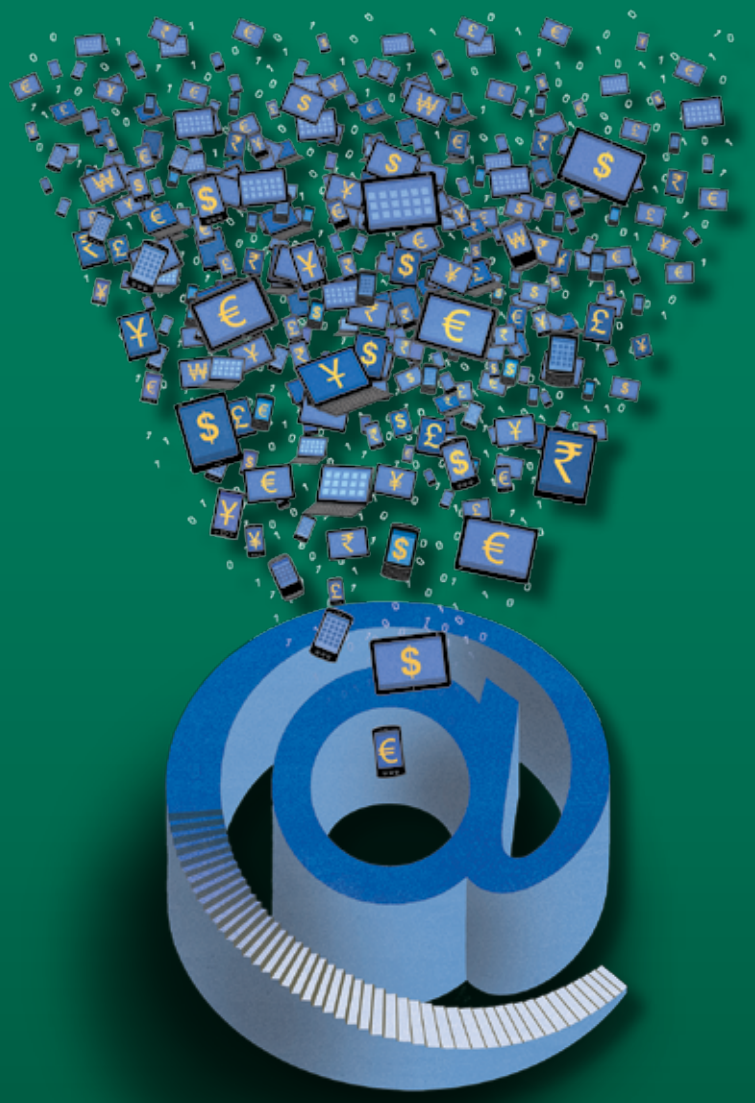
THE CONNECTED WORLD

THE GROWTH OF THE GLOBAL MOBILE INTERNET ECONOMY



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The Connected World

THE GROWTH OF THE GLOBAL MOBILE INTERNET ECONOMY

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Commissioned by

Google

FEBRUARY 2015 | THE BOSTON CONSULTING GROUP

CONTENTS

EXECUTIVE SUMMARY

POWERED BY THE RAPID adoption of smartphones and tablets (and the prospect of new applications, such as "wearables" and machine-to-machine communication)—as well as by vigorous competition between mobile ecosystems—the mobile Internet is having a big and growing global economic impact.

- In the 13 countries surveyed for this report, which represent about 70 percent of world GDP, the mobile Internet is already generating some $700 billion in revenues annually, the equivalent of $780 for every adult in our sample. The mobile Internet has also created employment for about 3 million people in those 13 countries.

- By 2017, we estimate that mobile Internet revenues will grow to $1.55 trillion across the sample, an annual increase of 23 percent.

- Even in the most mature mobile economies, such as Japan and South Korea, annual growth will be around 10 percent through 2017. In the major economies of the United States and the EU5, growth will be around 25 percent a year or more.

- The single largest contributor will be the apps, content, and services layer of the ecosystem, fueled by the rapid expansion of mobile shopping and advertising.

Developing markets are growing fast.

- Rapid growth in developing markets stems from fast-rising mobile penetration rates and increasing 3G and 4G data transmission coverage, both of which are propelling growth in apps, content, and services.

- India's mobile Internet sector is growing at almost 40 percent a year; China's and Brazil's are growing at annual rates of more than 25 percent.

- This rapid growth is having a significant impact on GDP, a direct and positive effect on employment, investment, and consumption, and an indirect beneficial impact on productivity, entrepreneurship, and information flow.

Consumers everywhere are the big winners.

- The benefit that consumers realize can be quantified using an economic concept called *consumer surplus*—the perceived value that consumers themselves believe they receive, over and above what they pay for devices, apps, services, and access.

- The mobile Internet's consumer surplus across the 13 countries surveyed is approximately $3.5 trillion a year.

- On a per capita basis, the average surplus is about $4,000, seven times what consumers pay for devices and access.

The app economy is flourishing and attracts substantial investment.

- There have been more than 200 billion cumulative app downloads from the various app stores since 2008.

- More than 100 billion of these downloads took place in 2013 alone.

- Leading app-store operators paid developers more than $15 billion between June 2013 and July 2014.

The growth of the mobile Internet economy is propelled by increasing affordability and accessibility, as well as by advances in technology and infrastructure.

- Policy makers can help keep the mobile Internet economy moving by pursuing proven policy goals that encourage continued improvement in these areas, as well as innovation, value creation, and consumer welfare and choice.

- These policy goals include promoting investment in expanded coverage, high-speed infrastructure, and affordable mobile Internet access; putting a priority on education and skills building; encouraging innovation and entrepreneurial activity; adapting existing legislation or policies to allow for the growth of new business models that create consumer value; and encouraging organizations to take a transparent approach to the way that they collect and use customer data, as well as how they charge consumers for services such as in-app purchases and subscriptions.

THE MOBILE INTERNET TAKES OFF—EVERYWHERE

HAS A SMALL DEVICE ever had a bigger impact?

Around the world, the smartphone, along with its cousin, the tablet, and a fast-expanding family of "wearables" and other "smart" devices are transforming the way people live, work, play, connect, and interact. In the process, they are converting the digital revolution into an increasingly mobile phenomenon.

Consumers put a value on the mobile Internet that far exceeds what they pay for it. Competition and innovation in the tech sector are unleashing invention in countless other areas as consumers adopt new behavioral patterns and businesses find ways to improve efficiency, develop new products and services, and expand their market reach. The mobile Internet has created millions of jobs, too.

And the wave has not yet begun to crest. Mobile penetration is increasing, the costs of access and devices are coming down, and more and more people in both developed and developing economies are using the mobile Internet as their first—and often their only—means of going online.

To be sure, there remain big issues of infrastructure, remote-area access, privacy, and data security, among others, to be addressed. But the combination of consumer demand and market-based innovation has consistently and successfully driven the mobile Internet's growth, generating enormous economic and

ABOUT THIS REPORT

The mobile Internet is having an enormous economic and social impact as it continues to grow in size and reach. It is already an important factor in many, if not most, markets around the world, as well as a significant generator of economic activity.

To better understand the global impact of this phenomenon, Google commissioned The Boston Consulting Group to prepare this independent report. The results have been discussed with Google representatives, but BCG is responsible for the analysis and conclusions.

Both Google and BCG are pleased to present these findings.

social benefits. As we have argued before, for almost everyone on the planet today, regardless of where he or she lives and works, the mobile Internet is already, or soon will be, a life-changing phenomenon. (See *Through the Mobile Looking Glass*: *The Transformative Potential of Mobile Technologies,* BCG Focus, April 2013.)

There is currently almost one mobile phone subscription for every person on Earth.

This report, the second in a two-part series, looks at the global impact of the mobile Internet in the 13 countries that make up about 70 percent of global GDP.[1] (The first report examined the mobile Internet's economic impact in the EU5; see *The Mobile Internet Economy in Europe*, BCG report, December 2014.) It provides an overview of the reach, ramifications, and potential of the mobile Internet so that policy makers and other leaders can better assess its current and future impact and pursue policies that foster its continued growth.

Exploding Demand for Mobile Access and Services

The numbers tell one part of the story. There are currently almost 7 billion mobile phone subscriptions globally, or one for every person on Earth. More than a third of these are smartphone subscriptions. Global smartphone sales are expected to have grown 18 percent in 2014, led by big emerging markets such as China, India, and Indonesia, as average unit prices fall. Mobile Internet penetration worldwide has doubled from 18 percent in 2011 to 36 percent today; by 2017, mobile access will exceed fixed-line access, with 54 percent penetration compared with 51 percent. At that point, mobile will account for almost 60 percent of all spending on Internet access.

Several factors are fueling this growth, including expanding coverage, increasingly sophisticated mobile-device functionality, sharply falling prices and fast-rising sales, a growing selection of smartphones and tablets on the market, and the development of new categories of devices such as wearables and connected home devices. Another factor is more reliable data connections that enable increasingly data-intensive activities. Some 60 percent of the world's population is now covered by 3G connectivity. The EU has 90 percent 3G coverage. The U.S. has 96 percent 4G coverage. Even Mount Everest is online—with 4G connectivity at 17,000 feet. Wi-Fi hot spots proliferate as well. In developing markets where 3G and Wi-Fi coverage is sparser, developers are optimizing apps to reach consumers on older 2G networks. One example is Nanu, a free-call app that operates like Skype or Viber but is optimized for 2G networks.

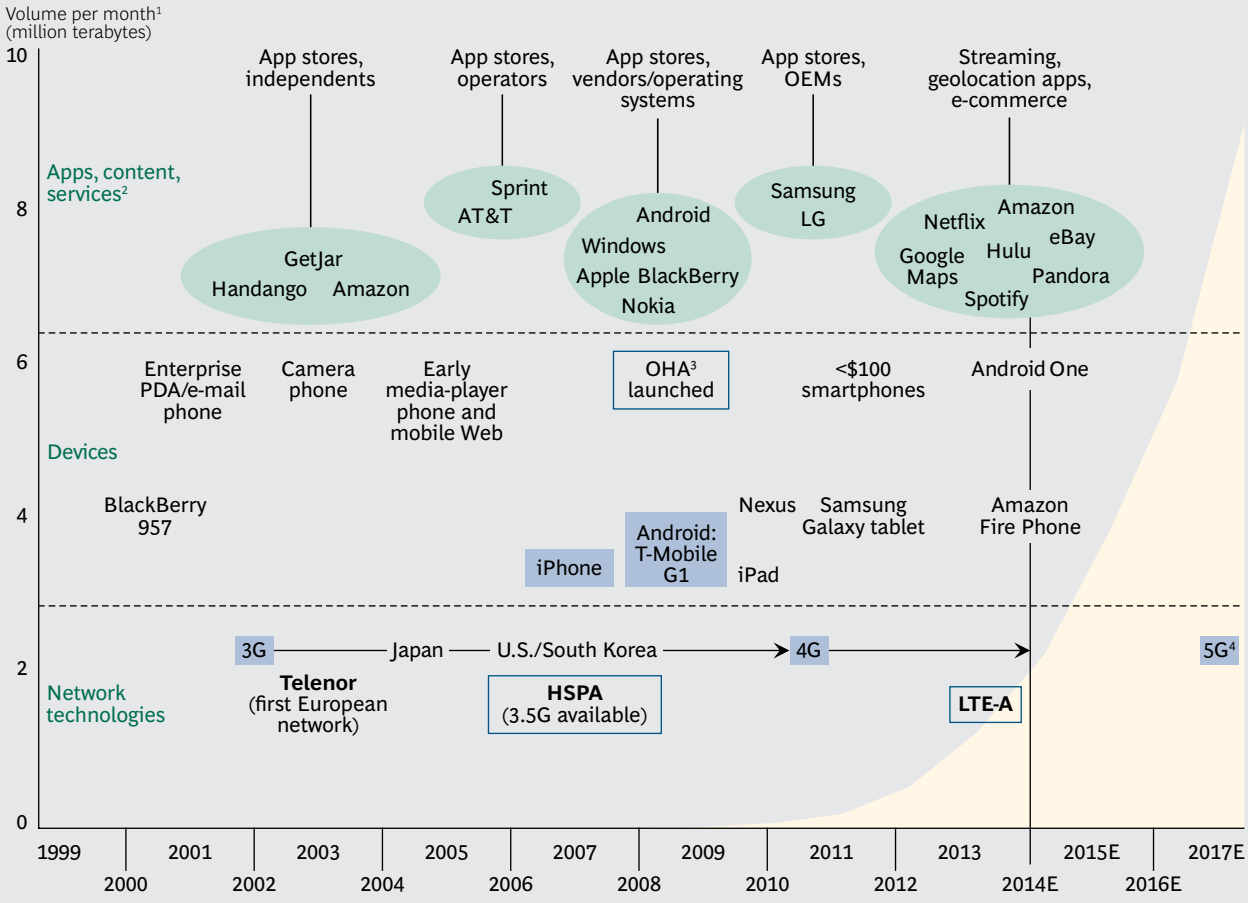
While much has been written on the infrastructure and related challenges facing mobile technologies, consumer demand remains strong. (See "Delivering Digital Infrastructure," BCG article, April 2014.) The volume of mobile Internet data traffic will continue to expand, driven primarily by increased demand for streaming of video and music content on mobile Internet devices. Global demand for such services will drive up data traffic sevenfold by 2017, from 1.2 terabytes per month in 2013, supported by more 4G networks coming online and existing operators increasing their speed, coverage, and capacity. (See Exhibit 1.)

More Capabilities for the User

As the mobile revolution has gathered steam, intensifying competition in operating systems and technology has led to fast-paced innovation in smart-device functionality. Nokia and Ericsson launched the first smart devices with multimedia features in 2000. BlackBerry contributed major advances with such innovations as push e-mail and encryption between 2001 and 2007. The launch of Apple's iOS and Google's Android operating systems led to a step change in the user experience with the widespread adoption of the touch screen and easy-to-use, full-featured mobile Web browsing and the rapid rise of third-party-app ecosystems.

