 15: Defining the consumer surplus



Source: Recon Analytics analysis and interpretation of publicly available models, 2015

The consumer surplus we outline here is a measure of the combined social and commercial benefits that US consumers generate from purchasing wireless mobile services.

The chart in Exhibit 15 shows that the consumer[18] is willing to pay for mobile services at the level indicated by P_1 every month. In fact, the consumer pays at the level indicated by P_0. As a result, every month the consumer gains a consumer surplus of P_1 minus P_0. This translates into increased disposable income that the consumer can put back into the economy in the form of buying goods and services—or other types of investments. The green area (labeled A, B, and C) represents the total consumer surplus.

In addition, the use of mobile services generates a producer surplus – the other shaded area of Exhibit 15. This is the price paid per month less the cost of supply per month times the number of subscribers or, more simply, the profit to wireless operators from supplying service. Together the consumer and producer surplus measure the overall economic welfare that results from wireless services.

Estimating today's consumer surplus

We estimate that US wireless services generated an annual consumer surplus of $640.9 billion by the end of 2015. As we noted in our report about 2011, the surplus, which had been generated almost entirely from the provision and use of voice applications until a few years ago, now includes significant and growing contributions from SMS and data.

Exhibit 16 outlines similar examples of calculating the consumer surpluses (see Appendix Two for details on the past examples of the consumer surplus we include in Exhibit 16).

Exhibit 16: Current US consumer surplus for wireless services
(in billions of indicated currency)

Estimate	Annual Consumer Surplus	Annual Revenues	Consumer surplus/revenue
Hausman estimate, mid 2002	$115 billion	$77 billion	1.49
UK Radio Communications Agency estimate for UK	£7.2 billion	£5.0 billion	1.44
Previous estimate for end of 2010	$502.7 billion	$163 billion	3.08
Estimate for end of 2014	$640.9 billion	$187.8 billion	3.41

Source: Recon Analytics, Various publicly available sources, 2011-2015

To estimate the consumer surplus for voice, SMS and data, we looked at the following:

- Voice MOUs at 2014 prices against the average per-minute charge.
- The number of text messages multiplied by the average charge per SMS.
- The number of MBs consumed multiplied by the average charge per megabyte.

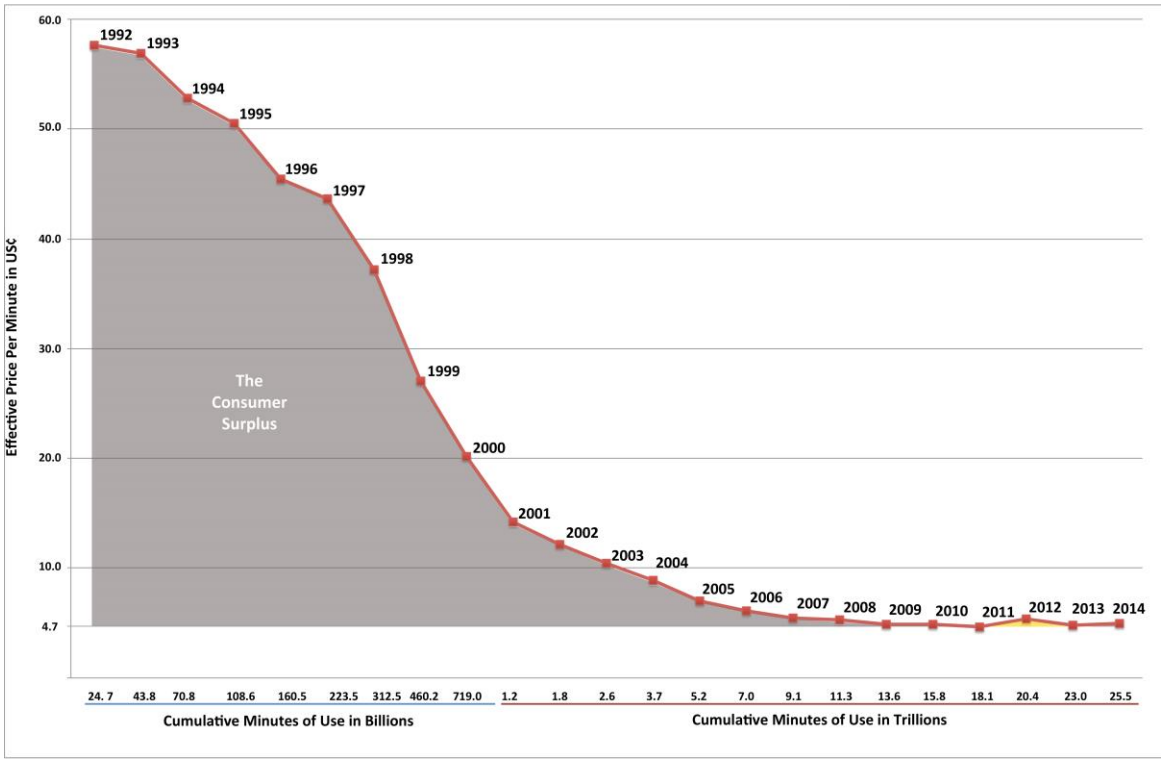
Subscribers who use voice, SMS and data are willing to pay at least the current price being charged, that much is clear. For voice specifically, though, the true demand curve is likely to be to the right of that shown in Exhibit 17.

