SPECTRUM FUELS SPEED AND PROSPERITY

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Executive summary

The wireless industry is a key contributor to the US economy—creating jobs and GDP as well as countless economic and social benefits. This remains a fact despite reports earlier this year that US mobile speeds have lagged some of its trading partners. In this report, we explore the realities behind these reports, and what can be done to address them. Among the many factors that contribute to download speed across countries are the availability of 4G spectrum, capital expenditures, the way people use their phones, the phenomenon of urban agglomerations, and pricing.

In this executive summary, we highlight a number of facts:

- The US was the early leader in 4G speed, but world-leading mobile broadband adoption combined with the lack of new spectrum has constrained the industry's ability to deliver faster speeds, and has increased the cost of delivering such high-speed service.
- There is a positive correlation between channel sizes and observed download speeds. Countries that deploy larger channel blocks generally have faster download speeds, and enjoy greater trunking efficiencies in higher-density markets that produce additional economic benefits.
- The US spends more in capital expenditures than any G7 country and the second-most per inhabitant.
- More than any other G7 country, Americans use their phones for tasks that rely on the speed of a 4G LTE network, such as watching movies and TV and using video applications (e.g., making video calls).
- Contrary to conventional wisdom, the US has the least concentrated population among the G7 countries. We developed the Urban Agglomeration Index (UAI) to quantify population concentration. We found that every other G7 country has much higher UAIs than the US, which means that operators in those countries can focus investment on significantly fewer places to make a large impact on average network performance.
- Unlike other G7 countries, US operators do not charge a premium for 4G access. As a result, US networks are more highly trafficked than in countries where download speeds are tied to premium pricing. Furthermore, in countries with premium pricing average speeds are higher, but median speeds are lower than in countries where there is no premium pricing for LTE (like in the US). In other words, despite the average speed difference, more US subscribers experience high download speeds than people in other countries.
- Among the G7 countries, US customers are the most satisfied with their wireless operator and their smartphones.

The impact the mobile industry has on the US economy was inconceivable even 20 years ago. The social and economic benefits for the country are dramatic, profound and transformative. To continue these powerful contributions, the United States must accelerate spectrum availability for operators and consumers. The upcoming AWS3 and incentive auctions will only partially alleviate spectrum needs. Additional licenses need to be made available quickly so that the US shores up the fundamentals it needs to maintain leadership in innovation and customer satisfaction as well as increase the prosperity of the country.

Through their large capital expenditures, operators provide the fuel to accelerate the economic benefits of the wireless industry for the US economy. The government has to do its share by adding more oxygen in the form of additional spectrum to rev up the wireless growth engine.

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OVERVIEW

This report examines wireless download speeds, spectrum availability, capital expenditures, usage patterns, urban agglomerations, pricing, and satisfaction for carriers in the United States and fellow G7 member countries in assessing what needs to be done to ensure and maximize the continued economic contributions of the US wireless industry[1].

The first large-scale 4G LTE network in the world, Verizon's 4G LTE network, launched on December 5, 2010. AT&T followed ten short months later. These early network moves coupled with an abundance of affordable 4G LTE devices gave the US the fastest download speeds in the G7 until the second quarter 2012, as Americans adopted 4G LTE at a rapid pace. However, because of limited and shared spectrum resources, the popularity of 4G in the US has allowed others to jump ahead in speeds. For example, Canada overtook the US lead in speed in 2Q 2012, followed by Japan in 3Q 2013, and France in 1Q 2014.

The availability of spectrum is the oxygen that allows the wireless engine to run. The US has utilized the least amount of spectrum for LTE compared to its peers, driven both by significantly more subscribers and the third lowest amount of spectrum available in absolute terms and the lowest per-subscriber for LTE. Almost every country has made licenses of various channel sizes available for auction, but the US has far fewer wide-channel spectrum allocations than countries such as France. This is significant because these wide-channel allocations make it easier and more affordable to roll out advanced services like 4G.[2]

If spectrum is oxygen, then capex is the fuel that powers the wireless growth engine of the economy. Carriers in the United States, which has the most people and a vast coverage area, spent more on capex than carriers in any other G7 country. Japan, with the second most inhabitants, spends the second most. There is a significant chasm between the US and the rest of the G7. In 2013, US operators spent twice as much per person as British and German operators, while Japan spent three times as much per person as the British and German operators. Such capital expenditures in the US have made the download speeds we all take for granted possible. At the same time, carriers in France could spend less but get faster speeds because of the trunking efficiencies they gain with the wide, contiguous channels available to them, and the fewer 4G subscribers currently supported by their networks.

In most countries, the mobile phone has become the ubiquitous replacement for the camera. In all G7 countries, at least 76% of people have used their mobile to take pictures; in the United States, that figure reached as high as 84% in the first quarter of 2014.

For applications that need a fast network, a similar trend appears. Video calling, in particular, has made the biggest inroads in North America: 22% of Americans and 16% of Canadians make video calls, as of Q1 2014. British consumers are not far behind with 14%, while their continental counterparts are only half as likely to engage in video calling as Americans.

The US is a big country, but even though 82.4% of the population lives in cities, only about one-fifth of the total population lives in the top five largest urban agglomerations. In contrast, the population is considerably more concentrated in Japan, where the top five metro areas add up to nearly half of the Japanese population. Other countries in the G7 have similar advantages to

[1] We point to this author's 2012 report on the impact of the wireless industry on the US economy (http://reconanalytics.com/2012/04/essential-engine-of-us-economic-growth/) as well as GSMA's work. (http://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf).

[2] This is not to endorse exclusively wide-channel allocations. Rather, it is to note the real world impacts of a lack of a sufficient number of such allocations. Policy reasons favor a mix of channel allocation sizes, but it must be understood that the lack of sufficient wide-channel allocations has ongoing impacts for carriers, consumers and the economy. Technologies like spectrum aggregation have the ability to partially alleviate these issues.

Japan—their population is concentrated and a lot of people live in a few places. The US is different; it has many agglomerations, but it is geographically dispersed. We created the Urban Agglomeration Index to understand these differences and the challenge it presents to a carrier looking to build out a network and cover the most people for the lowest cost.

In the UK and the rest of Europe, wireless licenses have typically been technology-specific, while in the US, license owners can use any technology they choose. This has the effect of limiting the potential number of partners for a carrier.

As far as pricing is concerned, US carriers have followed a strategy of pricing 4G at par with 3G. This encourages adoption and ensures that many customers make the switch to the new network with a new device. Apart from Canada (which has a similar approach to the US), for the most part, other G7 countries charge a premium for 4G access. This has dual effects: It limits the number of people who'll switch from slower 3G (and even 2G) networks and ensures that the 4G networks won't be bogged down with traffic, which has the effect of speeding up the service, because the networks experience less demand for the shared 4G spectrum.

Making customers happy takes more than a combination of devices and network speed. With a higher penetration of 4G and smartphones than any of its G7 counterparts, no consumers among the G7 countries are more satisfied with their smartphones and carriers than those in the US.

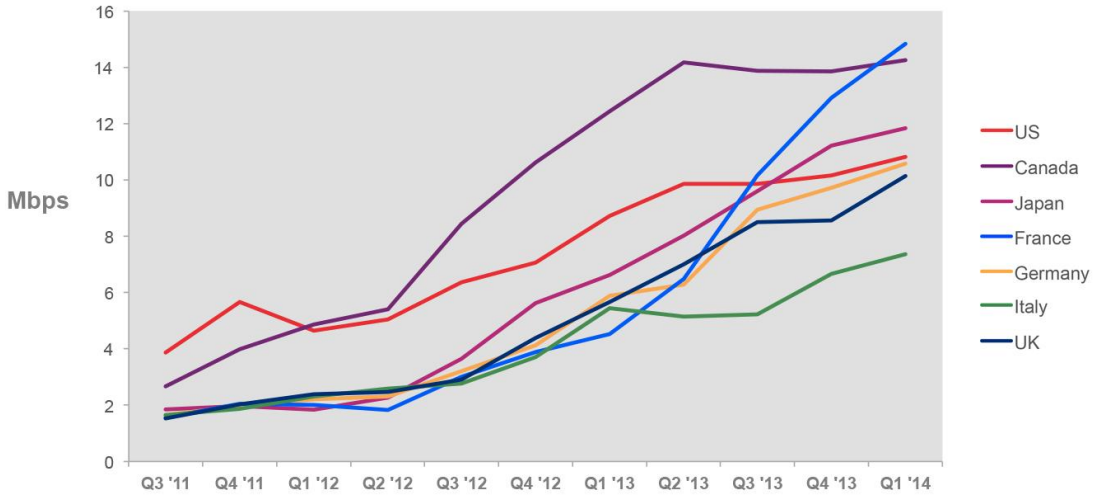
In this report, we examine the differences we just outlined, but, more importantly, we investigate the underlying causes of those differences, and both their implications for future economic and social benefits, and measures that can be taken to improve those benefits. The most important of these measures is for the government to accelerate the availability of more spectrum for commercial mobile service.

1. DOWNLOAD SPEEDS

Verizon Launches First Large-Scale 4G LTE Network

On December 5, 2010, Verizon launched the first large-scale 4G LTE network in the world, followed by AT&T merely ten months later. The aggressive early deployment of 4G LTE and the availability of a significant number of affordable 4G LTE devices provided American consumers with the fastest download speeds in the world until the first quarter 2012. At that point, we observe significant speed increases with the subsequent introduction of large-scale LTE networks in the other G7 countries (see Exhibit 1).