Competition among operating systems and their app ecosystems has also triggered an ex-

EXHIBIT 1 | The Launch of Apple and Android Devices Triggered an Explosion in Global Mobile Data Traffic

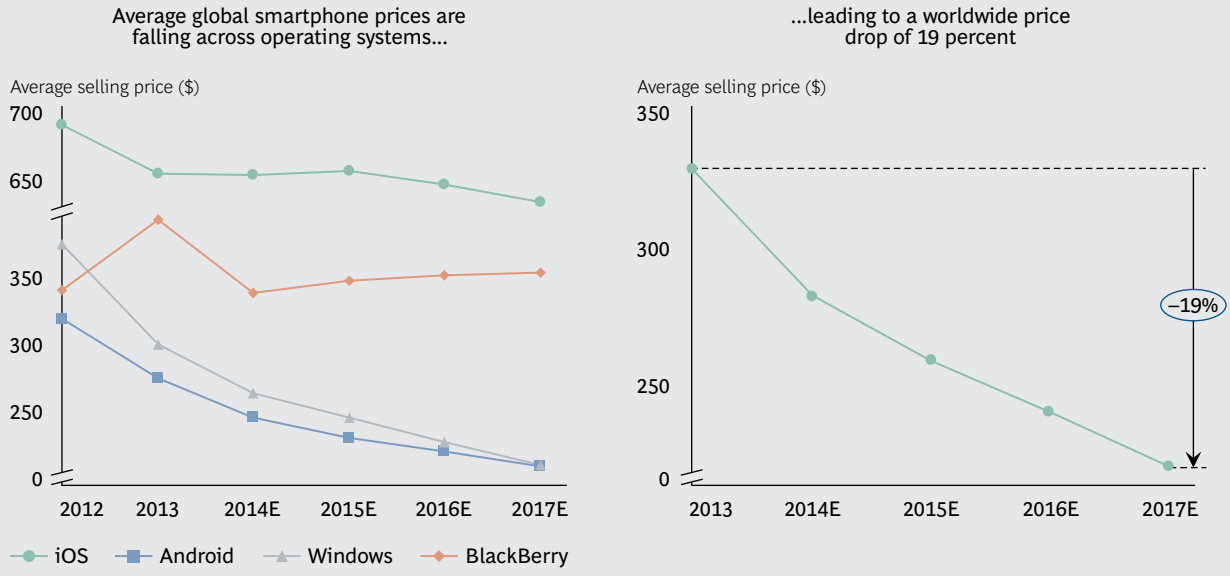


Sources: Cisco VNI Global Mobile Traffic, 2006, 2009, 2011, 2014.
[1]Volume associated with smartphones, tablets, and home gateways; includes video, VoIP, file sharing, machine to machine, gaming, and Web/data. Data estimated for 1999 to 2007.
[2]List of players is not exhaustive.
[3]The Open Handset Alliance is the consortium of technology and mobile companies that developed Android.
[4]South Korea to launch a limited 5G test network in 2017; full rollout expected by 2020.

plosion in device development and sales, as well as in global mobile data traffic. In many markets, especially in the developed world, smartphones have rapidly come to dominate mobile phone sales as competition provides consumers and businesses alike with more choice, cheaper devices, and new products. Average smartphone selling prices fell 25 percent worldwide between 2011 and 2013 and are expected to drop a further 19 percent by 2017, for reasons that include falling manufacturing and development costs, market saturation in some developed economies, and prolonged upgrade cycles. (See Exhibit 2.)

Choices for consumers abound. There are more than 18,000 Android mobile-device models currently in circulation, manufactured by a host of third-party OEMs. Global tablet sales will have surpassed 260 million units in 2014; according to the Pew Research Center, 42 percent of Americans 18 years and older own a tablet. TVs are increasingly becoming connected devices that can run apps and perform computing functions as well as display broadcast programming. Wearables—smart watches, connected glasses, and fitness monitors (so far)—are a new product category, and market growth and size projections vary. IDC predicts that total wearable shipments will grow from 19 million units in 2014 to 128 million in 2018. Connected technology is being built into more and more automobiles, homes, and machines. Estimates put the ultimate number of connected devices in the Internet of Things—machines or devices that

EXHIBIT 2 | Smartphone Selling Prices Are Expected to Continue Falling



Sources: IDC; BCG analysis

communicate directly with other machines or devices—at around 30 billion.

A Revolution in Behavior

From shopping to sharing to socializing, the mobile experience is a whole new universe of connectivity that's local (it's always where you are), personal (tailored to your needs and preferences), social (all your friends are there as well)—and it's always on. Continuous access to information, communication, friends, and entertainment—among myriad other things—is changing the way billions of people go about their daily lives. (See the sidebar "Changing Consumers' Lives—Every Day.")

Sharing photos and videos on the move is now commonplace, as are tweeting, pinning, and posting. Of Facebook's 829 million active daily users in June 2014, 654 million (almost 80 percent) were mobile users. Much has been made of the role of smartphones in social uprisings and the response to natural disasters. We regularly watch images on the evening news shot not on professional video cameras but on smartphones.

Travelers today use their phones to board planes, unlock hotel rooms, monitor devices at home (temperature and alarm settings, for example), and check in via live video with their families. Mobile payments are common in many economies; mobile apps are transforming banking. The lines between traditional retail, e-commerce, and m-commerce have blurred almost to the point of indistinction in some markets, as consumers research online, offline, and on the go and buy wherever and however they find the best selection, service, and deals. Moreover, customized mobile technologies and apps provide services to countless subsegments of consumers with highly particular needs. (See the sidebar "Providing the Services People Need.")

Consumers realize an enormous benefit from all this activity, which can be quantified using an economic concept called *consumer surplus*—that is, the perceived value that consumers themselves believe they receive, over and above what they pay for devices, apps, services, and access. The mobile Internet's total consumer surplus across the 13 countries in our sample is about $3.5 trillion a year, or about $4,000 per individual user. In the developed countries surveyed, the per capita surplus is $5,600, while in the sample's developing markets it averages $2,250.

Consumer surplus and the other benefits of the mobile Internet are only set to grow—potentially exponentially. An entire generation of 18- to 34-year-olds, a larger group than the

CHANGING CONSUMERS' LIVES—EVERY DAY

Mobile apps are changing the way millions of consumers go about their everyday lives. Apps are increasingly prevalent in all kinds of areas, from health and fitness to finance and from productivity to entertainment.

The banking industry has used digital and then mobile technology to totally transform the banking experience, putting these technologies to work on the tasks in which ease and speed are most valued by customers, such as paying bills, depositing checks, and transferring funds. Our research shows that U.S. consumers rate banks highest for digital satisfaction among 16 business segments, ahead of even online merchants. (See *Delivering Digital Satisfaction: U.S. Consumers Raise the Ante,* BCG Focus, May 2013.) Investment companies are following suit: according to the *Wall Street Journal*, some 725,000 customers used Charles Schwab's mobile apps in 2014, an increase of 12 percent over 2013.

Fitness is another area where mobile is making its growing presence felt. One leading app developer, Fitbit, makes wearable bands and other products that enable users to monitor both activity—the number of steps taken or stairs climbed during the day, for example—and inactivity, such as the amount and quality of a night's sleep. Users can set goals, keep track of their progress in real time, and compare results with friends and the Fitbit community. Fitbit accounted for half of the 2.7 million wearable bands shipped in the first quarter of 2014.

Productivity apps such as calendars and e-mail were among the first to be installed on mobile devices. Now they abound for just about every task imaginable—brainstorming, communication, presentations, and project management, to name just a few. And since life is about more than work, media and entertainment apps keep us amused while we are at the office, on the road, or at the gym.

Spotify uses digital and mobile technology combined with a new-to-the-industry business model to give users access to whatever music they want to listen to, whenever they want to listen, wherever they are. By allowing users to choose which songs they want to stream or download, Spotify makes available a library comprising some 20 million songs.

Spotify's service is available in 58 nations. Its user base reached 10 million in 2010, doubled in 2012, and then doubled again to 40 million in 2014. The company has paid more than $2 billion in royalties. It had revenues of $577 million in 2012, and $250 million in new funding in 2013 gave it an implied valuation of some $4 billion.

baby boomers, already accesses the Internet primarily through their mobile devices. A 2014 Nielsen survey in the U.S. found that more than 85 percent of these people own a smartphone. Young people in the 18- to 24-year-old age bracket spend an average of 37 hours and 6 minutes per month—the equivalent of almost a full working week—using their phones. Another survey found that almost 20 percent of U.S. Millennials use only their smart devices to go online.

Businesses Are Benefiting, Too

The mobile Internet is creating entirely new businesses and business models, as well as transforming traditional companies. All kinds of businesses are using mobile technologies to improve operations, cut costs, and reach new markets and customers. The digital economy is flourishing on mobile devices as consumers access and buy apps, music, videos, books, magazines, and other content anytime from anywhere and receive many purchases

PROVIDING THE SERVICES PEOPLE NEED

Mobile technology provides on-the-go Internet access to billions, but it can also provide essential services to much smaller groups of users with common—and critical—needs.

In Kenya, for example, which has a serious shortage of doctors (7,000 practitioners for 40 million people), MedAfrica provides a first-stop medical shop for the 10 million Kenyans with mobile Internet access. Users can diagnose illnesses based on visible symptoms, monitor treatments, validate doctors, check that their medication is authentic, and find directions to the nearest clinic or hospital.

Wheelmap, launched in Germany in 2010, provides accessibility information to wheelchair-bound people worldwide. The wheelmap.org website or mobile app reads a user's location and provides a map showing area restaurants, restrooms, schools, churches, and other destinations rated according to their wheelchair accessibility. Ratings are based on data provided by the users themselves—anyone can sign up to contribute. A green flag represents ready accessibility, yellow means partial accessibility, and red signals that the destination is not wheelchair accessible. The Wheelmap app has more than 470,000 crowd-sourced data entries and 35,000 monthly users. It is available in 22 languages and has spawned several copycats.

instantly. They can also buy physical goods on the go using dedicated retailer apps from brick-and-mortar stores such as Walmart, Belle International, and Cromā or from online shopping platforms such as Amazon, Rakuten, and Taobao.

The app economy is flourishing. There have been more than 200 billion cumulative downloads of mobile apps from the various app stores since 2008. The rate of growth is mind-boggling: more than 100 billion downloads took place in 2013 alone. The app economy already contributes $26 billion to GDP and has created some 800,000 jobs in the 13 countries in our sample.

Payment apps are increasingly popular, and some businesses are cutting out the cash register altogether (DASH, GoCardless, Uber, and Hailo, for example.) There are more mobile bank accounts in Kenya than in Kansas, but banks in the U.S. and other developed markets are using mobile apps to transform the banking experience for consumers (you can deposit a check by taking a picture)—and are winning plaudits from their customers in the process.

Retailers are embracing m-commerce. With 10 percent of mobile purchases from Walmart now happening at stores, CEO Doug McMillon told the 2014 Code Conference that his company is moving to "geo-fence" and "price-promote" store by store—essentially turning each of the company's 11,000 stores into its own multichannel shopping environment with its own product and price promotions. According to Walmart, customers viewed more than 1.5 billion pages on its site during the five days between Thanksgiving and Cyber Monday in November 2014, with about 70 percent of this traffic coming from mobile devices. The Subway restaurant chain uses geotargeting technology to send notifications of personalized deals to Subcard owners' phones when these customers are near a store. France's Groupe Casino employs near-field communication (NFC) tags on shelves to help visually impaired customers download product information to their phones. It also uses NFC technology to help all customers track costs and speed up checkout.

Some 60 percent of global mobile consumers use mobile devices as their primary or exclusive means of going online, and more than 80 percent of these people say they will make a purchase on a mobile device in the next 12 months, according to InMobi, a mobile advertising company. Forrester Research expects

that m-commerce sales will have made up 29 percent of U.S. consumers' online purchases in 2014, up from 21 percent the previous year. Our research shows m-commerce in the U.S. jumping 60 percent, from $72 billion in 2013 to $115 billion in 2014, and continuing to rise to $245 billion in 2017. Projected growth rates in developing markets are even more dramatic. In India, m-commerce will grow from $6 billion in 2013 to more than $14 billion in 2017. M-commerce in Brazil is projected to have grown 96 percent 2014 and will exceed $5 billion by 2017. In China, m-commerce will grow from $30 billion in 2013 to more than $160 billion by 2017. On November 11, 2014—Singles' Day, China's biggest shopping day of the year—mobile shopping sites handled 1 billion yuan ($163 million) in transactions in the first hour. Total merchandise sales volume settled through Alipay (Alibaba's e-payment affiliate) was approximately $4 billion (24.3 yuan), or 43 percent of all merchandise volume—double the 21 percent volume in 2013.

It's not just a retail phenomenon, either. All kinds of businesses are finding innovative ways to put mobile devices and technologies to work. According to one survey in the U.S., more than 85 percent of B2B customers access content on their mobile devices. Another survey found that at least 50 percent read reviews, access product information, and compare features using mobile devices. While m-commerce currently accounts for only 3 to 5 percent of B2B sales, these numbers are bound to grow as more users apply the lessons of the B2C marketplace to their businesses. IDC calculates that 14 percent of all tablet shipments in 2014 (which it estimates at about 245 million) went to commercial organizations, up from 11 percent in 2013. It expects the percentage of commercial shipments to increase to 18 percent by 2018.

Developing Economies Embrace the Mobile Internet

Access to the mobile Internet continues to grow quickly around the world, especially in developing markets, where limited fixed-line access and the relative ease of deploying mobile networks make the mobile Internet particularly well suited. In China, for example, there were 632 million Internet users as of the middle of 2014, or about 45 percent of the total population. In sub-Saharan Africa, mobile penetration is about 60 percent, compared with less than 2 percent for fixed-line access. Ultimately, entire nations in Africa will access the Internet only through mobile devices.