This warping of the demand curve arises from the diffusion effect. This effect comes from the ways in which people adopt multiple uses for their devices. Most people get a phone with a specific reason in mind (maybe staying in touch with their kids while they're at school). But they quickly embrace other uses, such as watching movies, video chatting, taking photos, and so forth. So if there were no change from the 2000 price for wireless services, the volume of use by subscribers who joined before 2000 would have increased by 2014 as these subscribers found new ways of using the services.

In 2012, the wireless industry introduced mobile share plans, which provided many Americans with unlimited voice and messaging as part of the service they were purchasing—in addition to a data package. As part of the plan introduction, the revenue allocation between voice, messaging, and data was changed. While consumers realized an even greater consumer surplus due to the introduction of the plans, the voice consumer surplus in that year shrank slightly, while messaging and data consumer surplus significantly expanded.

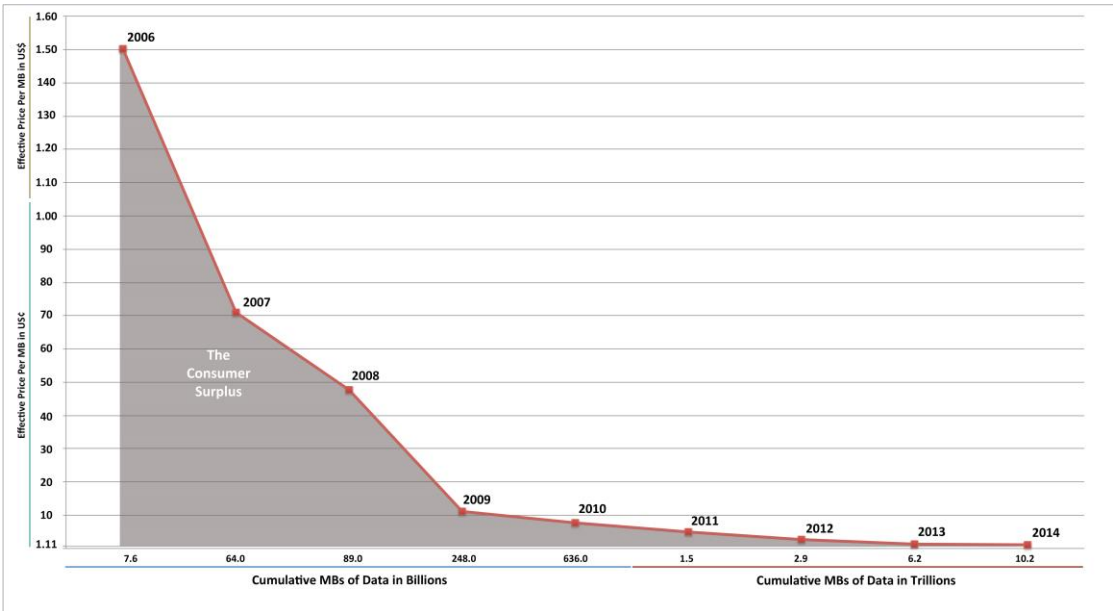
Therefore, the data point for 2000 on the current demand curve is to the right of that shown in Exhibit 17 (and the same holds true for 2007 onward in Exhibit 18 and from 2005 onward for Exhibit 19). This means that the areas under the curves of Exhibits 17, 18, and 19 represent a lower limit, and substantially underestimates the current consumer surplus. Exhibit 20 illustrates the consumer surplus over time. It provides a vivid picture of how far the wireless consumer surplus has come and the power that surplus gives back to consumers so they can spend it on whatever they want—or hold onto it for safekeeping.