Exhibit 1: Average Mobile Data Speed by Country



Source: Ookla; Capture Date June 13, 2014

Canadian wireless users then took the speed crown from their neighbors to the south after Canadian carriers launched their 4G LTE networks in 2012. Canada only surrendered the lead to the French in the first quarter 2014 after French carriers launched their LTE network.

In subsequent chapters of this report we will discuss the reasons for the observed speed differences in the various countries.

Why this matters

Wireless download speeds are an important indicator of the kind of applications that can be used on a network as well as how productive and pleasurable it is to use your connected device. Waiting for a website to load or having a video turn into a slideshow due to low download speeds significantly reduces the utility of the device and frustrates users. Video has the most stringent benchmark: In order to run a standard resolution video without interruptions, a device needs at least 1 Mbps download speeds, HD video needs 5 Mbps, and Ultra-HD video needs 10 Mbps. But accepting download speeds at face value can be deceiving. Wireless download speeds are a product of the use of a shared resource. The more people that download at a certain location the slower the speed gets. It says nothing about how large a network is, or the benefits that are delivered by such a broadly available and used network. For example, a 4G network that's

available only to a fraction of the population in a limited area is not nearly as valuable as a marginally slower network with a large and broad reach. That limited 4G network might be fast, but its actual utility can be very limited. Nonetheless, the figures do help paint an important picture of a phase in wireless rollout. Speeds in France have recently risen on the back of channel allocation that was more heavily skewed to large channel sizes (to drive inherent network efficiencies of large channels) even though they auctioned some blocks as small as 5 MHz x 5 MHz (which accommodate smaller carriers). The US, which has seen speeds continue to increase, albeit at a slower pace, has done so with less utilized 4G spectrum than many other countries even though it has many more subscribers, both in total numbers and as a percentage of total subscribers.

2. SPECTRUM AVAILABILITY

Spectrum Is Like Oxygen

Just like pushing more oxygen into an engine to get more speed out of it, spectrum is the oxygen that translates into higher achievable speeds for LTE subscribers.

The US mobile broadband experience is the stuff of lore around the world, in part due to the smartphone revolution that first happened here, enabled by large, reliable wireless networks and innovative pricing strategies that made smartphones and Internet access a reality for hundreds of millions of Americans. The US was also the first to roll out fully commercial LTE networks that offered significantly higher speeds than ever before.

But, as we saw in Exhibit 1, the US recently fell behind in wireless download speeds compared to several other countries in the G7, largely as it became a victim of its own success. Wireless is a shared resource, so if spectrum is limited and demand for services is rapidly increasing, the share each customer can have goes down. On paper, the US seems to have a decent amount of spectrum, but it is generally already used for current services.

The FCC has scheduled the AWS3 auction, which is a welcome development but does not fundamentally change the fundamental lack of spectrum that we're facing in the US. Nor can the FCC's upcoming incentive auction be factored into this analysis of current spectrum allocations, just as other countries' on-going consideration of spectrum re-allocation and refarming is omitted.

Not everything that has been auctioned can or is used for LTE services. Legacy services such as GSM, CDMA, and HSPA—with hundreds of millions of customers across the G7 countries—need to be serviced. It's when we look at what is actually being used for LTE that the picture becomes a lot starker.

As we can see in Exhibit 2, the US has utilized the least amount of spectrum for LTE compared to its peers, a fact driven both by significantly more subscribers and the third lowest amount of spectrum available for LTE. In the simplest of terms (and all other things being equal), if there is less spectrum available per user, speeds will suffer. But, in fact, there were both more users and more heavy usage, along with less spectrum available per user, in the US than in the other G7 countries. Cisco's Mobile VNI Forecast shows that 4G connections generated more than three times the traffic of non-4G connections in 2013[3].

[3] http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/index.html#~Country

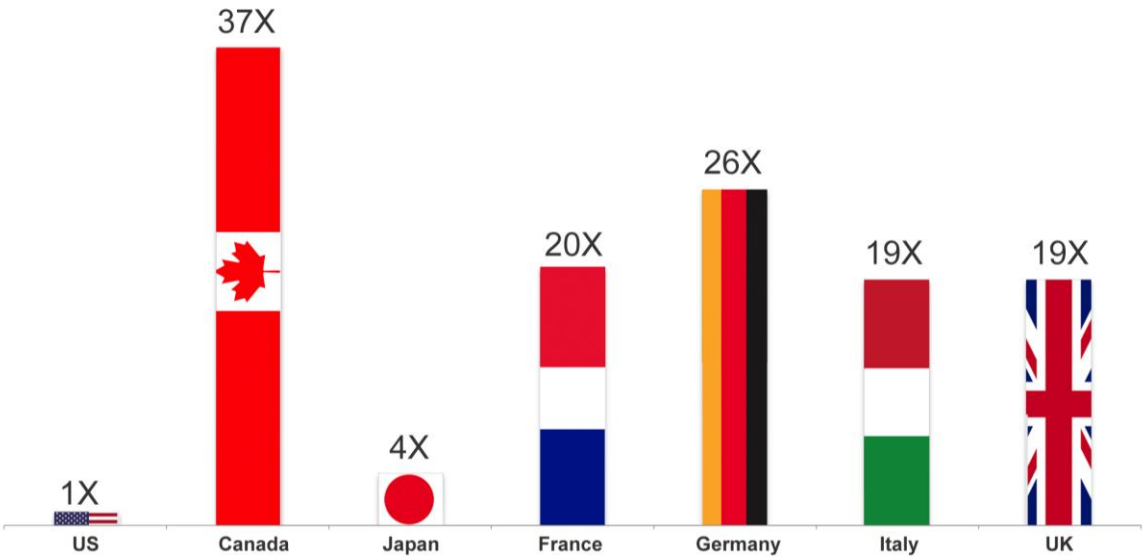
Exhibit 2: Deployed LTE Spectrum

	US	Canada	Japan	France	Germany	Italy	UK
FDD	57x57	72x72	100x100	80x80	60x60	15x15	55x55
TDD	20	30	30		20		
FDD Downlink and 2/3 of TDD	73	92	120	80	74	15	55
Subscribers in millions	330	27	122	73	107	89	76
LTE Subscriber	112.0	3.8	46.4	5.9	4.3	1.2	4.5
Hz/LTE subscriber	0.65	24.21	2.58	13.55	17.20	12.5	12.2

Source: Recon Analytics and Q1 2014 operator reports, 2014

Other countries have considerably more LTE spectrum available per LTE subscriber (see Exhibit 3). For example, Japanese carriers devote four times as much spectrum per subscriber to LTE as US carriers. In addition, Canadian carriers have a whopping 37 times the bandwidth while German operators have added 26 times what US operators have dedicated to serve their LTE customers. Considering that other countries have been able to bring so much more spectrum online for LTE customers, it is remarkable that the US is not much further behind when it comes to download speeds. That is a tribute to the ingenuity of the US wireless operators and the skilled engineers building and designing the wireless networks, and the significant investment made by US operators.

Exhibit 3: LTE Spectrum used per LTE subscriber



Source: Recon Analytics and Q1 2014 operator reports, 2014

This relative paucity of spectrum in the US has been aggravated by the way wireless licenses have been allocated—in terms of channel sizes. In the US, the largest channel size that was auctioned were three 15x15 MHz licenses in the PCS bands. Actually, over time, as the technical advantages of large channel sizes have become more apparent, the channel sizes auctioned have become smaller. Only as a benefit of mergers and acquisitions have US carriers been able to cobble together channels larger than 10x10 MHz and then only in a limited number of areas. Unlike the situation domestically, internationally, many countries have decided to align their spectrum policies with the advantages that physics and economics provides to larger channel sizes. This is not to disparage the policy reasons for a mix of allocation sizes, but to note the real-world impact of insufficient wide-channel allocations in the overall marketplace.

It's all about providing higher speeds at lower cost for the data-hungry masses of smartphone users, and limiting network congestion. The faster the network speed, the better the quality of video and data bits traversing the network. The lower the cost for consumers, the more they can actually enjoy wireless data services. Importantly, the impact that channel size has on network speed is very direct. Because wireless bandwidth is a shared resource, the speed with which packets traverse a mobile network is the fraction of the total bandwidth available divided by the number of concurrent users. Consider Exhibit 4, which illustrates the relationship between network speed and the size of the spectrum channel in a number of illustrative scenarios.