As mobile infrastructure is built and mobile usage increases, consumers benefit from the new services that grow up around these devices. The number of Chinese consumers using mobile devices to buy goods jumped 42 percent to 205 million in 2014. Facebook has 100 million users in Africa (50 percent penetration of connected Africans), of which 80 percent access the social network on a mobile device. With much of the continent still using 2G service, Facebook has developed technology that identifies the user's network speed and adapts ads as needed.

Access to the mobile Internet is growing quickly, especially in developing markets.

One big impediment to mobile usage in developing economies has been the high price of smartphones. This is changing, and quickly. Google launched its Android One phone in India in 2014; this model retails for about $100. Another new smartphone launched in India, by Intex Technologies and its partner, Mozilla, retails for 1,900 rupees—or about $33. Xioami's Redmi and Motorola's Moto G devices are also lowering prices dramatically for smartphone consumers in India. Some 650 million Indians already own mobile devices, making India the second-largest mobile market globally, and the growth in smartphone ownership will pick up as affordability continues to increase.

The Impact of the Mobile Economy

The mobile Internet is already generating some $700 billion in revenues annually—the equivalent of $780 for every adult—in the 13 countries that make up our sample. The mo-

bile Internet has also created approximately 3 million jobs in these countries.

Both revenues and jobs are growing as mobile access expands and people do more things with a widening selection of devices. Mobile has only touched the surface in multiple industries that have an enormous impact on GDP—health care, for example. The Internet of Things and machine to machine (M2M) communications—two areas where the mobile Internet is expected to have widespread impact—are only in their infancy.

The mobile Internet attracts substantial investment. For example, leading app-store operators paid developers more than $15 billion between June 2013 and July 2014. Major companies, from telecommunications and cable service providers (Verizon, Comcast, and AT&T, for example) to hardware, software, and semiconductor manufacturers (Hewlett-Packard, Microsoft, Qualcomm) to content providers such as Netflix and Pandora, invest billions of dollars in R&D and capital expenditures, and countless start-ups are also attracting investments, innovating, and launching new products.

As the volume of mobile traffic and activity relentlessly expands, the complexity of the industry that transports and delivers millions of terabytes of information every day increases dramatically as well. The industry is evolving rapidly. Competition within and among ecosystems is fueling innovation, diversity, and choice for end users.

Note

1. The 13 countries are Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, South Korea, Spain, the United Kingdom, and the United States.

COMPETITION DRIVES MOBILE INTERNET GROWTH

In both developed and developing markets, mobile usage is growing fast as consumers shift their online media consumption, commerce, information seeking, and social networking, among other activities, from fixed to mobile devices. Increasing mobile access everywhere is leading to new uses of the Internet—in fields from banking to education and from health care to the delivery of public services—further propelling its growth. Companies, governments, schools, hospitals, not-for-profits, and NGOs, among other organizations, increasingly realize that they need to interact with their stakeholders not just online but via smartphones and tablets. It is only a matter of time (and perhaps not much time) before the Internet becomes a mostly mobile phenomenon.

Mobile Internet Revenues Are Growing Fast

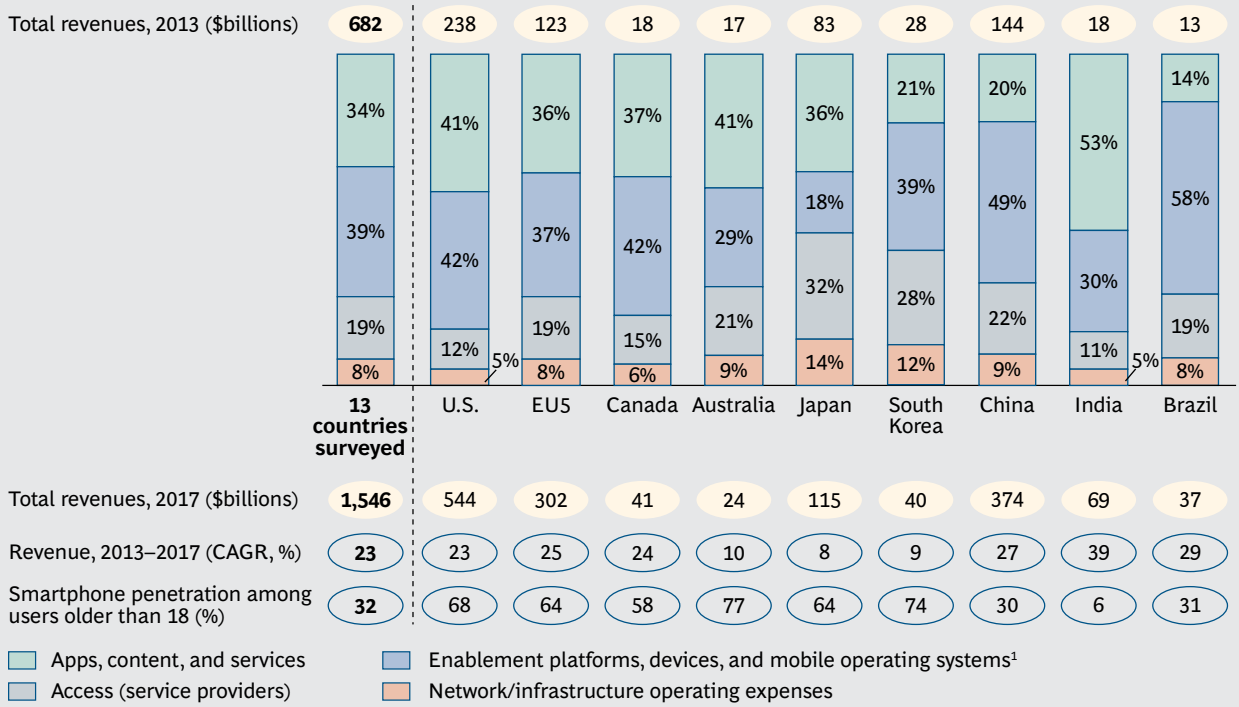
The revenues generated by the mobile Internet ecosystem are a big contributor to global GDP. We estimate that in 2013, they amounted to $682 billion in the 13 countries that account for approximately 70 percent of global GDP, or a substantial portion of the $2.9 trillion a year in revenues generated by all mobile technologies worldwide. (See Exhibit 3.) Smartphone users in the U.S. currently spend an average of $1,450 per year on their phones, data plans, apps, and content. Their European counterparts spend $740 per year, while in the Japanese market, annual per user spending amounts to $1,220.

By 2017, we estimate that mobile Internet revenues will have grown to $1.55 trillion across these 13 countries, an annual increase of 23 percent. Even in the economies where the mobile ecosystem is most mature, such as Japan and South Korea, annual growth will still be around 10 percent. In the major economies of the U.S., China, and the EU5, growth will be around 25 percent a year or more. The single largest contributor in the future will be apps, content, and services, fueled by the rapid expansion of mobile shopping and advertising.

The Mobile Internet Creates Jobs, Too

Revenues are only one part of the picture. The mobile Internet is a major job-growth engine as well. We estimate that it has created employment for about 3 million people in the 13 countries we studied. Many of these jobs are in Asia, where the manufacturing of mobile devices is centered. But the rapid growth in device sales has also generated retail jobs throughout the U.S. and Europe, as well as in other regions. Network and infrastructure installation and maintenance take place worldwide. Jobs related to mobile operating systems and enablement platforms, which handle everything from hosting to se-

EXHIBIT 3 | The Mobile Internet Ecosystem Generated $682 Billion in Revenue in 2013



Source: BCG analysis.
Note: Because of rounding, not all percentages add up to 100.
[1]Devices include smartphones and tablets.

curity to billing and payment, are based primarily in the U.S. and Europe. Most employment is associated with devices and with apps, content, and services. These jobs tend to be created in countries with well-educated and skilled workforces, and their numbers will grow as activity in these and other segments of the ecosystem expands. A significant proportion of these positions are entrepreneurial and situated in small enterprises—young (or maybe not so young) men and women hoping to impress users with the next big thing and hiring others when they do.

With revenues across the mobile Internet ecosystem forecast to more than double by 2017, there will be a related—and a significant, if not a proportional—increase in the number of jobs generated. Some of these will replace jobs currently found in the broader Internet ecosystem—for example, positions related to earlier generations of feature phones, particularly in developing economies. We also expect a substantial number of new jobs to be created as the demand for apps, content, and services rises disproportionately with the increase in the installed user base.

The advent of new apps that automate and enhance existing activities, in fields such as health care and education, should help fuel this growth. Many of these jobs will require a high level of technical skill and creativity, and it will be important for governments to support appropriate education, training, and mobility programs to ensure that their workforces are in a position to take advantage of the opportunities that will be generated by the mobile Internet.

Growth in Developing Markets

Rapid growth in developing markets stems from fast-rising penetration rates and increasing 3G and 4G coverage, both of which are propelling growth in apps, content, and services. India is growing at almost 40 percent annually; China and Brazil are growing at more than 25 percent a year. This growth is having a measurable impact on GDP, a direct effect on employment, investment, and consumption, and an indirect impact on productivity, entrepreneurship, and information flow. (See the sidebar "Developing-Market Snapshot: The Mobile Internet in Brazil.")

DEVELOPING-MARKET SNAPSHOT
The Mobile Internet in Brazil

Among the markets that the GSMA categorizes as fast growers, Brazil exemplifies the kind of impact that the mobile Internet can have on a national economy. There are more mobile connections in Brazil than people (266 million connections in a population of 203 million). Some 75 million of these connections are used by smartphones, a 42 percent increase over 2013. By 2017, three-quarters of the population is expected to own a smartphone. We estimate that the mobile Internet contributed $13 billion to Brazil's GDP in 2013, an amount that will grow to $37 billion in 2017. Mobile Internet activities add about $3 billion to public funding through tax receipts.

Brazil's national broadband plan has helped increase affordability, spur investment, and advance broadband penetration. New legislation provides tax exemptions for smartphone handsets. In 2012, Brazil successfully auctioned spectrum licenses to the four major mobile operators for mobile broadband in the 450 MHz frequency band (for rural coverage) and the 2.6 GHz frequency band (for urban coverage). Mobile 3G services now reach 3,400 municipalities in all states, covering 90 percent of the country's population. Mobile broadband has exploded from 7 million lines in service in 2009 to 70 million today. Mobile 4G services were launched in April 2013 in major state capitals. Brazil's recently reelected president, Dilma Rousseff, has promised to double Brazil's broadband connections and to increase average Internet connection speed to 25 Mbps by 2018.

Analysis by the Groupe Speciale Mobile Association (GSMA) shows that a 10 percent increase in mobile broadband penetration raises GDP by 1.4 percent in low- and middle-income nations. A doubling in mobile data use increases GDP per capita by 0.5 percentage points. Faster connections also bring benefits. A 10 percentage point increase in 3G versus 2G use raises per capita GDP by 0.15 percentage points.

None of this, however, reflects the economic impact of local entrepreneurs' ability to take their ideas global and generate increased revenues through their access to new customers and markets, a transformative benefit for small and medium-size businesses. (See the sidebar "A Chinese Game Developer Goes Global.")

Not all developing markets are experiencing similar levels of growth. The GSMA has identified two categories in the developing world. "Fast growers" include countries such as China and Brazil, where a quarter or more of

A CHINESE GAME DEVELOPER GOES GLOBAL

Launched by two friends in Beijing in 2008, Papaya was one of the first app developers to bring social gaming to mobile devices. The company has opened its platform to all developers of social games for mobile devices and offered monetization tools to help developers profit from their endeavors. It also launched AppFlood in 2012 to sell marketing and advertising tools and Papaya Studio, an incubator for game developer teams.

Growth took off after Payaya opened up its platform. Today, the company has 110 million users and more than 1,000 games, up from 15 million users and 350 games in 2013. AppFlood connects users with 82,000 apps and delivers more than 800 million impressions daily. The company has 150 employees and offices in London and San Francisco. Papaya Studio produced Kakapo's Slots Fever, the top-grossing game on Google Play in 2013.

mobile Internet connections are made on smart devices and where 3G networks are growing quickly. More than 100 million smartphones were sold in China in the second quarter of 2014, according to *The Economist*, and eight of the top ten smartphone manufacturers were Chinese companies. "Discoverers" include many countries in Africa and Southeast Asia where smart devices represent less than 10 percent of mobile connections, and 90 percent of users rely on 2G networks.

Competitive markets speed both broadband and mobile penetration.

In the discoverer category, three hurdles to higher penetration rates are lack of affordability, limited network coverage, and an unfavorable investment climate, and these can be formidable. Low income levels in many developing markets are the largest constraint on adoption. Extending networks to rural areas with little or no infrastructure is costly and promises little financial payback, since populations in which incomes are low generate low returns. Unpredictable regulation, high taxes, and high spectrum prices raise costs and slow adoption. In these developing countries, in particular, governments that take the long view can realize significant benefits. For example, a number of countries have policies that encourage digital and mobile technologies to leapfrog those of nations with more developed tech industries. (See the sidebar "South Korea: The Impact of Open Competition.")

National broadband plans can have a big impact as well. Research by the International Telecommunication Union (ITU) and Cisco Systems shows that such plans lead to 7.4 percent higher mobile Internet penetration, on average. History also shows that competitive markets speed both broadband and mobile penetration. The ITU/Cisco study found that countries with competitive markets have mobile penetration rates that are 26.5 percent higher than average.