Exhibit 17: Voice—Effective Price Per Minute and Cumulative Minutes



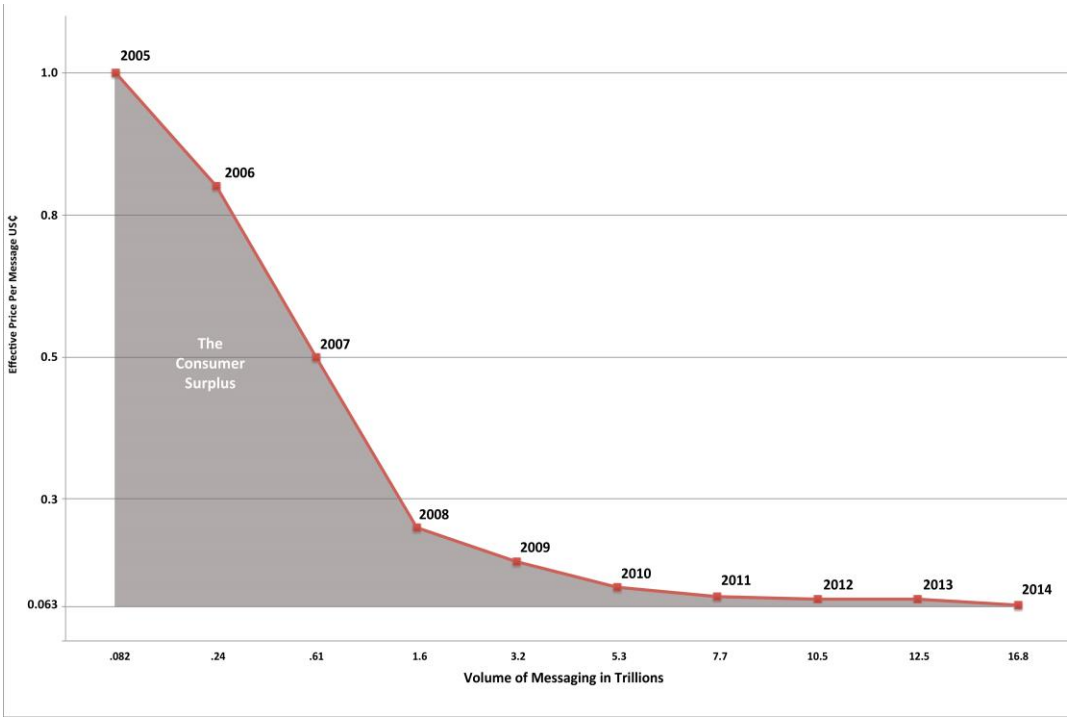
Source: Recon Analytics, Nielsen Customer Value Metrics, 2011 – 2014, CTIA 2014 Annual Wireless Indices