Exhibit 4: Network speed and channel size

LTE 4x2 MIMO	20 MHz Downlink	10 MHz Downlink	5 MHz Downlink	3 MHz Downlink	1.4 MHz Downlink
Aggregate capacity per sector	34 Mbps	17 Mbps	8.5 Mbps	5.1 Mbps	2.38 Mbps
Efficiency*	100%	98%	95%	90%	70%
Maximum peak speed with one user in a sector	34 Mbps	16.7 Mbps	8.1 Mbps	4.6 Mbps	1.7 Mbps
Expected average speed with five concurrent users in a sector	6.8 Mbps	3.3 Mbps	1.6 Mbps	0.9 Mbps	0.3 Mbps
Speed differential		49%	24%	14%	5%

Source: Recon Analytics, 2014; *Efficiency normalized to a 20 MHz channel

While the foregoing simple illustration suggests the relationship between network speed and the size of spectrum channels, it is in fact more complex. Not only is more money required to deliver the same volume of heavy traffic across different spectrum scenarios (making it cheaper to deliver bits under one scenario than another), but the resulting network cost-savings resulting from wide-channel trunking efficiencies allow the dedication of capital savings to produce other benefits to users. Wider spectrum channels make it easier to deliver faster speeds for accessing and downloading content because the wireless carriers have to manage just one contiguous channel. This is a result of what engineers call "trunking efficiency," which means that resources within a single larger channel can be more efficiently allocated than those from separate independent channels. In effect, channel sizes affect the design and cost of the network.

The faster the speed, the more satisfying the experience, which prompts more usage—and so the cycle goes. The most obvious advantage for consumers is that videos, which represent more than half of all bandwidth consumed on mobile networks, can be viewed without interruptions and at a higher quality than video delivered over narrow spectrum channels. As a result, small

businesses can more easily use video conference services, healthcare providers can more effectively use video for instruction or treatment, schools and libraries can more affordably use video-based instructional tools, and companies relying on mobile ad revenue for their next billion in revenue will be well served.

France's speed performance is a pretty clear-cut example of the significant impact that large channel sizes combined with relatively few customers can make on the speed of a network. It should come as no surprise that wider spectrum channels currently create faster speeds for the wireless broadband networks in this country. Operators around the world that have wider channels at their disposal are able to provide their customers faster wireless services at a lower cost (particularly in dense environments, because of scale economies and trunking efficiencies). Operators in countries with smaller channel sizes can make up some of the inherent disadvantages of smaller channel sizes by spending significantly more on capital expenditures. The relatively strong performance of the US is a testament of how far significant capital expenditure can get a country and where it reaches its limits. The economic and productivity improvements that result from the proliferation of more and faster wireless service have been shown conclusively in various studies[4] for both industrialized and developing countries. On the other side of that equation, countries where not enough spectrum is provided in a sizeable and timely fashion risk falling behind and not enjoying the full economic, social and technical benefits of on-going wireless innovation. Speed differences between countries at any one point in time may be ephemeral, but may also reflect fundamental factors that can help drive economic and social benefits and efficiencies, or undercut them by making it more difficult and expensive to deliver service.

Why this matters

As we noted, spectrum is like oxygen. In fact, it's very much like the air we breathe. We take it for granted. But this seemingly endless supply is, in fact, finite. And the way in which the US government allocates spectrum has been slow and limited. For the vibrant US wireless industry to continue to set the pace for the rest of the G7 and the world, there needs to be a reassessment of the measures the government employs. We need to consider the real world implications of such policies as allocating larger blocks, which translates into more efficient engineering and faster networks at lower capital expenditure levels.

[4] We point to this author's 2012 report on the impact of the wireless industry on the US economy, which includes considerable research on productivity gains (http://reconanalytics.com/2012/04/essential-engine-of-us-economic-growth/). Reports from GSMA (http://gsmamobileeconomyeurope.com/GSMA_Mobile%20Economy%20Europe_v9_WEB.pdf and http://www.atkearney.com/communications-media-technology/ideas-insights/the-mobile-economy-2013), University of Michigan (http://michiganmobilemusings.com/category/economic-impact-of-mobile-technology/), Ericcson (http://www.ericsson.com/res/thecompany/docs/sudan_economic_report.pdf), the Australian Communications and Media Authority (http://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/mobile-broadband-boosts-australias-economy), to mention only a few, show the positive effect of the wireless on economies around the world

3. CAPITAL EXPENDITURES

Capex: The Fuel That Accelerates Wireless Networks

If spectrum is the oxygen, then capital expenditures are the fuel that accelerates wireless networks. Unsurprisingly, carriers in the United States, which has the most people among the G7 countries and a large area to cover, spends more on capex than any other G7 member country. Japan, with the second most inhabitants, spends the second most. The smallest nation by population, Canada, spends the least. What is striking, though, is that in the midst of this technological transformation, all countries besides Canada have increased their spending on improving their wireless network year after year. Only Italy and Canada have not continuously increased their capex.

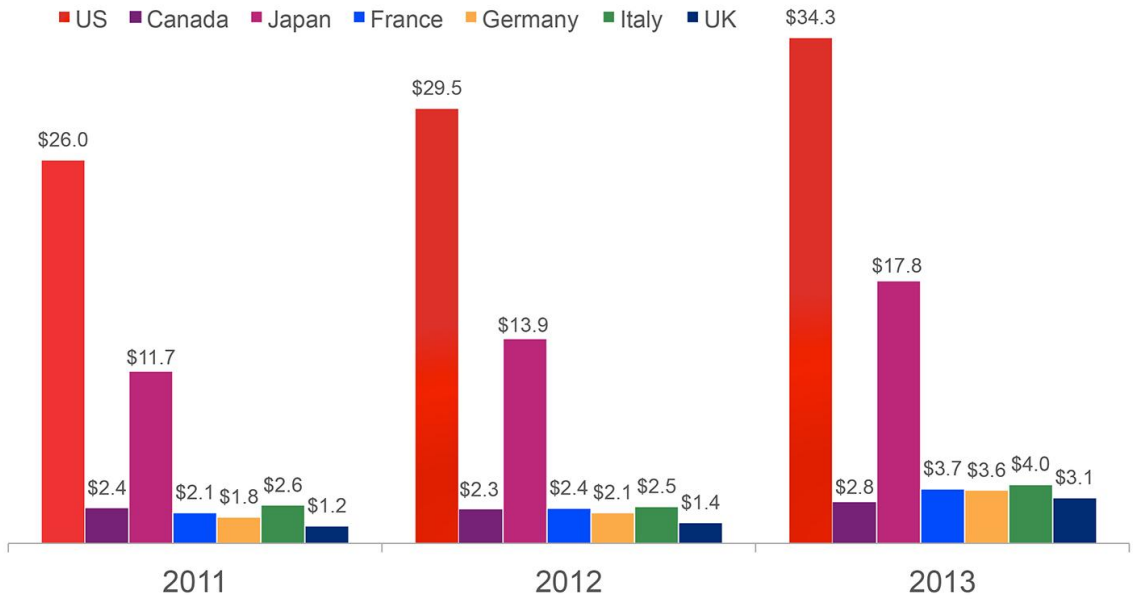
We can clearly see the effect on download speeds of stagnant or lowered capital investments. It takes about a year for the lowered fuel supply to be reflected in the speeds. For example, Canada, which was leading in wireless download speeds as of Q2 of 2013, stopped pumping network spending a year earlier and promptly download speeds plateaued. As a result, France, buoyed by its steady pace of investment increases, quickly overtook Canada as the country with the fastest wireless download speeds. Italy also plateaued in seventh place among the G7 countries after slowing the capex fuel supply in 2012 (see Exhibits 5 and 6). At the same time, this also works when more capital expenditure and/or more spectrum become available. A year later, you see an increase in download speeds.

Exhibit 5: G7 Capital Expenditures (in billions)

	US	Canada	Japan	France	Germany	Italy	UK
2011	$26.0	$2.4	$11.7	$2.1	$1.8	$2.6	$1.2
2012	$29.5	$2.3	$13.9	$2.4	$2.1	$2.5	$1.4
2013	$34.3	$2.8	$17.8	$3.7	$3.6	$4.0	$3.1

Source: Operator reports and Recon Analytics analysis, 2014

Exhibit 6: G7 Capital Expenditures (in billions)



Source: Operator reports and Recon Analytics analysis, 2014

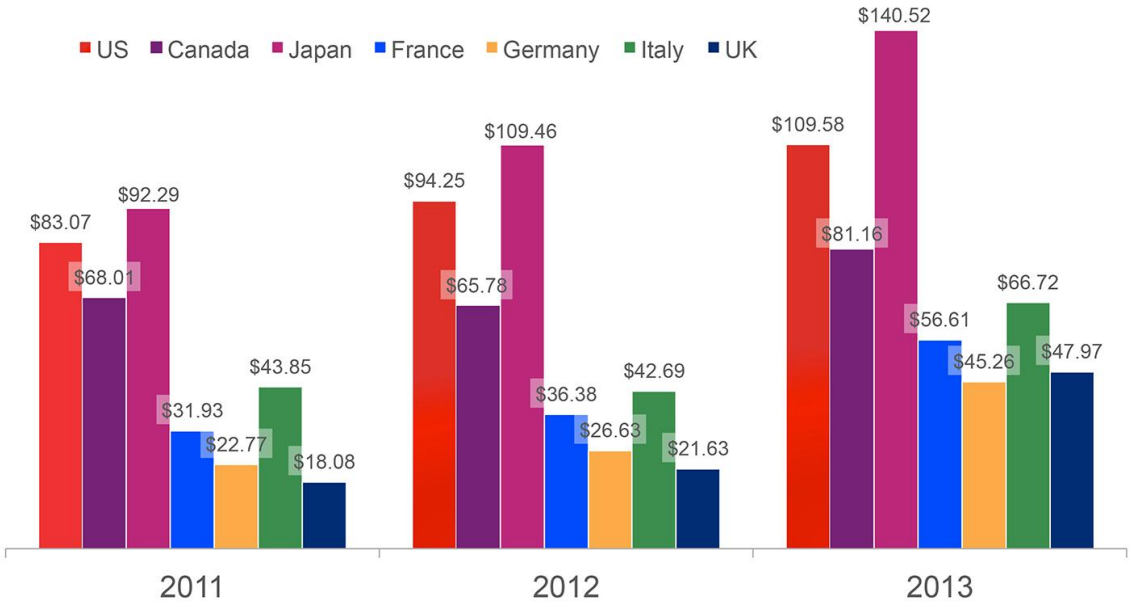
Another perspective on capital expenditures is per-capita capital expenditure (see Exhibits 7 and 8). With all of the G7 countries reaching subscriber saturation and growth coming from multiple device ownership and multiple carrier relationships, per-capita capital expenditure focuses on what really matters: How much is being spend to provide connectivity for each person. Here, the United States only trails Japan when it comes to capital expenditure per person.