One of the biggest infrastructure constraints (common to both developed and developing markets) is the availability, allocation, and use of mobile spectrum—the bands of radio waves over which data and voice communications (as well as other over-the-air media) travel. Lack of harmonization at the regional and international levels—meaning, for example, that the same operator's 3G network operates on different bands of spectrum in different countries or in different regions of the same country—leads to significant inefficiencies and higher costs. The GSMA estimates that by 2020, better harmonization could add $370 billion to GDP and 112,000 new jobs in Latin America, and $49 billion to GDP and 506,000 jobs in sub-Saharan Africa. North Africa could realize an additional $50.5 billion in GDP and 4 million jobs by 2025.

Beyond the direct economic impact, there are also social benefits stemming from greater mobile Internet penetration and usage. These include improved education, health care, and nutrition. By 2017, better distribution of life-saving information could save 1 million lives in sub-Saharan Africa through avoided malaria, HIV, and perinatal conditions. Using mobile technologies to track food deliveries, monitor food temperature, and optimize delivery routes could save enough food to feed 40 million people (the population of Kenya) in 2017—simply through reduced spoilage.

The App Economy Soars

Mobile apps—the software programs that perform designated functions on a mobile device—may be the fastest growth story in recent history. Originally designed primarily for productivity purposes (mobile calendars, for example) and information retrieval (e-mail), mobile apps quickly expanded into numerous other fields, including gaming, navigation, health and fitness, media consumption, communication, and commerce, to name a few.

Apps are coded by developers, many of whom are entrepreneurs, and they are sold through distribution platforms such as the Apple App Store, Google Play, the Windows Store, Amazon Appstore, and BlackBerry

SOUTH KOREA
The Impact of Open Competition

South Korea highlights the benefits of policies that encourage innovation and competition. Before 2010, local manufacturers dominated the mobile handset market as regulation discouraged foreign companies from competing. Almost 80 percent of handset sales in 2009 were generated by Samsung and LG Electronics. Despite state-of-the-art technological capability (including a well-developed 3G network), smartphone sales were limited by high prices, poor user interfaces, and a lack of Korean-language apps.

The removal of regulatory restrictions was followed quickly by the entry of foreign OEMs. Apple launched the iPhone in Korea in late 2009, and Android-powered phones appeared shortly thereafter. Competition, both between the two ecosystems and among Android-device manufacturers, has been intense. Today, more than 73 percent of South Korea's population of 50 million owns a smartphone, and South Korea is the only country in the world whose entire population can access 4G connectivity. As of the end of 2013, more than 50 percent of all actual connections were 4G. The South Korean government's Mobile Gwanggaeto Plan 2.0 (named for a fifth-century king) aims to accommodate rapid growth in the number of LTE subscribers by quadrupling the bandwidth allocated for mobile carriers by 2023.

Thanks in part to these kinds of supportive policies, exports have grown quickly. Samsung and LG are now leading device manufacturers, shipping their products around the world. South Korea is also fast becoming a hub for start-ups in the Asia-Pacific region. The number of Korean Android app developers has tripled over the past two years, and South Korea is now one of the top five countries in the world for app developers using the Android operating system. Numerous rising stars are achieving global prominence. With more than 65 million downloads, ColorNote is the top note-taking app in Google Play in 50 countries. Almost 95 percent of its users are based outside of Korea. Users of the KakaoTalk free calling and messaging platform can follow their favorite brands and celebrities, receive coupons, and purchase goods. KakaoTalk has 140 million users in 15 languages. NHN Entertainment, a builder of mobile games that is owned by Naver Corporation, which runs South Korea's largest Internet portal, has more than 20 million users.

Big business is benefiting as well. Samsung and LG Electronics have become multinational mobile technology leaders in handsets and other devices. Samsung manufactured more than 30 percent of the smart devices sold in 2013 in the 13 countries we surveyed (up from 7.7 percent in 2008). LG shipped almost 5 percent of the devices sold in 2013 in the surveyed countries, compared with 4 percent in 2008. The company was an early innovator in dual-core processors.

South Korea is also home to many companies that design and manufacture the components that go into all kinds of smart devices and other consumer electronics, such as touch screens, LCDs, antennas, and modules for cameras and keyboards.

World. App developers have made 1.3 million apps available through both the App Store and Google Play, some 255,000 through the Windows Store, 240,000 through Amazon, and 130,000 through BlackBerry World. In 2013 alone, apps were downloaded 102 billion times globally (of which 9.2 billion downloads were of paid apps), a 60 percent increase over 2012. Downloads are forecast to rise to 269 billion (15 billion paid) by 2017. Although many apps are given away free of charge, app revenues in our 13-country sample will nearly triple, from $26 billion in 2013 to $76 billion in 2017.

App Developers: Show Us the Money!

Even with the astronomical growth in the app economy, many app developers still struggle to monetize their endeavors. The vast majority of app downloads continue to cost nothing: nine out of ten downloads in 2013 were free, and eight of the ten most-used apps globally are given away, although many popular "free" apps generate income through advertising or in-app purchases (of extra content such as bonus game levels).

> The vast majority of app downloads continue to cost nothing.

Developers are faced with a challenging business environment: a hit-driven market, in which relatively few apps gain critical mass, and low barriers to entry, with copycats and knockoffs of successful apps an all too common phenomenon. Large developers backed with big resources can tilt the playing field by paying to advertise their apps through a variety of channels. As a result, many independent developers earn little. More than half of all developers earn less than $500 a month per app, and the top 1.6 percent of developers earn more than the other 98.4 percent combined.

App developers, along with others throughout the mobile ecosystem, face continuing challenges in such areas as security. Threats are on the rise. Reports of mobile malware rose 167 percent in the 12 months ending in June 2014, with some 15 million mobile devices reportedly infected in 2014, up from 11.3 million in 2013. Just as Windows has been the target of most malware aimed at desktop operating systems, the most popular mobile operating systems are targeted because they are where the largest number of users can be found. Fragmented open-source code can be more vulnerable to malware, and third-party app stores are key targets. One response from entrepreneurial developers has been new apps designed to secure phones (such as MobileIron, Samsung Knox, and XenMobile), but these usually rely on installation and updating by users rather than by device manufacturers. There are signs that consumers are purchasing apps on the basis of security and privacy. Threema and Telegram are two popular chat apps that stress their encryption and security.

Developers Seek to Adapt

In the face of these and other challenges, developers are using a variety of strategies to adapt. For example, some are choosing to specialize, producing niche apps in narrow fields (such as wedding planning) where they can charge a premium. On average, developers that focus on "mass-market reach" apps earn half as much as developers that build niche apps for consumers willing to pay for the service.

Building sustainable revenue models for independent developers continues to be a big challenge. We expect developers to focus on two primary approaches.

Advertising-Supported and "Freemium" Revenue Models. More and more advertiser spending will shift to mobile over time, as consumer usage continues to increase and targeting technology improves. Global mobile advertising revenues are expected to have reached $18 billion in 2014, up from $13.1 billion in 2013, and this growth will continue until 2017, when spending will exceed $41 billion.

About 90 percent of Apple's global App Store revenue in 2013 was attributable to freemium apps—which are free to download but can ultimately lead to in-app purchases—up from 77 percent in 2012. Freemium apps have demonstrated their profitability but some have also come under criticism for allowing users to incur unexpected costs, such as through any in-app purchases that they wind up making.

Building Apps for Others. One area where developers are demonstrating success is building apps for other businesses. Some 70 percent of developers say they are profitable when doing contract work for others. Demand for app development is growing as industrial applications increase. Companies often do not have their own in-house devel-

oper talent and are willing to pay for functionality that can increase sales and profits.

Developers are finding new opportunities in the Internet of Things. Some 25 billion new IoT devices (including cars, heating and air-conditioning units, lighting systems, farm equipment, wearables, and security systems) will come online from 2015 to 2020, doubling the current number. (See the sidebar "The Next Big Thing: The Internet of Things.")

A big area of potential growth is machine-to-machine communication—networked devices of all kinds, in such industries as automotive, consumer goods, and utilities, that exchange information and perform functions without the physical assistance of humans. An aircraft engine that monitors and reports operating data in-flight is one example; buses and trucks that continually report their location, speed, and other information is another. Research organization IDATE expects the M2M market to reach €40 billion by 2017, with Europe being the biggest geographic market in terms of revenue. The EU had 52 million M2M connections in 2012 (about a quarter of the global total), and these are expected to grow to 295 million in 2017 (30 percent of the global total).

THE NEXT BIG THING
The Internet of Things

The long-anticipated, much maligned Internet-enabled fridge is actually a reality. The Internet of Things brings inanimate objects online and enables them to communicate their internal state and other information to humans and other "things" through the Internet. Many of these objects are things on the move, such as cars and aircraft; they use mobile technologies, sensors, and software to stay connected. Once an object can represent itself digitally, it can be controlled remotely.

The number of connected devices is growing fast. There were 500 million of them in 2003 and 12.5 billion in 2010; these numbers are expected to rise to 25 billion in 2015 and to 50 billion in 2020 as costs, especially for sensors, fall. A sensor that cost €50 in 2009 sold for €15 in 2013.

The potential applications are endless. A few examples: airplanes that warn of component wear and potential failure; cars that automatically schedule their own maintenance; buildings with HVAC systems that can be controlled remotely; buses that update their performance against schedule in real time; tracking devices in farm animals that monitor food intake, temperature, and movements. In almost every sector, the Internet of Things will vastly lower costs, improve safety, and heighten efficiency for consumers and businesses alike.

Already companies such as Italy's Solair Corporate are designing company-specific apps for the Internet of Things. Using Solair technology, manufacturers can monitor machine performance to optimize production, streamline maintenance plans, identify faults early, and reduce costs. The company provides an automated app platform that helps connect and automate machines and activities in such areas as fleet management, maintenance, and health and safety in six markets: retail, industrial machinery, smart buildings, energy, transportation, and health care.

Another example is OnFarm, an app that helps farmers increase crop yield and quality while reducing costs. OnFarm provides real-time data and an analytics dashboard with which farmers can monitor weather, soil moisture, fertilizer levels, insecticide applications, and the location of crops and equipment on the go. The app is being used by almond farmers and vineyard owners in the U.S. and is being piloted by potato, corn, and wheat farmers. Its developers used crowd-sourced funding to raise $800,000 (twice their target) from six investors in 30 days in 2014.

CONSUMERS WIN BIG

THE REVENUE NUMBERS MEASURED in the previous chapter are large. But they pale in comparison with what must be considered the real value of the mobile Internet: what all this activity is worth to the end user. Consumers worldwide are the big winners here. And the margin of victory runs into the trillions of dollars.

The mobile Internet's total annual consumer surplus across the 13 countries surveyed is approximately $3.5 trillion. On a per capita basis, the average annual surplus is about $4,000, seven times what consumers pay for devices and access. (See Exhibit 4.)

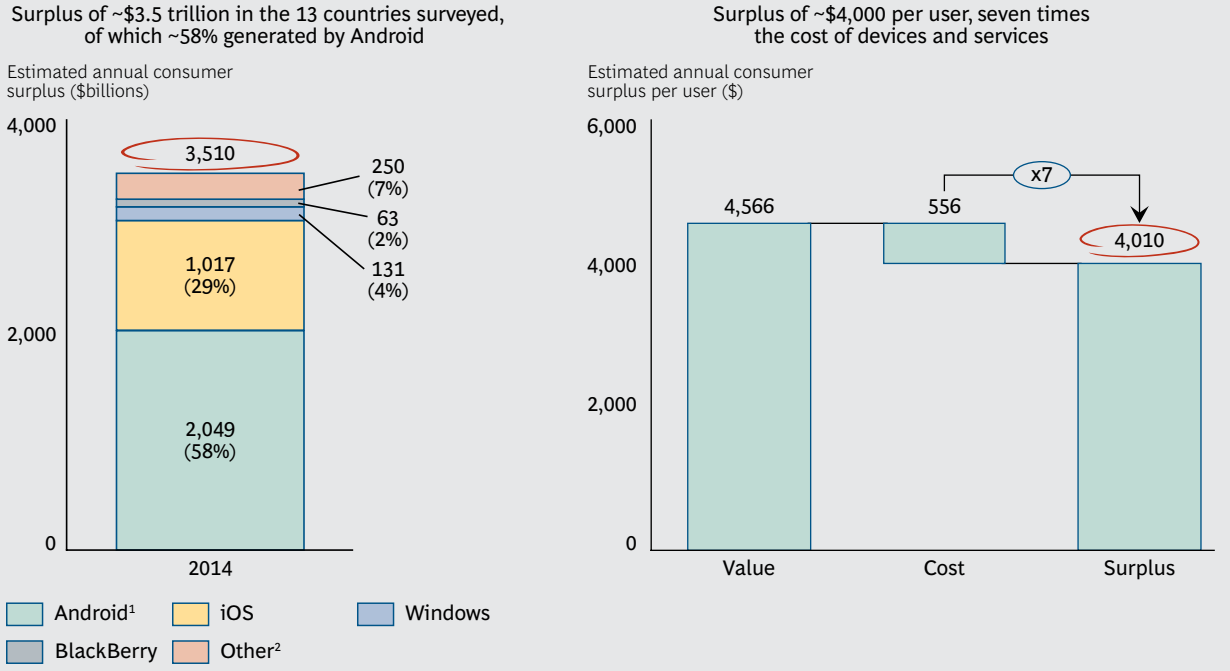
Large majorities would forgo most offline media before forgoing mobile Internet access.

The largest aggregate consumer surplus is in the U.S. ($827 billion), followed by China ($680 billion) and Japan ($462 billion). Among developing nations, Brazilian consumers enjoy a surplus of $169 billion, which is only slightly less than that of consumers in the major European economies of Italy ($188 billion) and France ($184 billion)—and is more than the consumer surplus in Spain ($146 billion). On a per capita basis, consumers in Japan, Germany, France, and Australia all enjoy mobile Internet surpluses of more than $6,000 per year. Across the 13 markets surveyed, Android is responsible for 58 percent of the total surplus and Apple, 29 percent, reflecting Android's popularity in most developing markets. (See Exhibit 5.)