Exhibit 18: Data—Effective Price Per MB and Cumulative Data



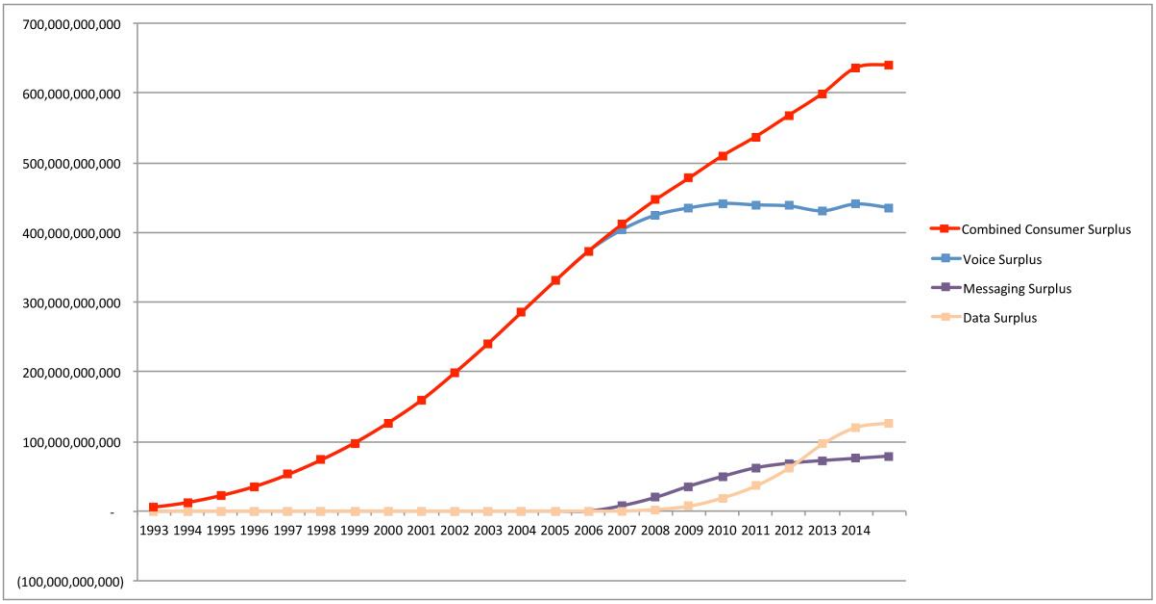
Source: 2006 – 2008 Recon Analytics, 2009 – 2014, CTIA 2014 Annual Wireless Indices

Exhibit 19: SMS—Effective Price per Message and Cumulative Volume of Messages



Source: Recon Analytics, Nielsen Customer Value Metrics, 2011 – 2014, CTIA 2014 Annual Wireless Indices

Exhibit 20: Annual Consumer Surplus—Combined, Data, Messaging and Voice
(in US$)



Source: Recon Analytics, Nielsen Customer Value Metrics, 2014, CTIA 2014 Annual Wireless Indices

Key Takeaways

- The wireless industry is making a greater impact on America than ever.
- In 2014, the US wireless industry generated $282.1 billion in US GDP, up 44% from $195.5 billion in 2011.
- The industry's global economic impact has grown at a breakneck speed to $332.9 billion, an expansion of 71% since our last report.
- In 2014, the wireless industry generated $194.8 billion of domestic economic value (excluding imports and exports) in the US—34% more than what we reported in 2012.
- The wireless industry has become the midwife of countless new businesses—conceived from the fertile minds of American entrepreneurs—that sprouted where nothing existed a few short years earlier.
- Apps became a $36 billion juggernaut in 2014.
- Health apps now make a daily, if not hourly, difference in the lives of millions of people.
- The industry is still only on the threshold of what's possible with the marriage of high-quality, super-fast mobile connections and billions of devices.
- The overall annual wireless consumer surplus—measured across voice minutes of use, SMS, and data usage—is $640.9 billion:
    - The voice consumer surplus sits at $435.5 billion.
    - The messaging consumer surplus is $78.9 billion.
    - The data consumer surplus amounts to $126.5 billion.

Appendix One: How we calculate the consumer surplus

Consumer surplus reflects the value that consumers derive from paying less than they would otherwise be willing to pay for a service. To calculate the consumer surplus US consumers and businesses enjoy as a result of using wireless services, we used the following calculation:

The price users are prepared to pay, on average, for wireless service

-

The price consumers actually pay

x

The volume of traffic

Appendix Two: Past consumer surplus estimates

Similar to the employment multiplier, we reviewed the numerous authors that have estimated the consumer surplus from wireless broadband services in the past.[19]

In particular:

- Jerry Hausman first estimated the consumer surplus for the US in 1997, using price elasticity models to establish the demand curve. He then estimated the consumer surplus, which he updated in 2003. Hausman estimated the US consumer surplus was approximately $80 billion to $150 billion per year in mid-2002. The industry generated $77 billion in revenues in 2002.
- Thomas Hazlett testified before the US Senate that the estimated US consumer surplus was at least $80 billion per year in 2003.