Exhibit 7: G7 Per-Capita Capital Expenditures

	US	Canada	Japan	France	Germany	Italy	UK
Population in millions	313.00	35.10	126.70	65.60	80.50	59.70	63.70
2011	$83.07	$68.01	$92.29	$31.93	$22.77	$43.85	$18.08
2012	$94.25	$65.78	$109.46	$36.38	$26.63	$42.69	$21.63
2013	$109.58	$81.16	$140.52	$56.61	$45.26	$66.72	$47.97

Source: Recon Analytics, 2014

Exhibit 8: G7 Per-Capita Capital Expenditures



Source: Recon Analytics, 2014

There is a significant gap between the US and Japan and the rest of the world, and many of the remaining G7 countries. For example, in 2013, the US operators spent twice as much, and Japanese operators three times as much, on improving their networks than the British or German operators. Without the significant increase in capital investment in most of the countries, the download speed increases would not have been possible. Carriers in countries such as France, which have 20x20 MHz channels available for LTE, could achieve faster speed increases with lower investment because the efficiencies of wide, contiguous channels significantly boost the effect of the capital invested. In short, their money goes a lot further. The UK, with one exception, is using 5x5 MHz or 10x10 MHz configurations, so their speeds are slower.

In some countries (e.g., Canada and the UK), operators have sought to leverage their capital expenditures and reduce the number of network elements and sites they each need to build by sharing networks while still competing through customer-facing MVNO-like retail operations. In effect, operators coordinate their investment and network build-out. One result may be more efficient spectrum utilization, but with the trade-off of less competition based on network differentiation.

Why this matters

The key reason that the US wireless industry has not fallen further behind as it deals with limited bandwidth is the world-beating capex being poured into making the most of the limited spectrum available. It has supported growth in usage that is unrivalled in the G7. With additional spectrum, especially supported by larger channel allocations, the United States could have world-leading download speeds.

4. USAGE PATTERNS

About More Than Phone Calls

Of course, the mobile device is about more than phone calls now. It has become a powerful computer in the palm of your hand that can do things that only 20 years ago were solidly in the realm of science fiction. At the same time the devices have become more powerful so, too, have the networks. A 2G or 3G network lets device owners take pictures and share them with their friends and family. It also lets them listen to music streamed over the wireless connection. It requires a more powerful 3G network to watch a basic video with your phone. But if you want to do video calling, you better have a 4G network.

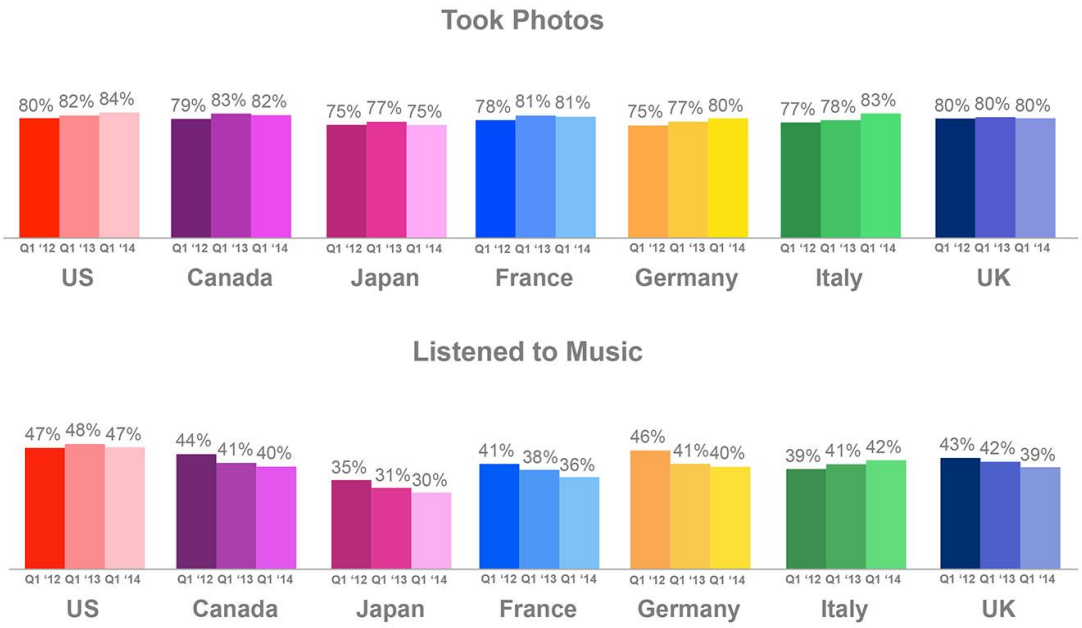
With that in mind, it's interesting to look at the activities of smartphone owners across the G7 to see the differences and similarities. These figures provide direct indication of how involved and integrated mobile devices are in the lives of the people in each given country.

Maybe surprisingly, Americans have integrated their mobile phone into their life more than consumers in any other G7 country (see Exhibit 9). Even more so, in the United States, the usage is increasing, both in terms of the many forms of mobile data and overall voice traffic volumes[5].

For example, in most countries, the mobile phone has become the ubiquitous replacement for the camera. In all G7 countries, at least 75% of people have used their mobile to take pictures. In the United States, that figure reached as high as 84% in the first quarter of 2014, the highest percentage of all G7 countries. This number shouldn't come as a surprise, considering the love affair that American youth (and adults) have with selfies.

[5] http://www.ctia.org/your-wireless-life/how-wireless-works/annual-wireless-industry-survey

Exhibit 9: Device usage possible on slow networks

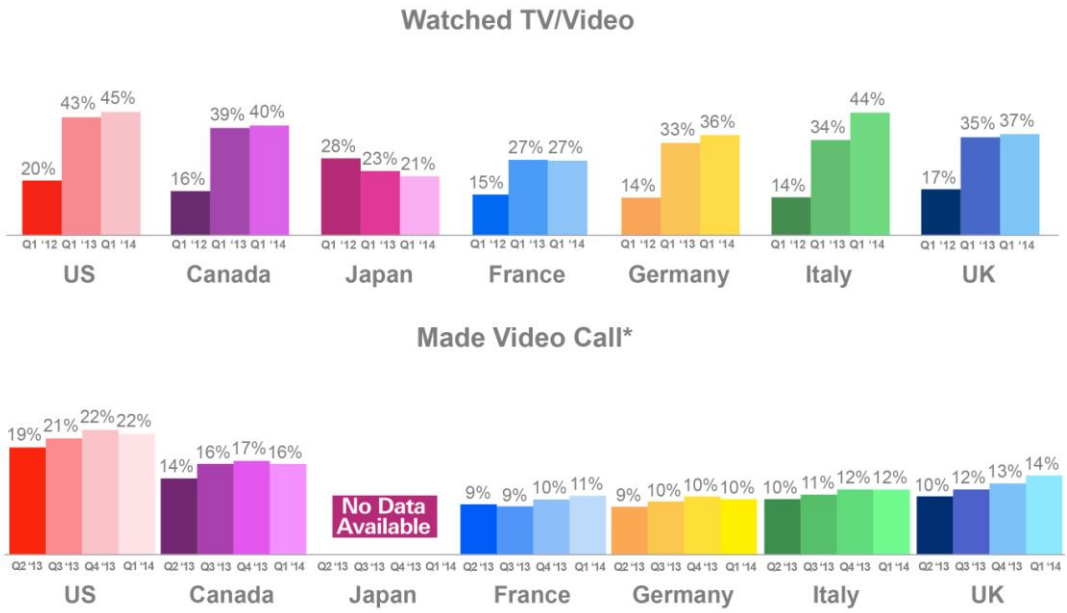


Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Video call question added to survey in Q2 2013

When we look at applications that need a fast network a similar trend appears. Americans use their mobile devices to watch videos and TV, as well as make video calls, more often than mobile users in any other country (see Exhibit 10). Here, despite technological progress and better wireless networks, Japan is falling behind. Usage figures illustrate a slide as the number of Japanese wireless users who watch a video or TV on a mobile device fell from a G7-leading 28% in 2012 to 21% in 2014, now dead last among the G7 countries. Again, this highlights how fast-changing the mobile sector is and how the reported metrics of countries can change rapidly in a short period of time.