Consumers use their mobile devices for a wide variety of purposes. The most valued feature is still phone calls, but this is followed closely by Web browsing, searching the Internet, and e-mail. Mapping capabilities, social networking, and financial functions are also very popular. (See Exhibit 6.)

It's no exaggeration to say that consumers everywhere have come to depend on the mobile Internet. Whether it's for communication, consumption, commerce, or information, they are loathe to give up the capabilities that the mobile Internet confers. Large majorities would forgo most offline media (the one exception is TV) before forgoing mobile Internet access. Substantial majorities are also willing to give up such luxuries as fast food, chocolate, alcohol, coffee, and movies. (See Exhibit 7.) A significant minority of consumers are not willing to give up their mobile Internet access at any price. As one person put it, "The Internet is part of my body. I feel the Internet running in my blood. I'd rather give up something else than this."

EXHIBIT 4 | The Mobile Internet Generates a Huge Economic Surplus for Consumers

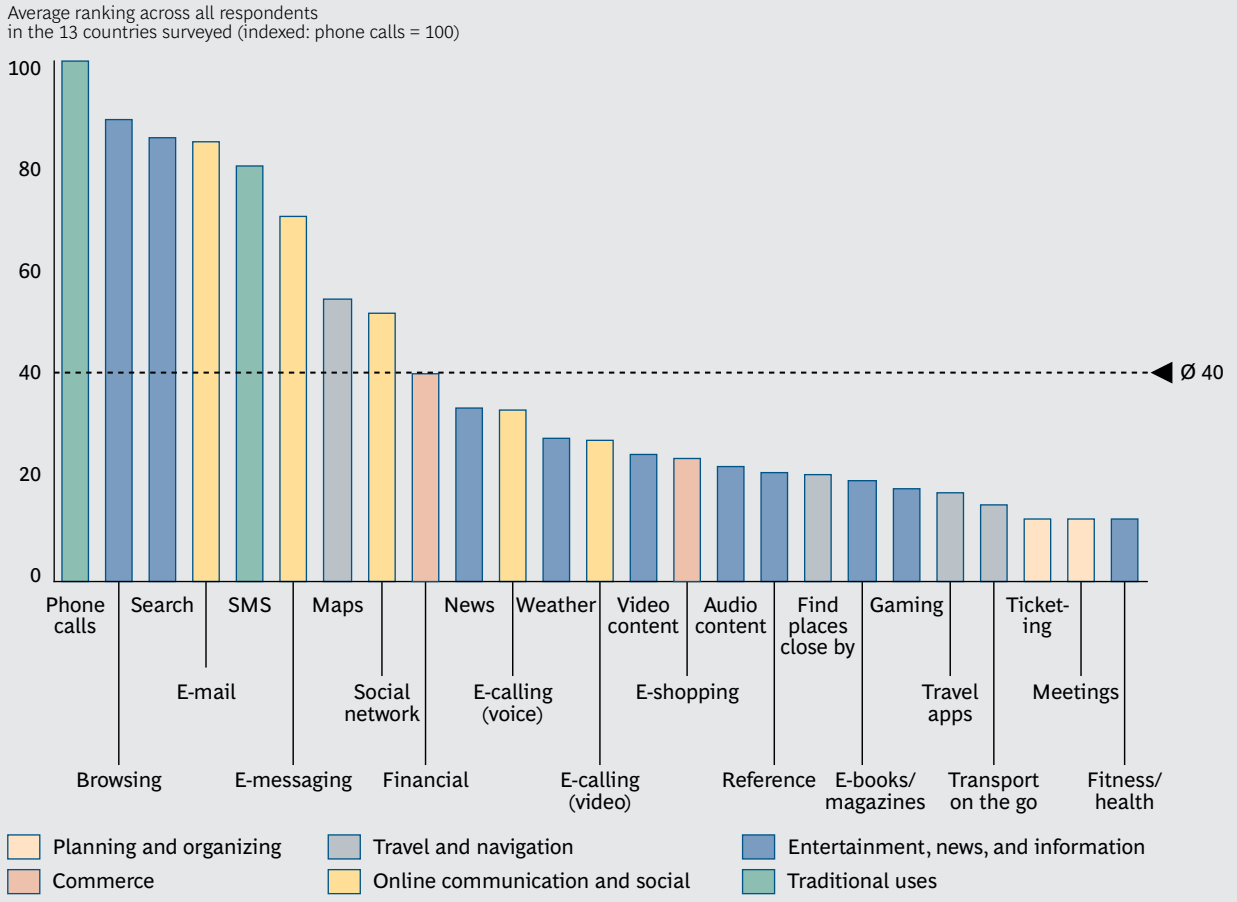


Sources: BCG consumer surplus survey, September 2014; comScore; Ovum.
[1]Includes operating systems not compatible with Google Mobile Services.
[2]Other operating systems include Symbian, Linux variants, Web-based systems, Bada, and Tizen.

EXHIBIT 5 | Android Generates the Largest Total Surplus, Followed by iOS

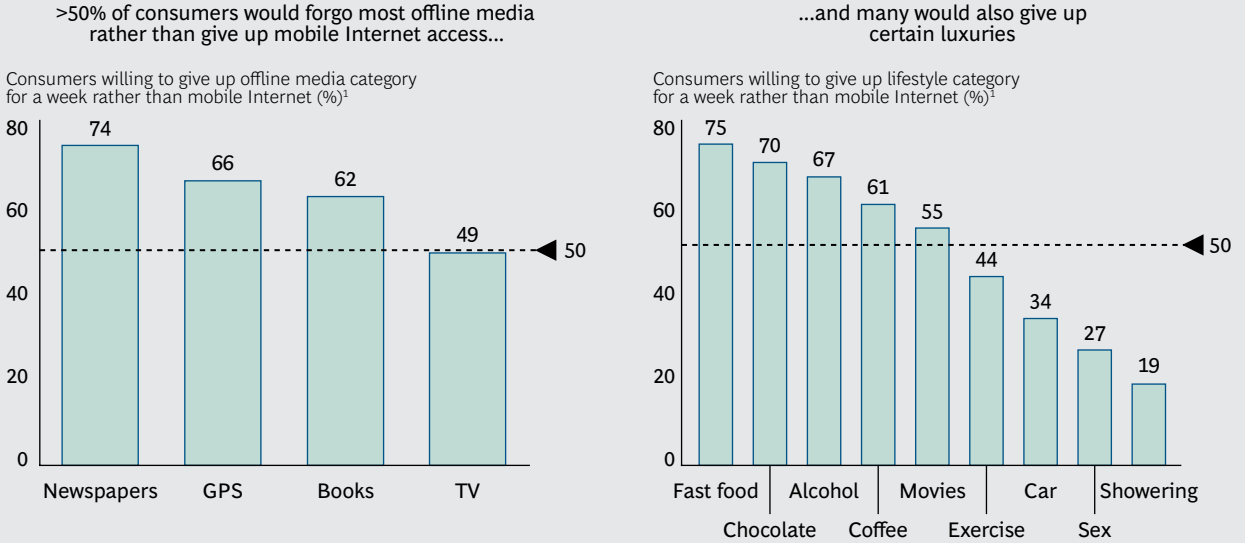
Source: BCG consumer surplus survey, September 2014.
[1]The numbers shown are the percentages relative to the average for all mobile devices.
[2]Totals and averages include other operating systems not shown here.
[3]The number of hours spent using a smart device to access the Internet per day.

Exhibit 6 | Phone Calls Remain the Most Valued Use for Smartphones, Followed by Browsing, Search, and E-mail



Source: BCG consumer surplus survey, September 2014.

Exhibit 7 | Users Would Make Some Sacrifices in Exchange for Mobile Internet Access



Source: BCG consumer surplus survey, September 2014.
[1]Average for individuals who use, consume, or participate in the relevant item or activity.

THE MOBILE INTERNET STACK

THE MOBILE INTERNET ECOSYSTEM is big and complex, involving thousands upon thousands of individual companies and organizations that interact with one another in countless different ways. Some of these entities are global in scale and reach, employing thousands of people and generating billions of dollars in revenue—telecommunications providers, device manufacturers, and software companies, for example. Many have multiple products, services, business units, and profit centers—think Apple, Microsoft, Amazon, and Samsung. Others are as small as an individual app developer working on a PC (or tablet) at his or her kitchen table.

A Multilayered Stack

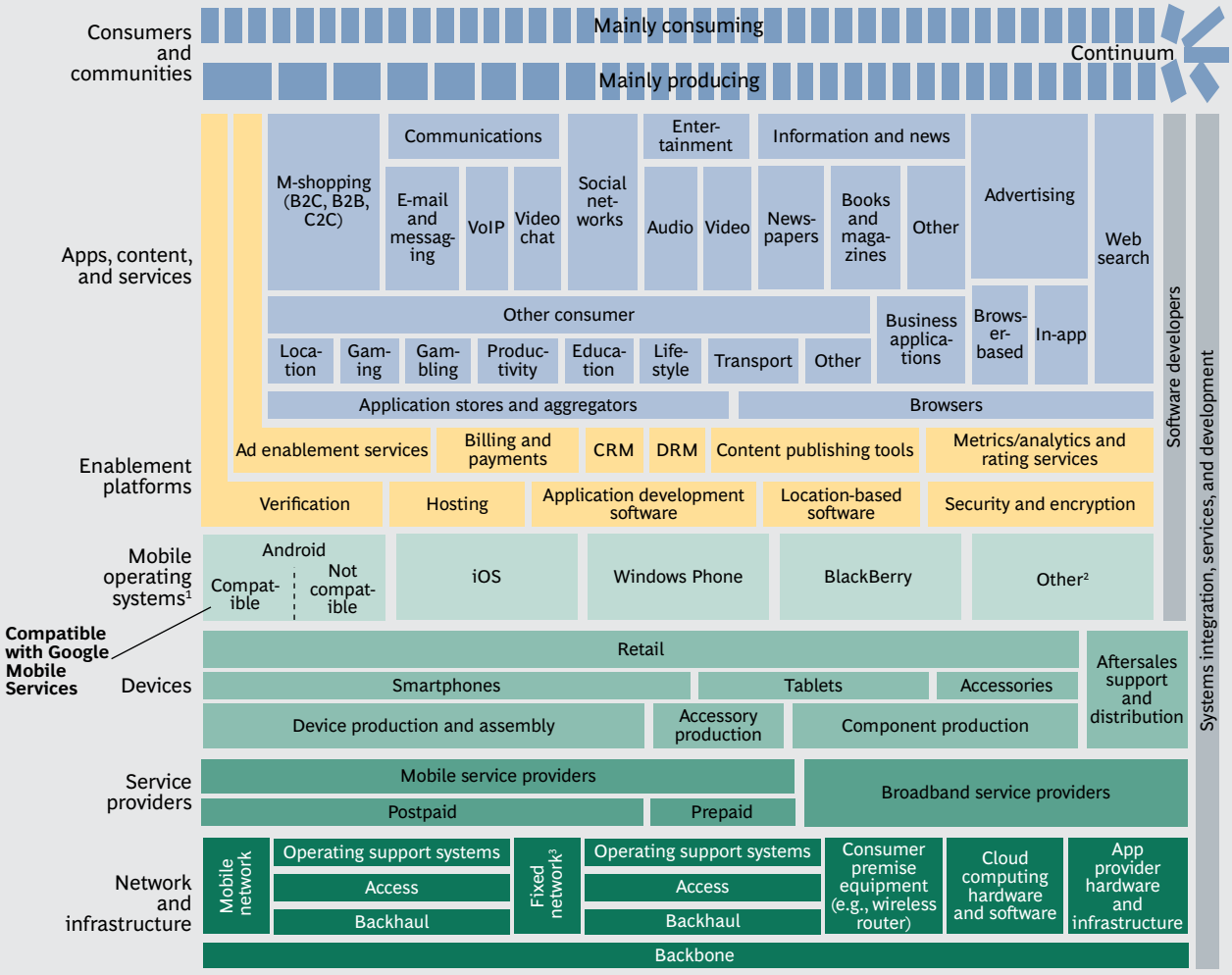
To illustrate the structure of the mobile Internet ecosystem, and how all these disparate players fit together and interact, we have borrowed from network engineering the concept of the "stack," a set of layered software and hardware that work together to drive a computer or other device. Each layer of the stack is made up of competitors and collaborators, interacting among themselves and with the other layers to provide services to the layers above and ultimately to the end user. The skeleton of the stack is a set of rules, usually technology paradigms, laws, and government and industry regulations, that define how groups coexist and co-participate. Stack architecture is typically found in information services, but it is now starting to emerge in health care and other industries.

At the foundation of the mobile Internet stack is the physical infrastructure—the mobile and backbone networks that provide the necessary connectivity and bandwidth, without which the stack could not function. Next come the mobile and broadband service providers that facilitate network access for users. Mobile devices, manufactured and marketed by OEMs in partnership with the companies providing the mobile operating systems (and sometimes also with telcos), occupy the next layer. The mobile operating systems that power smartphones, tablets, wearables, and other devices occupy their own layer of the stack, followed by enablement platforms. (Some vertically integrated companies, such as Apple, operate at multiple layers of the stack.) Near the top of the stack stand the app developers, content creators, software providers, and social networks. At the very top are consumers and communities—the people and organizations that make use of all the layers below in their interactions with one another. (See Exhibit 8.)

The economics and nature of competition vary considerably within layers of the stack. The app market, for example, is international in scope, but a significant portion comprises apps that are entirely local in nature (for such reasons as language and culture). There are several big, global names in content (music

Exhibit 8 | The Mobile Internet Ecosystem

The mobile Internet ecosystem is a complex landscape of multiple interacting layers and elements



Source: BCG analysis.
Note: Box sizes are not meant to represent relative size or importance.
[1]Includes software preinstalled by operating-system providers.
[2]Others include Symbian, Series 40, and Firefox.
[3]Mobile and fixed networks may share core and backhaul elements.

and video, for example), but also some strong national and regional players—as well as millions of users. (Dailymotion.com, a French video website, has 20 million unique visitors who generate 2.5 billion video views each month.) M-commerce has both big international names (Amazon and eBay are two) and strong local and regional flavors (such as Alibaba in China and Flipkart in India), thanks to differing consumer tastes and supply chain considerations. Traditional retailers are rapidly blurring the lines between digital and brick-and-mortar commerce, adding further complexity to the mobile stack. (See "The Mobile Internet Takes Off—Everywhere," above.)