The UK's Radio Communications Agency also estimated a consumer surplus for wireless services there, using a willingness to pay survey. In 1999, wireless services generated revenues of £5.0 billion while the consumer surplus was estimated at £7.2 billion for the year.

[1] Global value added is $195.5 billion, which is reflected in the second column of Exhibit 2, and in the amounts in Exhibit 3.
[2] We estimate that $200 million of the $6.2 billion goes to shareholders of international companies; as such, it is not included in the $600 million retained by ad agencies in the US, but is added to the figure for the international and domestic value chains.
[3] S. J. Blumberg and J.V. Luke, *Wireless substitution: Early release of estimates from the National Health Interview Survey, January–June 2015*. National Center for Health Statistics. December 2015, available at http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201512.pdf
[4] Stephen E. Siwek, Economists Inc., *Measuring the U.S. Internet Sector, Internet Association*, December 2015, available at http://internetassociation.org/wp-content/uploads/2015/12/Internet-Association-Measuring-the-US-Internet-Sector-12-10-15.pdf
[5] Bay Area Council Economic Institute Report, *Technology Works: High Tech Employment and Wages in the United States*, Engine Advocacy, December 2012, available at http://documents.bayareacouncil.org/TechReport.pdf
[6] Robert J. Shapiro, Sonecon, *The U.S. Software Industry: An Engine for Economic Growth and Employment*, Software & Information Industry Association, 2014, available at http://www.siia.net/Admin/FileManagement.aspx/LinkClick.aspx?fileticket=ffCbUo5PyEM%3D&portalid=0
[7] California Department of Labor, http://www.labor.ca.gov/panel/pdf/multipliers.pdf (accessed November 2011)
[8] Scottish Government, http://www.gov.scot/Topics/Statistics/Browse/Economy/Input-Output
[9] Ethan Pollack, *The Jobs Impact of Telecom Investment*, Employment Policy Institute, May 31, 2011, available at http://w3.epi-data.org/temp2011/EPI_PolicyMemorandum_185%20%282%29.pdf
[10] It is, nonetheless, interesting to note that using the 4.64 multiplier from the California Department of Labor would push the number of induced jobs to more than 21,752,874 and The Bay Area Council's 5.3 multiplier would bring the figure to 24,847,033.
[11]Revised data that reflects larger numbers is available, but we have kept the original numbers because it underscores our conservative approach.
[12] Method one:

1. Determine value add for each sector
2. Divide by BLS data for average salaries
3. Arrive at number of employees in each segment and determine status of employees (i.e., direct, support, indirect)
4. Multiply average salaries by number of employees
5. Arrive at income, FICA, Medicare tax on that income

Method two

1. Gather BLS data for employment in each sector
2. Figure percent that is attributable to wireless
3. Arrive at number of jobs attributable to wireless
4. Include mean annual salary
5. Total the direct income for each sector
6. Add all sectors together
7. Arrive at income, FICA, Medicare tax on that income

[13] ACT Wireless, *State Tax Rankings*, at http://www.actwireless.org/taxes-and-fees/state-tax-rankings/
[14] Based on the induced employment figure of 3.8 million people.
[15] Note: We include deployed spectrum in our figures. Companies have won a considerable amount of spectrum that is still being evaluated for deployment. While this spectrum has potential value, unused spectrum doesn't contribute economic value in the same way that deployed spectrum does.
[16] An additional 20 MHz WCS was deployed in 2015, so we have not included it in our calculations.
[17] The consumer surplus was $537.3 billion in 2010 and $373.1 billion 5 years before that.
[18] For our purposes, the term "consumer" encompasses early adopters that usually spend more on wireless services as well as marginal consumers that may be tempted by the current prices.
[19] One note on the calculations and numbers: These types of calculations are not undertaken very often. The main reason is that the numbers are hard to get. Examples such as the ones we cite are hard to come by, so we have used our best judgment, based on decades of experience. In addition, we have been very conservative in how we use the calculations and the resulting numbers.