Video calling, in particular, has made the biggest inroads in North America: 22% of Americans and 16% of Canadians make video calls, as of Q1 2014. British consumers are not far behind with 14%, while their continental counterparts are only half as likely to engage in video calling as Americans.

Exhibit 10: Device usage requiring fast networks



Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Video call question added to survey in Q2 2013

Why this matters

US consumers love their phones and they love rapid results. If the US had insufficient data speeds it would impede the effective use of advanced smartphones. As a result, the US would lag in the adoption of applications that require fast speeds. That is hardly the case. Despite not offering the world's fastest download speeds, the United States leads the world in adoption of smartphone services that take advantage of fast networks. Even though everyone would welcome faster speeds, the current speeds are not impeding adoption, especially when compared to the several other G7 countries that have, on average, faster networks. In fact, this situation also highlights an important distinction between "average" and "median." Although average speeds in some countries are higher than in the US, the median speed that consumers experience is probably higher in the US. This enables broader adoption of services that require fast download speeds.

5. AGGLOMERATION

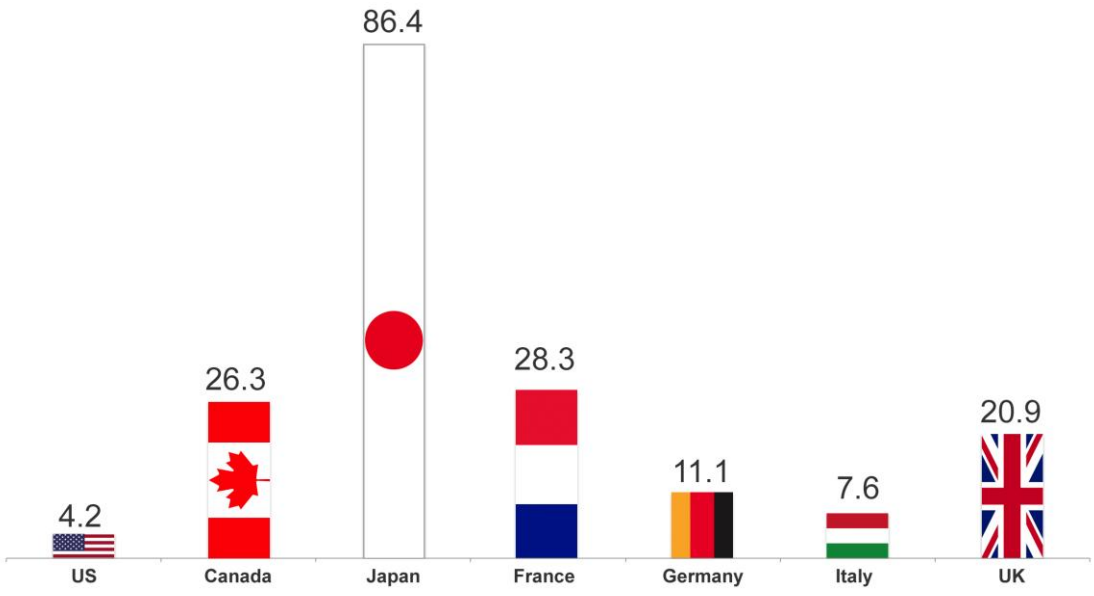
Background on The Urban Agglomeration Index

The Urban Agglomeration Index (UAI), created for this research, describes how concentrated the population of a country is. It takes into account the percent of the population of a country that lives in urban areas and what share of the urban population lives in the largest city. We have chosen to follow in the steps of the other prominent concentration measure, the Herfindahl-Hirschman Index, which is a cornerstone of describing market concentration.

Similar to the Herfindahl-Hirschman Index, in the UAI we square the percentage of people who live in urban areas and multiply it with the square of the percentage of the urban population that lives in the largest urban area. The Urban Agglomeration Index shows the impact that a highly urbanized country can have. In a country with a high UAI, the operators can focus on significantly fewer places and make a broad impact on network performance. This stands in contrast to countries with a low UAI, where people live in a more rural setting and in more numerous but comparatively smaller urban centers. In a high UAI country a carrier can concentrate capex in a relatively small area and enjoy a return on capex that is magnitudes greater.

Exhibit 11 outlines the Urban Agglomeration Index for the G7 countries.

Exhibit 11: The Urban Agglomeration Index

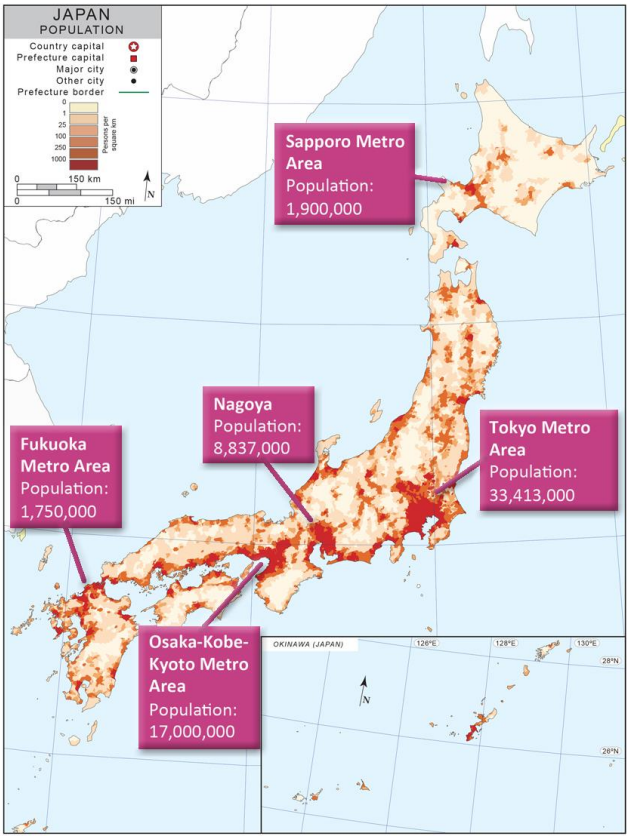


Source: Recon Analytics research, 2014

Japan and the US

Let's look at the numbers up close. In Japan, 91.3% of the population lives in urban areas and 32.2% of the urban population lives in Tokyo—the largest metropolitan agglomeration. This results in an UAI of 86.4.

Exhibit 12: Urban Agglomeration in Japan



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/1oSdZ8w

When we compare this with the US, differences appear. Fewer Americans than Japanese live in urban centers; only 82.4% of the US population lives in urban areas. But in stark contrast, only 7.9% of the country lives in New York—the largest metropolitan agglomeration in the US. That's because the country has a large number of major urban areas, such as Los Angeles, Chicago, Dallas, Miami, and Washington, DC. This results in an UAI for the United States of only 4.2. In contrast, Japan has an Urban Agglomeration Index that is more than 20 times that of the US.

If a carrier can cover Tokyo, it has made a huge dent in the Japanese market. And if that carrier adds the two other nearby cities along a roughly 300-mile corridor that runs from Tokyo to Nagoya and Osaka, they've basically won the battle. Just looking at the map, in Exhibit 12, shows the picture very clearly. In that corridor, there are urban agglomerations amounting to close to 60 million people—almost half of the entire population of the country.

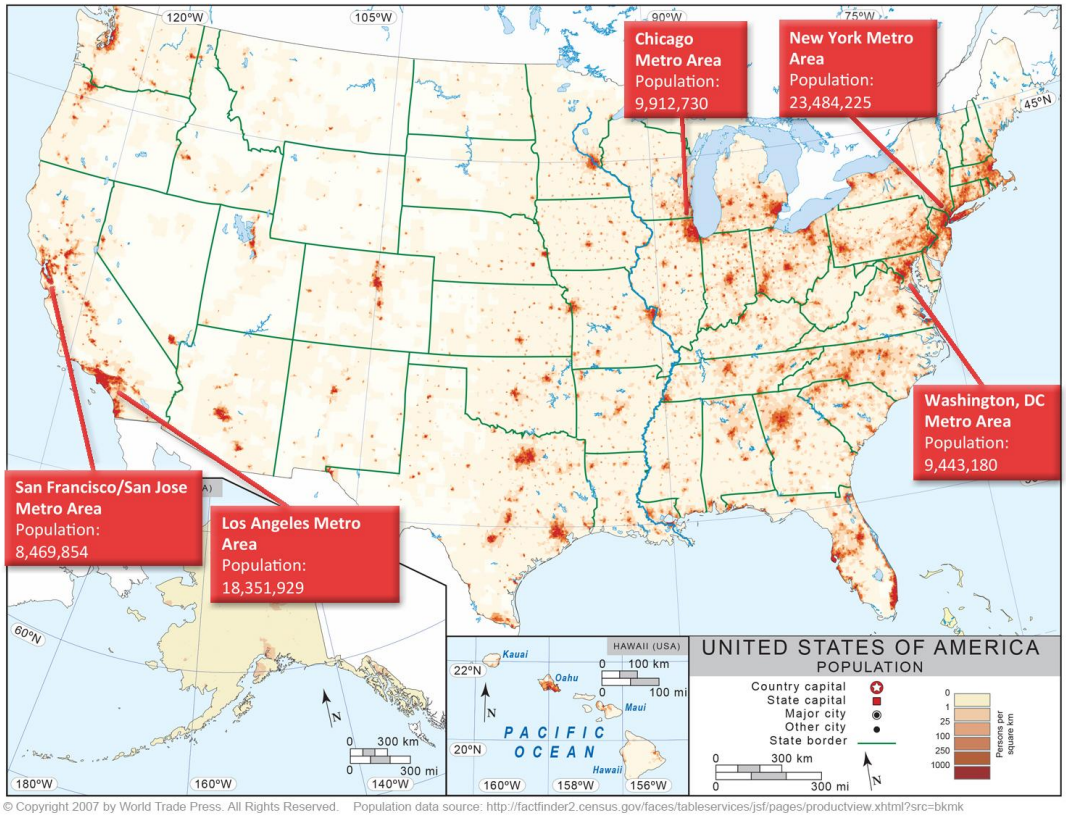
The top five metro areas in the US are New York, Los Angeles, Chicago, Washington, DC, and San Francisco/San Jose, adding up to more that 69 million people out of a total of 314 million. There are certainly a lot of people living in New York and Washington, DC, (which are the number one and number four most populated metro areas, respectively) but all told, the people there add up to only a little over 10% of the US population (see Exhibit 13).