The enablement platforms layer consists of services such as ad placement, billing and payments, identity verification, and publishing tools; it involves global companies like SAP, Spring Wireless, IBM, and Woodwing. Likewise, device manufacturers tend to be global businesses, with a wide range of companies (Samsung, Apple, Lenovo, Huawei) competing across countries and regions. For legacy and regulatory reasons, the service providers—telcos—are primarily national or multilocal companies. Some are developing regional strength—four carriers are active across multiple European countries, for example.

The Mobile Operating System Layer: Different Players, Different Goals

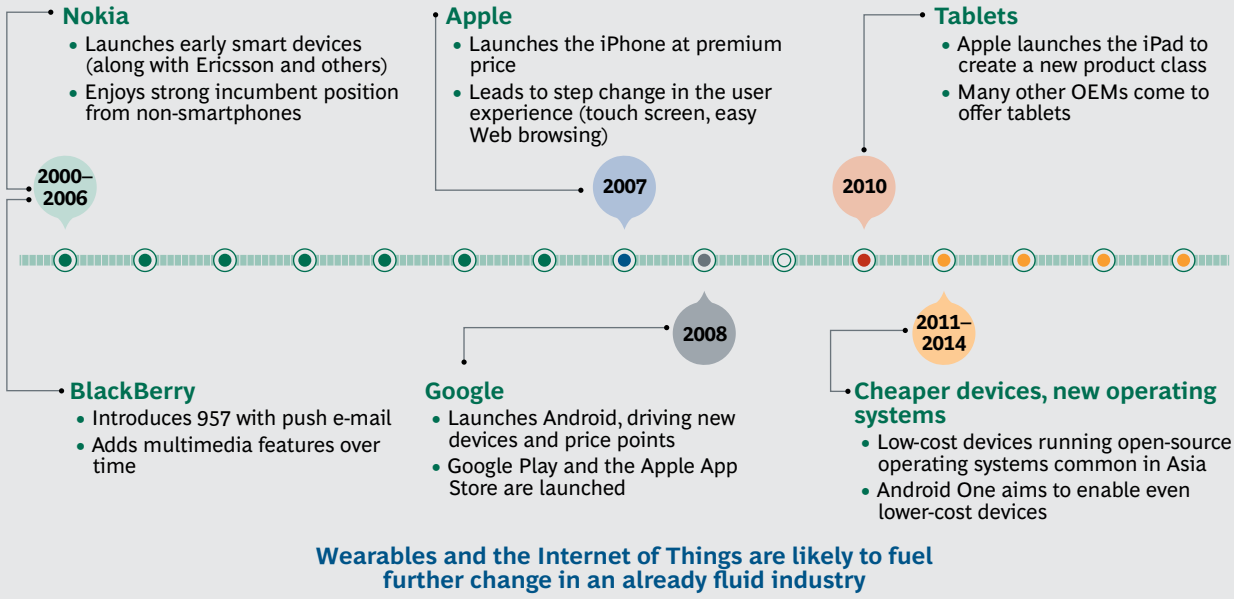
The center layer of the mobile stack is occupied by the operating systems that make smartphones smart, and that enable the convergence of computing power and portability in tablets and turn wearables into something much more than a wristwatch or an article of clothing. This layer is particularly dynamic and fast changing. Understanding distinctions among the major operating systems, each of which has its own goals, strategies, and impact, is essential to grasping how the mobile Internet industry works.

The operating system and device layers of the stack are both very fluid, and the size, roles, and influence of the various players have shifted dramatically over time. (See Exhibit 9.) Nokia and BlackBerry accounted for more than two-thirds of smartphone sales in 2008. As recently as 2010, four major operating systems (Nokia's Symbian, Google's Android, Apple's iOS, and BlackBerry OS) shared 92 percent of smartphone unit sales in our 13-country sample—with BlackBerry and Symbian accounting for 54 percent. Just four years later, the landscape looked completely different, with Android accounting for 78 percent of devices sold and iOS, 16 percent, while BlackBerry and Symbian sales had fallen to 1.9 percent and less than 0.5 percent, respectively. (See Exhibit 10.) Android and iOS also account for most of the value generated today in the countries surveyed. (See Exhibits 11 and 12.)

Each of these operating systems has very different strategies for increasing consumer adoption. Android aims to increase mobile Internet usage with an open-source operating system that is given away free with few restrictions. Android's ultimate goal is to provide as many users as possible with access to the Internet, thereby maximizing revenues through the use Google's services. Because device makers can install the operating system at no cost and differentiate on top of it, Android furthers competition among manufacturers and lowers costs for consumers. Its open-source architecture means it has many partners across multiple layers of the stack.

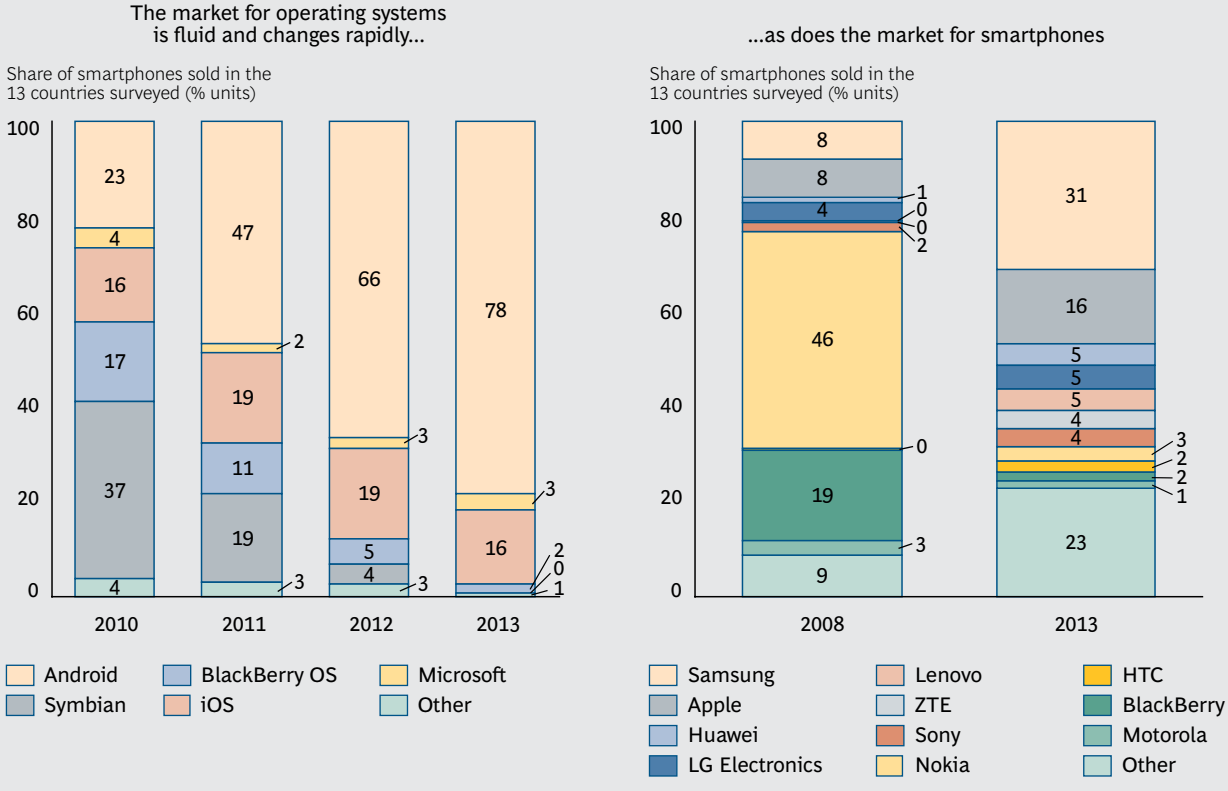
While Android supports a diverse set of devices, many at low price points, Apple focuses on selling premium devices that perform at a high level through the tightly controlled vertical integration of Apple computers, phones, tablets, other devices, and the apps they run. To deliver on its brand promise, Apple develops innovative products

EXHIBIT 9 | Change Will Remain a Constant in the Mobile Internet Ecosystem



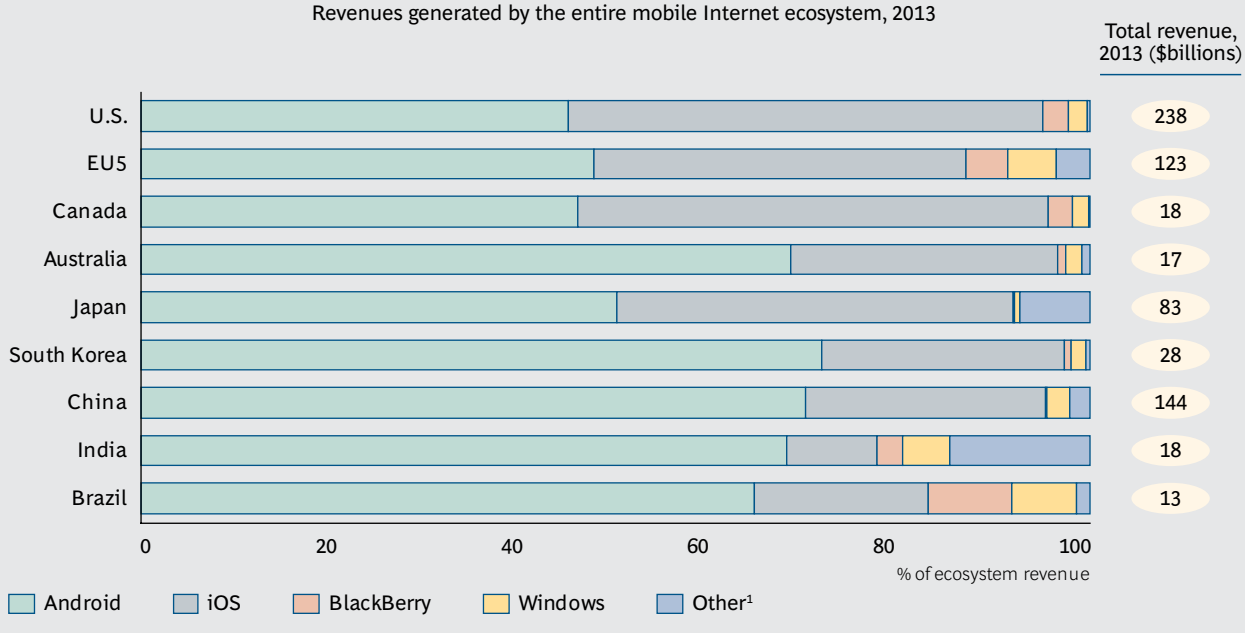
Source: BCG analysis.

EXHIBIT 10 | A Fast-Changing Market for Operating Systems and Devices



Sources: Gartner; BCG analysis.
Note: Because of rounding, not all percentages add up to 100.

EXHIBIT 11 | Android and iOS Are the Most Prevalent Operating Systems



Overall, Android generates $370 billion in revenues, iOS $263 billion, BlackBerry $14 billion, and Windows $18 billion

Source: BCG analysis.
[1]Includes Symbian and Series 40.

EXHIBIT 12 | Mobile Internet Revenue, by Operating System and Market

Value measure by operating system	Android	iOS	Windows Phone	BlackBerry OS	Others[1]
Revenue ($billions)	370	263	18	14	18
Consumer surplus ($billions)[1]	2,049	1,017	131	63	250
Share of unit shipments (%)[2]	72	24	3	1	0
Share of installed base (%)[2]	61	26	3	4	6
Revenue per installed base ($)	429	717	466	275	196
Consumer surplus per person ($)[3]	4,095	4,144	3,359	2,334	3,660

Value measure by market	13 countries surveyed	U.S.	EU5	Canada	Australia	Japan	South Korea	China	India	Brazil
2013 revenue ($billions)	682	238	123	18	17	83	28	144	18	13
2017 revenue ($billions)	1,546	544	302	41	24	115	40	374	69	37
Compound annual growth rate (%)	23	23	25	24	10	8	9	27	39	29

Source: BCG analysis.
Note: All figures are for 2013 unless otherwise indicated. Because of rounding, numbers may not add up to the totals shown.
[1]Includes Symbian and Series 40.
[2]Share of smartphones and tablets combined.
[3]As calculated from BCG's consumer surplus survey results.

that depend on the tight control of the user interface and experience. Its highly integrated model imposes exacting design criteria and standards on its supply chain. The resulting products appeal to many users: Apple is the world's most valuable company by market capitalization.

Two other operating systems together share about 5 percent of the market in the 13 countries we studied. Microsoft is building a third major ecosystem with its Windows Phone and new devices by leveraging the strength of its brand, its powerful desktop operating system, and its vast experience and capabilities in software design. It also aggressively promotes its cloud-based software and services. BlackBerry, once the market leader in corporate or "enterprise" mobile services, aims to sell devices, software, and services to the enterprise market based on its secure operating system and messaging services as well as a predictable user experience. It recently partnered with the Amazon Appstore to address the consumer side of the market, signaling its continuing desire to focus resources on enterprise services and phones.