In contrast, the population is considerably more concentrated in Japan, where the top five metro areas add up to nearly half of the Japanese population. Underscoring the difference, the top five US metro areas come to only about a fifth of the total US population. This makes the US the least concentrated G7 country and Japan the most concentrated.

In addition to the lower Urban Agglomeration Index, the metro areas in the US are far more geographically dispersed than other G7 members. San Francisco and Los Angeles are about 380 miles apart, while New York and Washington, DC, are 226 miles apart. In Europe, those kinds of distances span several countries and are thereby covered by a different set of carriers. Chicago is in the center of the country (700 miles from DC, 790 miles from NYC, 2,000 miles from Los Angeles, and 2,130 miles from San Francisco). In Europe, such distances span much of the continent.

Then there's the distance between the coasts in the US. New York is 2,900 miles from San Francisco and 2,800 miles from Los Angeles, which is almost the same distance as New York is from London. Imagine the logistics and expense for a carrier to build and maintain infrastructure that far apart. Traveling a similar distance in Continental Europe would take you from Lisbon to Moscow (albeit, not really in Europe) crossing approximately seven national borders in the process.

Exhibit 13: Urban Agglomeration in the US



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://1.usa.gov/1bkh0D4

So, because of the sheer size of the US, it's clear that the logistical complexities involved in covering the top five metro areas are considerable. Perhaps more importantly, though, as we noted, a carrier that covered each one of those metro areas would still leave 79% of the population without coverage. In fact, to the contrary, the US wireless industry now covers 97% of the US population with 4G LTE, although not with the same degree of spectrum depth devoted to LTE as many of the other G7 countries.

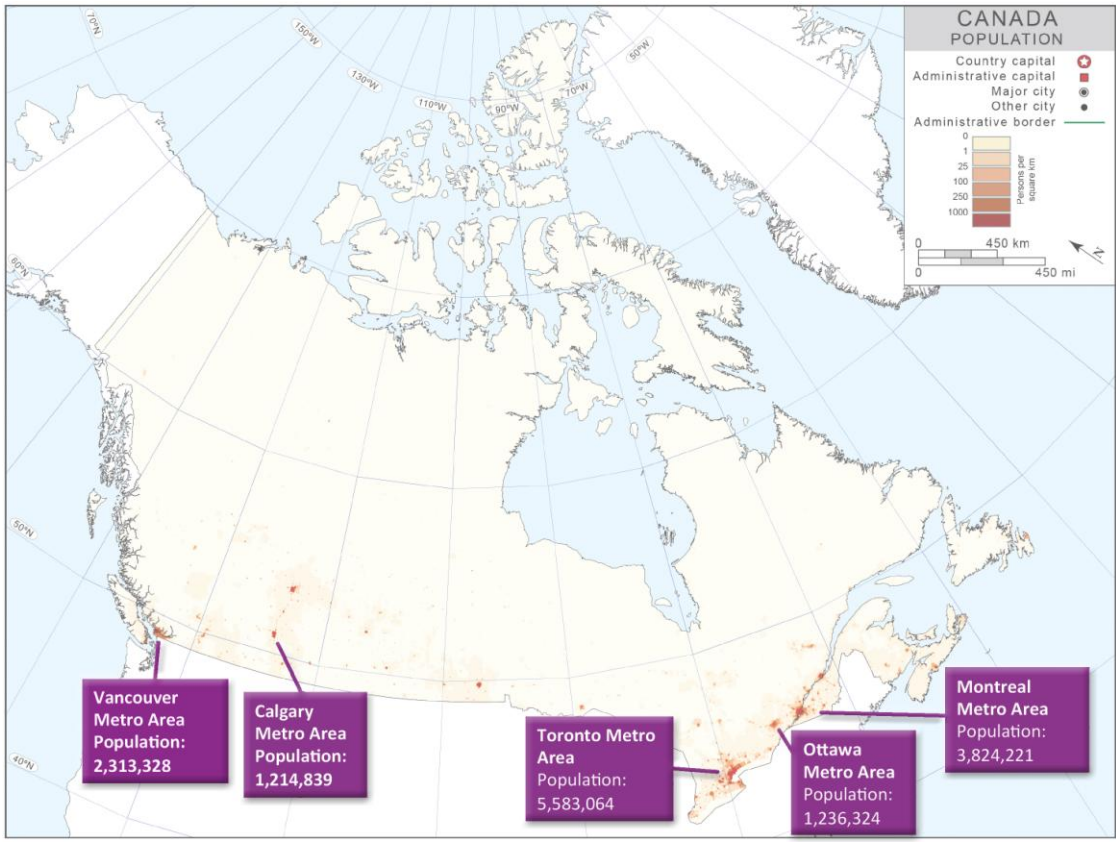
Canada

Canada, the northern neighbor of the US, is both similar and strikingly different at the same time. Roughly the same proportion of people in both countries lives in urban areas: 80.7% in Canada versus 82.4% in the United States. But Canada's population is a lot more concentrated: 75% of the Canadian population lives within 100 miles of the US border. Furthermore, 20.1% of the country lives in Toronto—the country's largest urban agglomeration, with more than 5.5 million people (see Exhibit 14). This results in an Urban Agglomeration Index of 26.31—more than six times that of the US. The second-largest urban agglomeration in Canada is Montreal, just over 300 miles away from Toronto. A mere 100 miles to the west of Montreal is Ottawa, the fourth largest urban agglomeration in Canada. Together, these three cities account for more than 30% of Canada's population.

In the west of Canada, Vancouver and Calgary (the country's third and fifth-largest urban agglomerations), account for 10% of the country's population. Vancouver lies about 420 miles to the west of Calgary.

So, it's clear that covering two fairly compact corridors in Canada, would make it easier and more cost efficient to provide top notch coverage to 40% of the country's population.

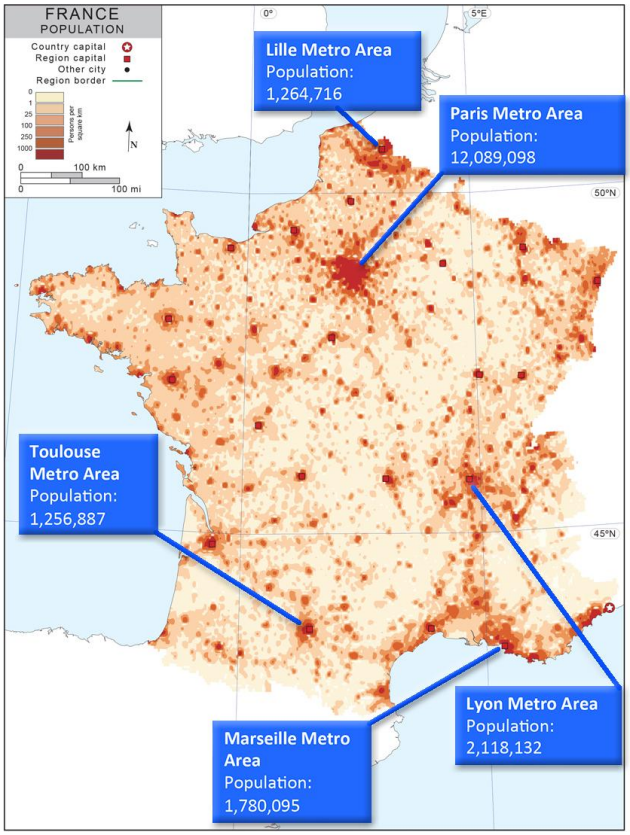
Exhibit 14: Urban Agglomeration in Canada



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/UE7REV

France

Exhibit 15: Urban Agglomeration in France



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/1s8hIzH

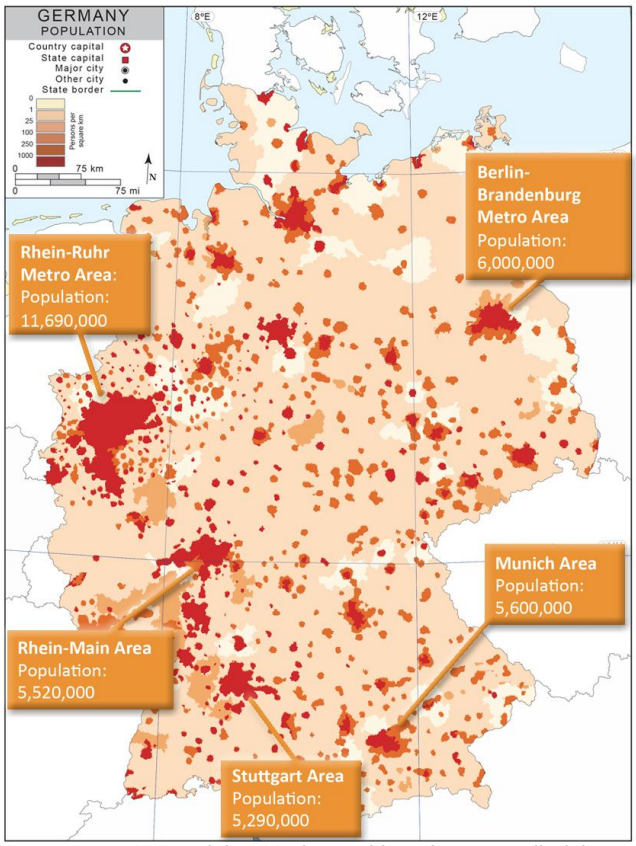
In France, 85.8% of the population lives in urban areas and 19.6% of the country lives in Paris—the country's largest urban agglomeration, with more than 12 million people (see Exhibit 15).

This results in an Urban Agglomeration Index of 28.28—the second most concentrated country among the G7 and almost seven times as concentrated than the US. The second-largest urban agglomeration in France is Lyon, just over 240 miles away from Paris. Two hundred miles to the south of Lyon is Marseilles, the third largest urban agglomeration in France.

Together, these three cities account for more than 24% of population in France. Add in Lille, the fourth largest urban agglomeration in France (just 127 miles north of Paris) and Toulouse, the fourth largest urban agglomeration (250 miles to the west of Marseilles), and a carrier could cover 25% of the population.

Germany

Exhibit 16: Urban Agglomeration in Germany



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/1xGJlj3

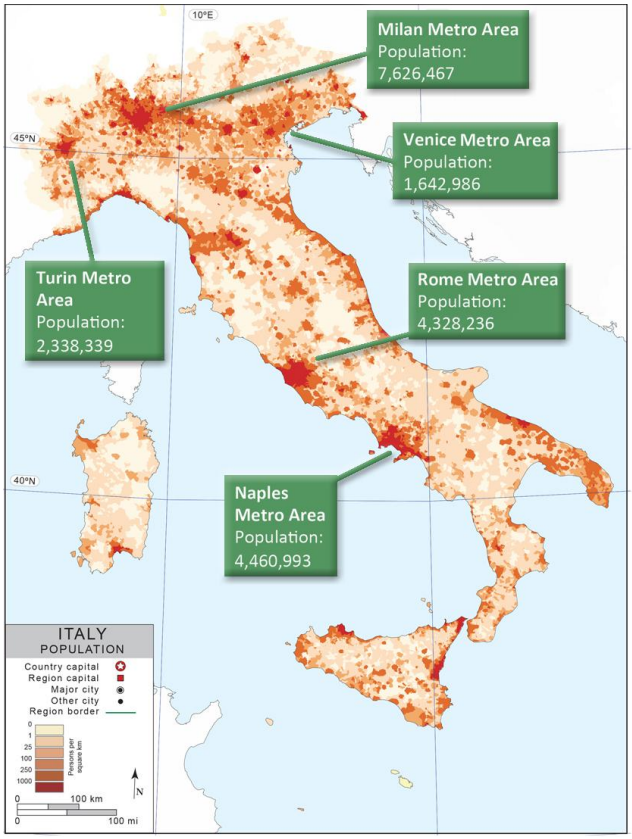
In Germany, 73.9% of the population lives in urban areas and 14.3% of the country lives in the Rhein-Ruhr metro area—the country's largest urban agglomeration, with almost 11.7 million people (see Exhibit 16). This results in an Urban Agglomeration Index of 11.1—almost three times that of the US, but only the fifth most concentrated country among the G7.

The second-largest urban agglomeration in Germany is Berlin, just under 300 miles away from Dusseldorf, which sits at the center of the Rhein-Ruhr area. One hundred miles to the south of the Rhein-Ruhr metro area is the Rhein-Main metro area (the fourth-largest urban agglomeration in Germany), with Frankfurt at its core. Just to the south of the Rhein-Main metro area is Stuttgart, less than 100 miles away. 120 miles to the southeast of Stuttgart lay Munich (the third-largest urban agglomeration in Germany).

In the corridor between the Rhein-Ruhr urban agglomeration to 300 miles south in Munich, there are urban agglomerations accounting for more than 34% of the German population. Add in Berlin, to the northeast, and a carrier could cover almost 42% of the population, simply by operating in five markets.

Italy

Exhibit 17: Urban Agglomeration in Italy



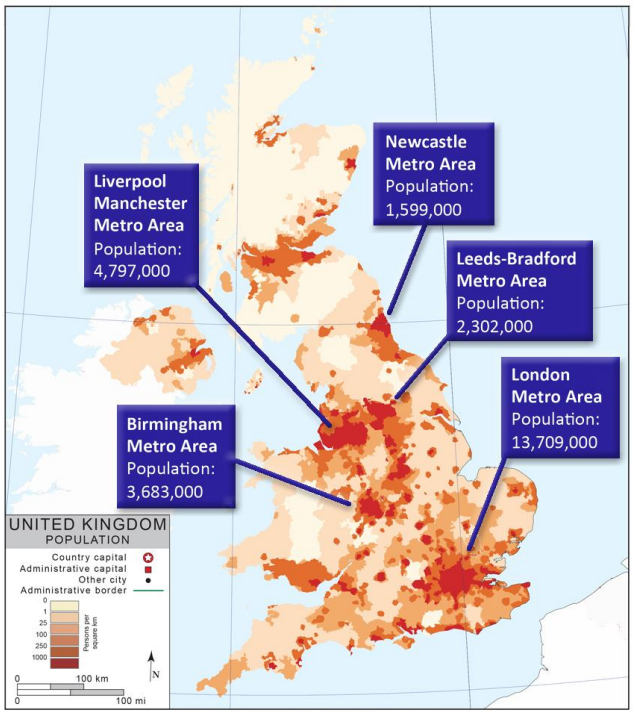
Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/UE7ZEf

In Italy, 68.4% of the population lives in urban areas and 12.7% of the country lives in the Milan metro area—the country's largest urban agglomeration, with 7.6 million people (see Exhibit 17). This results in an Urban Agglomeration Index of 7.6, the second lowest among the G7 countries. The second-largest urban agglomeration in Italy is Naples, which is less than 120 miles away from Rome (the third-largest urban agglomeration in Italy). Seventy-seven miles to the west of the Milan metro area is the Turin metro area (the fourth-largest urban agglomeration in Italy). To the east of the Milan metro area is Venice (the fifth-largest urban agglomeration in Italy), just about 150 miles away.

The Po-Valley region, which stretches from Turin to Milan and Venice, is the economic heartland of Italy. In that region, the urban agglomerations account for almost 19% of the Italian population. To the south, the Rome and Naples urban agglomerations add up to 14% of the Italian population. Put these two narrow corridors together and a carrier could easily cover 33% of the Italian population.

United Kingdom

Exhibit 18: Urban Agglomeration in the UK



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/1u4BUBV

In the United Kingdom, 80% of the population lives in urban areas and 18% of the country lives in the London metro area—the country's largest urban agglomeration, with 13.7 million people (see Exhibit 18). This results in an Urban Agglomeration Index of 20.9. The second-largest urban agglomeration in the UK is the Liverpool Manchester metro area, which is less than 65 miles away from the Leeds-Bradford metro area (the fourth-largest urban agglomeration in the UK).

Eighty-one miles to the north of the Leeds-Bradford metro area is the Newcastle metro area (the fifth-largest urban agglomeration in the UK). The third largest urban agglomeration in the UK, Birmingham, lies midway between London (100 miles to the south) and Liverpool (less than 80 miles to the north).

In the relatively tight, but expanding London-Birmingham-Liverpool-Manchester-Leeds-Bradford corridor, the urban agglomerations add up to nearly 39% of the UK population. Add to that the Newcastle urban agglomeration just up the road, and a carrier could easily cover 41% of the UK population with just five markets.

Why this matters

While we cannot change where people live, the Urban Agglomeration Index explains the difficulties operators face in making an impact with their capital investments. It is simply easier to have a meaningful impact in a country like Japan (where 91.3% of the population live in urban areas and 32.2% of them live in Tokyo) than in the United States (where 82.4% live in urban areas but New York makes up only 7.9% of the urban population). Focusing capital expenditures in Tokyo delivers a much bigger bang for the buck than New York. Even ignoring the additional cost of providing service in a geographically larger country, operators in a country with a lower UAI have a harder time providing the same download speeds than countries with a higher UAI without significantly higher capital investments. It is even more difficult with fewer wide-channel allocations to take advantage of the economies of scale offered in more densely populated markets. A diverse mix of allocations that includes sufficient wide-channel allocations can make a difference to US consumers and the economy.