Today's lineup will almost certainly change as current players and other competitors develop new technologies and services. Newer operating systems, such as Amazon's Fire OS, Nokia's X platform, Xiaomi's MIUI, Firefox OS, and Tizen, are increasing both user choice and competition in the stack while decreasing prices. Fire OS and X platform are both Android "forks," or altered copies, that legitimately use variations of the open-source Android operating system to pursue their own directions. In fact, few device OEMs today use a "pure" version of Android. Google makes the entire source code freely available for modification through the Android Open Source Project, and each OEM can decide whether it wants to include Google Mobile Services (Google Play, for example) on its devices. Those that do must have their device and operating system specs checked (using Google certification tools) to ensure that all app programming interfaces are supported.

Although OEMs can still make modifications to the user interface and user experience to differentiate their devices in the marketplace, Android's baseline compatibility standards aim to reduce fragmentation.

Other OEMs take a different route, choosing to install their own versions of these apps or services instead of Google Mobile Services. To do so, they can develop or license their own set of apps, and no further interaction with Google is required. Examples of this approach include Amazon's Fire OS, which seeks to create its own ecosystem of devices and apps built around its e-commerce model, Nokia's X line series of devices, and Xiaomi's MIUI, the brainchild of China's largest smartphone vendor. (MIUI does not include Google apps in the Chinese market, but they are included in other Asian markets such as India, Singapore, and Indonesia.) Xiaomi pursues a low-cost, low-margin model that is engendering intense competition across Asia, and it will likely expand beyond the region to increase competition elsewhere.

The Firefox and Tizen operating systems, like Android, are both based on Linux. Like the popular Firefox Web browser, Firefox OS was developed by Mozilla. The first Firefox OS phones were designed to bring better performance to the low end of the market. Mozilla and its partners are also expanding into mid-tier devices and could move up the value chain from there. Tizen, sponsored by Samsung and Intel, among others, serves two purposes: it provides its sponsors, which include device makers, semiconductor manufacturers, and telecoms, with an alternative to Android, and—by developing a well-resourced and strongly backed competitive open operating system—it encourages Google to preserve the openness of the Android.

The Great Debate: Open Versus Closed Systems

In recent years, competing operating system strategies have emerged, each with variations on open or closed models. Android grants OEMs full access to its operating system code. Windows is available on Microsoft phones and on the devices of licensed third-party OEMs. BlackBerry's proprietary system is available only on BlackBerry handsets. Finally, Apple's iOS is a vertically integrated operating system available only on iPhones and iPads. Industry participants debate which is preferable, and each offers advantages and disadvantages to consumers, device makers, and developers. The attributes of each determine how the company behind the operating system interacts with other participants in the stack. (See Exhibit 13.)

Open systems provide greater choice when it comes to operating systems and devices.

Broadly speaking, open-source operating systems, which can be modified and adapted by OEMs, have many participants involved in system development, device manufacturing and marketing, and app development and marketing. Each device manufacturer does business independently from the operating system developer, and multiple app vendors operate under standards and testing that are less tightly controlled than those of closed operating systems. The leading example, of course, is Google's Android and its many device manufacturers. The Firefox and Tizen operating systems also fall into this category.

In closed systems, by contrast, proprietary code is not made available to OEMs or other participants. There is tight vertical integration across the system developer, device OEMs, and app vendors. These operating systems typically involve only a single or small number of device manufacturers and a single app store with strictly controlled standards and testing.

Open systems generally provide consumers with greater choice when it comes to operating systems and devices (remember that there are more than 18,000 Android-powered device models). These include pure Android systems, compatible Android OEM modifications, and the Android forks. Consumers also typically have more opportunity to customize the device experience (for example, by personalizing the look, feel, and features of their

EXHIBIT 13 | Attractiveness of Various Operating Systems to Other Participants in the Stack

	Criteria	Android	iOS	Windows Phone	BlackBerry OS
Consumers	Availability of apps	High	High	High	Medium
	User experience	High, variable	Highest	Medium	Low
	Personalization	High	Low to medium	Medium	Low
	Average device price	Low	High	Medium	Medium
	Overall consumer rating	●	●	◑	◔
Enterprises	Security of use	Low, improving	High	Medium	Highest
	Integration with IT	Low to medium	Medium	Medium to high	Medium
	Overall enterprise rating	◔	◑	◑	◕
Developers	Device penetration	Highest	High	Low	Low
	Programming	Easy	Easy	Medium	Medium
	Approval process	Easy	Hard	Medium	Medium
	Revenue per app	Low to medium	High	Low	Lowest
	Overall developer rating	◕	◕	◔	◔
OEMs	License fee	None	Proprietary operating system[1]	High, falling	Proprietary operating system[2]
	Open source code	Yes		No	
	Flexibility to customize	High		Low	
	Overall OEM rating	●	○	◑	○
Carriers	Revenue generation	High	Medium	Low to medium	Low
	Customer perception	High	Highest	Low to medium	Low
	Subscriber acquisition cost	Medium	Medium	Low	Low
	Overall carrier rating	◕	◕	◑	◔

Sources: Press search; expert interviews; BCG analysis.
[1]Parts of iOS 8 will be opened to developers to allow limited customization.
[2]BlackBerry has not yet opened its BB10 OS.

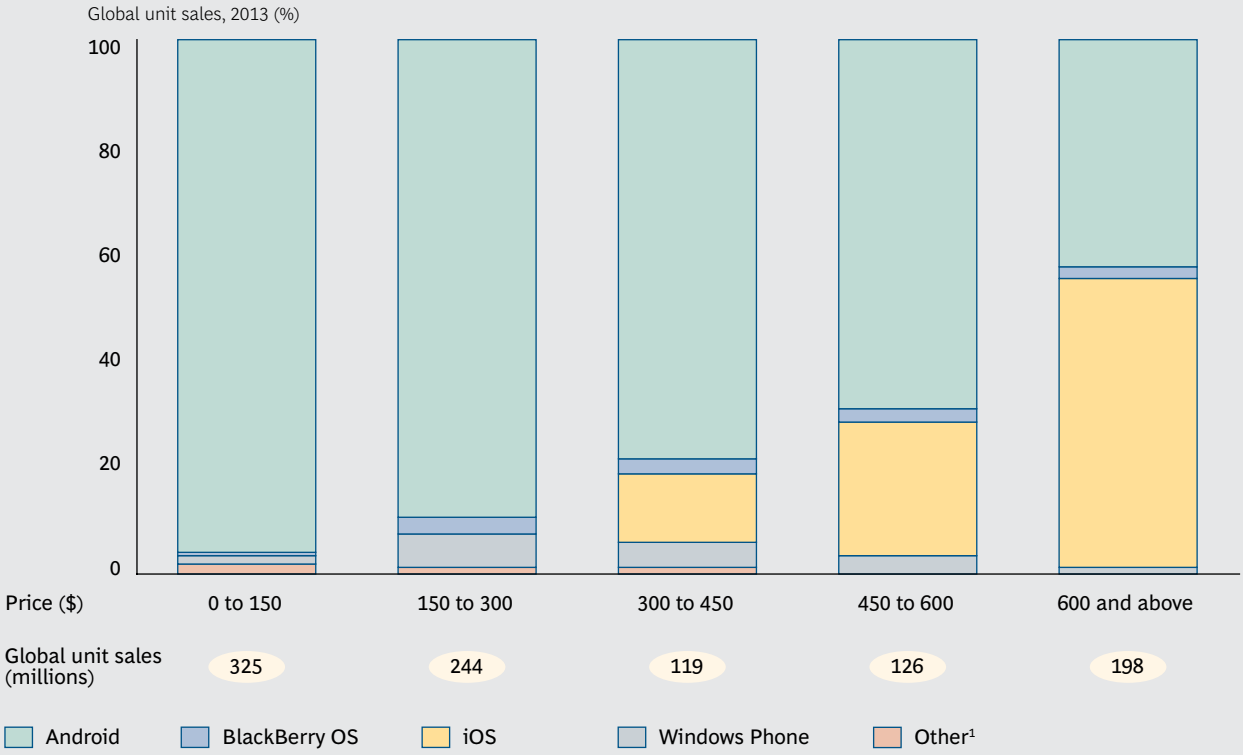
smartphones). And app developers are often able to more deeply integrate with open systems, creating further differentiation and customization. The various "launcher" apps that are available on Android enable users to opt for a completely different user interface than the one that comes pre-installed on most devices. Finally, open systems tend to lead to a greater range of price points, since multiple OEMs control the pricing of their respective devices. (See Exhibit 14.)

Open access to source code and device features promotes innovation, but it can also mean features are not fully tested on all devices and may be less reliable. The forking of an operating system can reduce its scale of use and hence developer interest, and consumers can find that forked systems don't run all apps properly. There is also a higher potential for security flaws on noncompatible forked operating systems (malware, spyware, privacy violations), and multiple app stores create more potential sources of security attacks.

Closed systems, in contrast, offer consumers a limited number of one-size-fits-all devices that are typically made available at few—and often premium—price points. Apple, for example, offers two sizes of its iPad tablet, and a narrow range of storage capacity options. Many features are not customizable, although all features have usually been fully tested on all devices, which increases reliability. Apps are available only from a single app store, which can limit choice but is an effective means of reducing security attacks and risks for users.

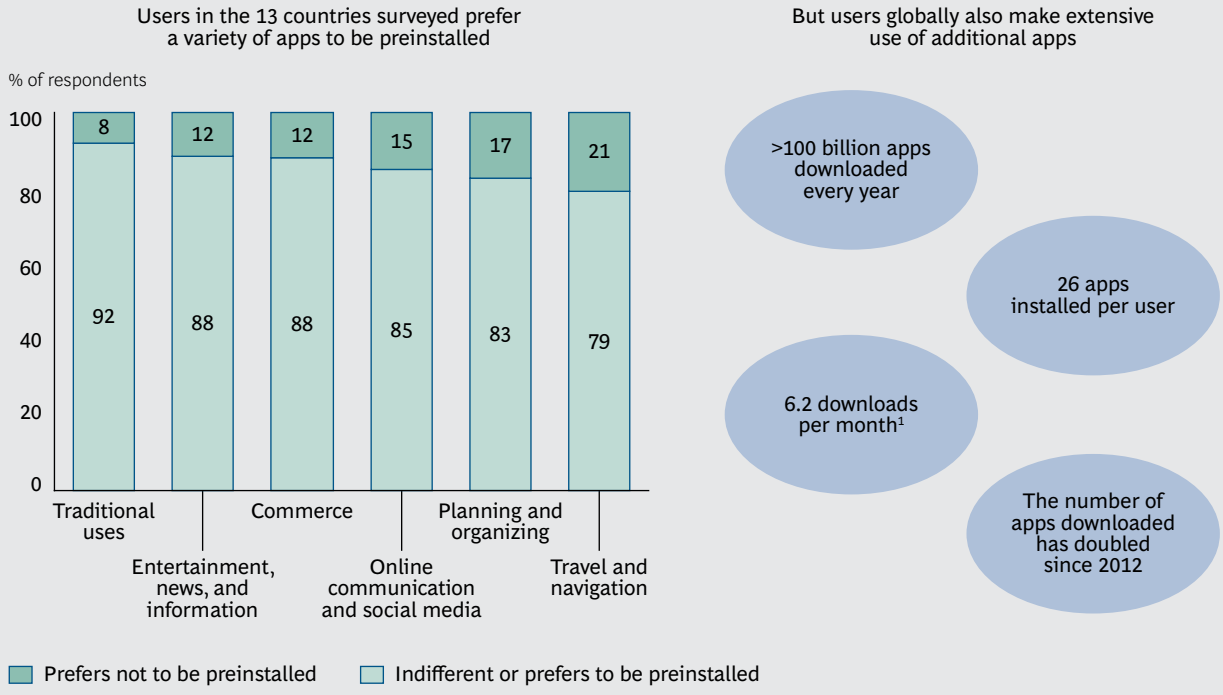
Whether the operating system is open or closed, consumers' priorities are in certain respects consistent: they want a ready-to-go, out-of-the-box experience combined with the flexibility needed to download supplemental apps. (See Exhibit 15.)

Exhibit 14 | Global Unit Sales Vary According to System Price Range



Sources: IDC; BCG analysis.
[1]Includes Firefox OS, Linux, Maemo/MeeGo, Symbian, and others.

Exhibit 15 | Consumers Want an Out-of-the-Box Experience and the Ability to Download Additional Apps



Sources: Gartner; Statista; BCG consumer surplus survey, September 2014.
[1]Number of downloads per month worldwide on Android devices in 2013; on iOS devices, there were 3.9 downloads per month worldwide in 2013.

For developers, the greater consumer choice provided by open systems leads to a more segmented device market that spans many price points. In open systems, no single app store is the sole "gatekeeper," with the power to control market access for a developer's app; developers have multiple options to get their apps onto devices. The fragmentation of devices and operating system forks, however, adds complexity. Developers potentially must create multiple versions of the same app for each operating system flavor, and app performance may vary across devices. In this way, fragmentation can easily and quickly drive up development and support costs.

The often more focused ecosystem of a closed system can be attractive to developers, especially since users are often paying a premium for devices and apps. At the same time, the single-gatekeeper app store can determine whether any single app gets access to the ecosystem. One large app store with exacting standards for a small number of devices means that developers typically only have to create one or a very few versions of a given app.

Competition among open and closed systems promotes innovation and keeps the mobile ecosystem thriving. It drives rising revenues, the growing consumer surplus, investment, and jobs.

GREATER AFFORDABILITY WILL DRIVE FURTHER CHANGE

SMARTPHONE PRICES HAVE BEEN coming down, and the rapid advent of more affordable phones (those costing $100 or less) will drive both greater penetration and new uses. While only about 20 percent of smartphone shipments in 2013 were of phones priced below $100, more and more OEMs are now making affordable phones, including global manufacturers (Samsung, HTC), local players (Xiaomi, Micromax), and new entrants (Mozilla, Intex). In France, Wiko devices (launched in 2012) sell for about €70 and captured nearly 7 percent of sales in 2013. Wiko expanded into the UK market in 2014. Also in 2014, in India—a potentially massive market—Intex Technologies launched a Firefox smartphone for $33 (the same price as a feature phone), and Google launched Android One, a set of high-quality, affordable phones from different manufacturers, all priced around $100 and with inexpensive Internet access. Both companies plan to roll out these low-priced phones across Asia soon.

Affordable does not mean subpar. In 2013, almost 90 percent of smartphones priced below $80 had processors faster than 1 GHz (compared with 42 percent in 2012), and 38 percent had displays bigger than four inches (compared with 8 percent in 2012).

The increasing affordability of devices, especially smartphones, will drive three developing trends:

- *A Continuing Explosion in Smartphone Devices.* It took more than a decade for the number of smartphones sold to reach 1 billion units, but only three years for the next billion to be sold. Global smartphone penetration will approach 35 percent in 2017, up from 20 percent in 2013 and 10 percent in 2011. The installed user base will double in 2017 to almost 3 billion, from 1.5 billion in 2013.

- *The Rise of the Affordable-Smartphone User.* Affordable smartphones open up entirely new demographic and geographic categories of consumers—users who are likely to have below-average incomes and to live in rural areas with unreliable network coverage. Affordability has been the biggest single cap on data usage growth, leading content companies such as Google and Facebook to look for ways to lower the cost of Internet access. The total amount spent on smartphones will increase, but the average amount spent per consumer will fall as users of affordable smartphones upgrade from feature phones and focus more on price than on brand.

- *A Big Increase in Data Coverage and Quality.* As more users come online, they will bring about an increase in network coverage, capacity, and quality. We expect global 3G coverage to increase from 60 percent in

2013 to 90 percent in 2019, and LTE access to increase from 20 percent to 65 percent. The average worldwide connection speed will soar from 189 Kbps in 2010 to 3,898 Kbps in 2017.

As the growing scale of the mobile Internet drives revenue growth for operating systems, apps, content, and service providers (through more ad revenues, paid downloads, in-app purchases, and paid premium content, for example), it will also generate more competition. In addition, traditional revenue streams such as phone calls and SMS (short message service, more commonly known as texting) will be replaced by larger data packages, as consumers upgrade from feature phones to devices capable of data-driven options such as Microsoft-owned Skype and Facebook-owned WhatsApp. Initially, some providers may subsidize data usage to attract new customers. Device OEMs will benefit from rising revenues and greater economies of scale, but they will equally need to manage margins in a low-cost, increasingly competitive market.

As discussed above, the growth of wearables and machine-to-machine communication—the Internet of Things—is likely to fuel further change in an already fluid industry.

KEEPING THE MOBILE INTERNET MOVING

THE ECONOMIC BENEFITS OF the mobile Internet are big, clear, and undeniable. As we have seen, competition has driven innovation and experimentation that have generated billions of dollars in new economic activity, millions of jobs, and a large and growing consumer surplus. It should be a goal of policy makers everywhere to keep the mobile Internet moving forward.

To be sure, the disruption that game-changing technologies such as mobile often cause creates issues for consumers and others that require full debate and fair resolution. One of the most important of these involves data privacy, data security, and the ways in which data is used by those that collect it. We have discussed previously the need to balance the potential value that personal data can unlock with the rights of individuals and societies to determine what are, and are not, legitimate uses of data. (See "Rethinking Personal Data: Strengthening Trust," BCG article, May 2012.)

There are also concerns about new business models, such as those at work in the "sharing economy" that create considerable consumer value but disadvantage legacy companies that often have to adhere to different sets of rules. Some consumer advocates and others point to the potential for overcharging consumers through in-app purchases and other subscription models, the cost ramifications of which some consumers may not fully understand.

These are all legitimate concerns. Policy makers can help keep the mobile Internet economy moving by pursuing proven policy goals that can mitigate risks to growth and encourage innovation, value creation, and consumer welfare and choice. Other policy goals should include the following:

- Promoting investment in expanded coverage, high-speed infrastructure, and affordable mobile Internet access, especially in developing markets
- Putting a priority on education and skills building
- Encouraging innovation and entrepreneurial activity
- Adapting existing legislation or policies to allow for the growth of new business models that create consumer value
- Encouraging organizations to take a transparent approach to the way that they collect and use consumer data, as well as how they charge consumers for services such as in-app purchases and subscriptions

In addition, policy makers need to take into account how quickly technologies and the innovations they enable are evolving and, where necessary, modernize regulatory regimes and regulation in ways that support in-

novation and investment across the entire mobile Internet value chain. Simple, transparent, ex ante policies work best in fast-changing environments. Existing regulations should be reviewed for the possibility of reducing or eliminating rules that impede technological innovation and business model experimentation. And taxation of digital activities should not become an undue burden for the sector, as it may undercut innovation and stunt the growth of independent developers. Governments should avoid, or look for alternative approaches to, adding new regulations or expanding existing regulations to new sectors. In some instances, self-regulation can be a viable option in competitive markets.

Policy makers also need to recognize that, like individual countries and markets, companies and organizations operating at each layer of the stack face different kinds of challenges. (See "The Mobile Internet Stack," above.) As we argued in "Reforming Europe's Telecom Regulation" and "Delivering Digital Infrastructure," for example, there is a need for reform at the network and infrastructure layer of the stack on major issues facing telcos, such as the availability and harmonizing of spectrum. In other parts of the stack—the operating system; device; and apps, content, and services layers being three examples—the market economy is doing its job quite handily. Competition reigns, prices are falling, innovation is bringing new technologies, products, services, and apps to market at a near breakneck pace. And consumers are realizing a huge and growing benefit. The mobile Internet economy is creating jobs and making a material contribution to GDP.

The greatest opportunity for transformative economic and social impact is in developing markets. And the biggest challenge in many of these countries is the need to expand access and penetration by constructing basic infrastructure and bringing prices down.

The economics of many developing economies make infrastructure (as well as other) investments tough. Public-private partnerships are one time-tested method of getting big infrastructure projects off the ground, although it is important to ensure that the capabilities and experience of private market players are not lost and that public-sector involvement does not lead to market distortions. Bridging the divide may require nontraditional and innovative approaches. Google's Project Loon is experimenting with high-altitude balloons that can beam down an LTE network to "connect people in rural and remote areas, help fill coverage gaps, and bring people back online after disasters." In Kenya, Microsoft has partnered with the Ministry of Information, Communications, and Technology and a local Internet service provider to bring low-cost Internet access and charging stations to rural communities that lack electricity, using a solar-powered wireless broadband network featuring TV white-space radios. And Internet.org, a partnership founded by major technology companies, including Ericsson, Facebook, MediaTek, Nokia, Opera Software, Qualcomm, and Samsung, works with governments and NGOs to bring basic Internet services to people who do not have them. Facebook founder Mark Zuckerberg describes it as "the on-ramp for the Internet."

Local app development is beginning to take hold in a few developing countries, providing important local-language resources for users. Chinese users already spend far more time on apps developed locally than on those from other countries. Brazilian users are also spending considerable time using locally developed apps. Local digital ecosystems are vital in serving local needs and boosting competition in an increasingly international digital-services market. By maintaining a free and open Internet, governments have a role to play in fostering the development of these ecosystems and enabling compelling app development within them.

We are still only starting to realize the benefits of the mobile Internet for consumers, businesses, and society. These benefits are built, fundamentally, on competition-driven consumer choice and access. In an age of globally mobile capital and talent, the economies that develop and maintain such markets will see the greatest payback.

APPENDIX

METHODOLOGY

The following describes our approach to sizing the mobile Internet economy.

Sizing the Value of the Mobile Internet Economy

To develop an appreciation for the size and importance of the mobile Internet ecosystem, we measured the 2013 revenues associated with each of the layers of the stack shown in Exhibit 8. We chose revenue as an intuitive metric for the level of activity associated with smart devices in order to help illustrate the growing role that the associated ecosystems are playing in the economy.

Scope. We measured revenues pertaining to the use of smart devices, which we define as smartphones and tablets. The numbers cited reflect revenue flows associated with final consumption at each layer of the stack. The countries surveyed were Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, South Korea, Spain, the UK, and the U.S.

We discriminated between those activities uniquely or predominantly performed on a smart device and those performed on other devices, such as feature phones. We therefore excluded voice and SMS activities on smart devices but included other data usage. We also recognized a proportion of fixed-line data use associated with Wi-Fi access via smart devices.

Approach. As a general rule, we took a conservative approach to quantifying the total revenue of the stack in each market, erring toward the lower end of estimates. We identified five key revenue inflows to the system: m-commerce; consumer (personal and enterprise) spending on apps, digital content, and services; advertiser spending on mobile advertising on smart devices; consumer spending on smart devices and accessories; and consumer spending on smart-device-related access to mobile data. The device revenue recognized was as accrued by the manufacturer of the device. Because of significant differences among countries in the approach to subsidization by carriers, no attempt was made to fully account for device price subsidies. We also measured some revenue flows within the stack (between layers) to identify the value associated with layers that do not have a direct inflow: enablement platforms, mobile operating systems, and network/infrastructure. These layers are ultimately "funded" by the inflows from end users to other layers of the stack. Where possible, these internal flows were apportioned to the appropriate layer, and double counting was avoided by deducting from other layers as necessary.

Production. Given that our focus was on revenues associated with consumption, we did not specifically measure production revenues (associated with devices, content,

and apps, for example). The value of production is included in the final price paid by consumers; therefore this does not affect the measurement of total value. However, differences in the import/export mix might underrepresent regions in which production is an important activity. We have therefore noted this in the report where relevant.

Investment. We did not include capital expenditures or spending on R&D in our figures. We consider these activities to be funded by revenues generated by consumption and so we did not include them in the total value estimate. We recognized operational expenditures related to the network/infrastructure layer (and discounted service provider revenues accordingly to cover this expenditure and to avoid double counting).

Sizing Employment

The following were our considerations in estimating employment associated with the mobile Internet economy.

Scope. The scope considerations for measuring employment were exactly the same as those for measuring value. We did not include employment related to capital expenditures owing to the cyclical nature of this activity.

Approach. We measured the employment associated with consumption in each market. The approach was a mix of company-by-company analysis and cross-market estimates. Where practical, we measured the employment related to smart devices for the major players within a given layer, then extrapolated to the whole market based on the market share of the major players. For activities in which the level of fragmentation within the industry was high or in which it was difficult to isolate employment associated with smart-device activities, we benchmarked the revenue per employee of a subset of representative players and extrapolated for the whole market.

Calculating Consumer Surplus

Consumer surplus quantifies the benefit of smart devices to consumers over and above what they pay for devices, data, and content. We measure what is called the equivalent surplus—the amount of additional income that consumers would need to receive to generate the same value as their devices. Quantifying this value is an inherently difficult exercise. To elicit reliable valuations, we used a methodology that asks consumers to choose between keeping their smart device or giving it up in return for a certain amount of money. Each respondent is given several offers in sequence, and by analyzing which ones are accepted and which are rejected, we derive a monetary value for the smart device.

Two Measures of Consumer Surplus. There are two alternative measures of consumer surplus. The first—compensating surplus—measures the maximum amount consumers are willing to pay for a good or service. Willingness to pay is an appropriate measure for companies trying to optimize pricing (as it represents the maximum amount they can charge for services). However, it can be problematic as a measure of welfare benefit to consumers, because it depends on the ability to pay—and may therefore understate the benefit of a service to lower-income consumers. For this reason, we focus instead on the second measure: the equivalent surplus. This can be interpreted as the minimum amount that consumers would be willing to accept to forgo using their devices.

Scope. To estimate the value of the mobile Internet, we surveyed a representative sample of around 1,000 smartphone and tablet users in each of the 13 nations surveyed.

Approach. Estimating the cost to consumers of using their devices is straightforward, but estimating the value they receive from their devices is a more difficult exercise. To extract a reliable valuation, we used a conjoint analysis methodology that asked each respondent to accept or reject a series of "deals." Each deal involved giving up mobile Internet access for a period of time in return for money. The conjoint analysis questions are very easy for consumers to understand, and they avoid many of the biases associated with open-ended questioning. By varying both the length of time respondents were

asked to forgo their mobile devices and the monetary compensation offered, we were able to use statistical methods to calculate the consumer value that each respondent placed on his or her smart device. This value—minus the cost of use—is the consumer surplus that the respondent enjoys from the smart device, which we then scaled up to generate an overall consumer surplus number for the entire country.

FOR FURTHER READING

The Boston Consulting Group publishes extensively on topics related to the digital economy. Recent examples include those listed here.

The Mobile Revolution: The Economic Impact of Mobile Technologies
A report by The Boston Consulting Group, January 2015

The Mobile Internet Economy in Europe
A report by The Boston Consulting Group, December 2014

Delivering Digital Infrastructure
An article by The Boston Consulting Group, April 2014

Europe's Digital Economy Needs a New Foundation
An article by The Boston Consulting Group, October 2013

Reforming Europe's Telecom Regulation
An article by The Boston Consulting Group, July 2013

Through the Mobile Looking Glass: The Transformative Potential of Mobile Technologies
A Focus by The Boston Consulting Group, April 2013

Rethinking Personal Data: Strengthening Trust
An article by The Boston Consulting Group, May 2012

The Internet Economy in the G-20: The $4.2 Trillion Growth Opportunity
A report by The Boston Consulting Group, March 2012

NOTE TO THE READER

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Acknowledgments

The authors are grateful to the following partners and colleagues for their insights and assistance with the development of this report: Philip Evans, David Brooks, Samuel Cohen, Caterina Preti, Henry Fovargue, Marcus Müller, Gaby Barrios, and Emmanuel Huet. In addition, they would like to thank Arnaud Miconnet of Sunesis Research.

The authors are also grateful to David Duffy for his help in writing the report and to Katherine Andrews, Gary Callahan, Kim Friedman, Abby Garland, Gina Goldstein, Amanda Provost, and Sara Strassenreiter for assistance with its editing, design, production, and distribution.

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2/15

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