6. PRICING

The Differential Between 3G and 4G Pricing

In the US, carriers traditionally do not charge a premium for next generation wireless services. Just like when 3G came out, and again when 4G came out, the US carriers charge the same price. The reason for this is to drive the rapid adoption of new services. As a result, 4G adoption has grown quickly in the US, with the most 4G subscribers in the G7. In the other G7 countries, with the exception of Canada, the differential between 4G and 3G pricing can be significant. And, at the very least, it can be incredibly complex for a consumer to understand.

We researched carriers in the G7 and present our results here.

In the UK, there are four wireless network operators. All but one charges a premium for 4G access. When this operator decided not to charge a premium, its largest competitor charged it with "devaluing LTE." The largest player accused the smallest of undermining the value proposition of 4G by not charging a premium—something we take for granted here in the US.

In Italy, operators also charge a straight premium for 4G services. Operators price 4G between 50% and 67% more than 3G, which creates a significant hurdle for a consumer looking to move up to 4G.

In Germany, maximum download speeds are tied to the data allowance and therefore cost. Entry-level plans have data speeds up to 21 Mbps, with faster speeds tied to larger data allowances available at 50, 100, and 150 Mbps.

French carriers are taking cues from both British and German counterparts. One operator charges a straight premium like its British counterparts, whereas another carrier ties the 4G speeds to the size of different data packages like a German operator.

In Japan, the pricing is more granular in some cases, with certain carriers charging by the packet (128 bytes or 1/8 of a kilobyte) or kilobyte. Most large-bucket-rate 4G services are more expensive that their 3G counterparts. Only when customers exceed their bucket sizes, or use metered services, do 4G overages get charged at a lower rate than 3G overages.

By using the price differentiation of speed tiers to control the number of people who can access 4G, an operator has more control over the user experience and overall speed than when it prices 3G and 4G at parity, which encourages everyone to sign up for 4G. As a result, the more expensive 4G networks are less crowded and provide faster speeds for the subscribers who are willing to pay a premium to access them. The US model, which doesn't have this price tiering, provides more people a fast 4G network but at speed below those that a speed-tiered business model could achieve. The result is that the average speed may be lower, but the median speed is higher in the US.

Why this matters

When US carriers offer their customers a new service they provide it at the same price as the legacy service. This drives adoption because the new service is not an exclusive premium service and is one of the key reasons for the US subscriber leadership in LTE. In other countries, operators have pursued an exclusive premium strategy aiming at providing considerably faster service for a significant premium on an uncongested network with substantially fewer customers. As a result, the average speed in some of these countries is higher, but the median speed – the one most people get – is lower.

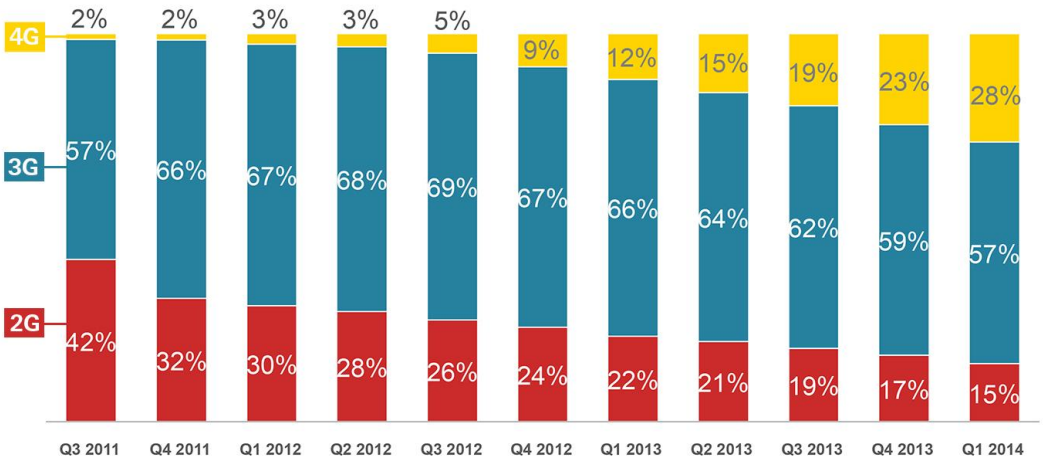
7. SATISFACTION

What makes a customer happy?

Wireless customer satisfaction is a complex creation: Some of the major drivers—network quality and devices—are discussed in this paper. As the new 4G LTE networks become available, customers need to purchase new devices to be able to take advantage of the network, as the old devices do not have the necessary parts in them to connect to the new network. Unsurprisingly, generally customers with a better network and newer device are happier customers, so to get a good view into satisfaction; it makes sense to start with an investigation into the penetration of 4G and the types of devices consumer use.

Penetration of 4G capable devices in G7 countries grew slowly from the third quarter of 2011 (see Exhibit 19). Growth was initially tepid due to the lack of 4G LTE networks around the globe. The United States was the only country with a robust nationwide 4G LTE network and mass consumer adoption. Over time, as more networks came online, device penetration followed.

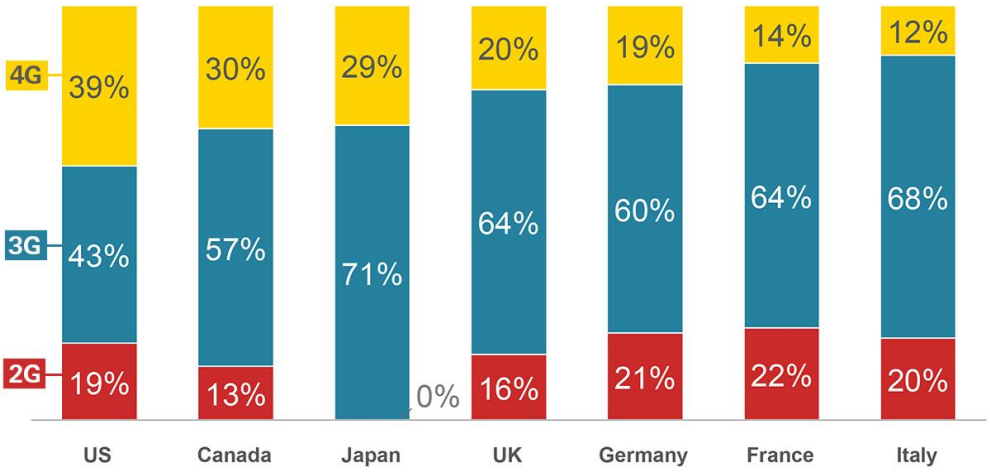
Exhibit 19: G7 Mobile Penetration by Network Capability of Phone Q3 2011 – Q1 2014



Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Data for Japan first available Q4 2011

The US leads all G7 countries in the level of 4G-capable devices; 39% of all phones are capable of accessing a 4G network (see Exhibit 20). Canada comes in second, with 30%, and Japan comes in third, with 29%. Lagging behind the top three are the UK, at 20%, Germany at 19%, France at 14%, and Italy at 12%.

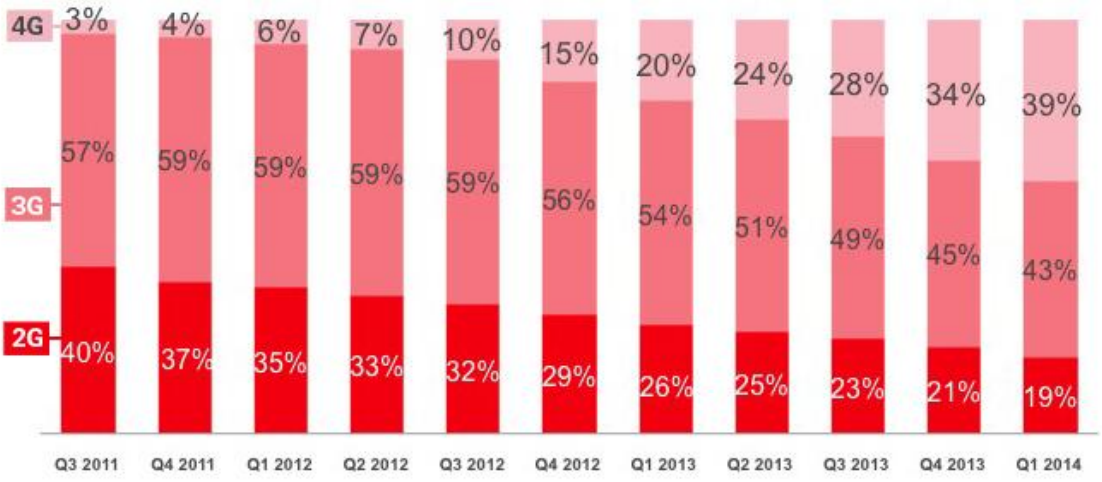
Exhibit 20: Mobile Penetration by Network Capability of Phone, Q1 2014[6]



Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter)

After the introduction of 4G in the US in late 2011, it took several quarters to gain traction, but, similar to the overall G7 trend, it started to move quickly in the fourth quarter of 2012 to its current G7 lead position at 39% in the first quarter of 2014 (see Exhibit 21). The reason for this is the greater maturity of 4G LTE in the United States (accounting for factors such as broader buildout and greater handset availability) and the faster handset replacement cycle. It's a fact borne out by previous Recon Analytics research that Americans get new phones more frequently than customers in other countries.

Exhibit 21: Mobile Penetration in the US by Network Capability of Phone, Q3 2011 – Q1 2014

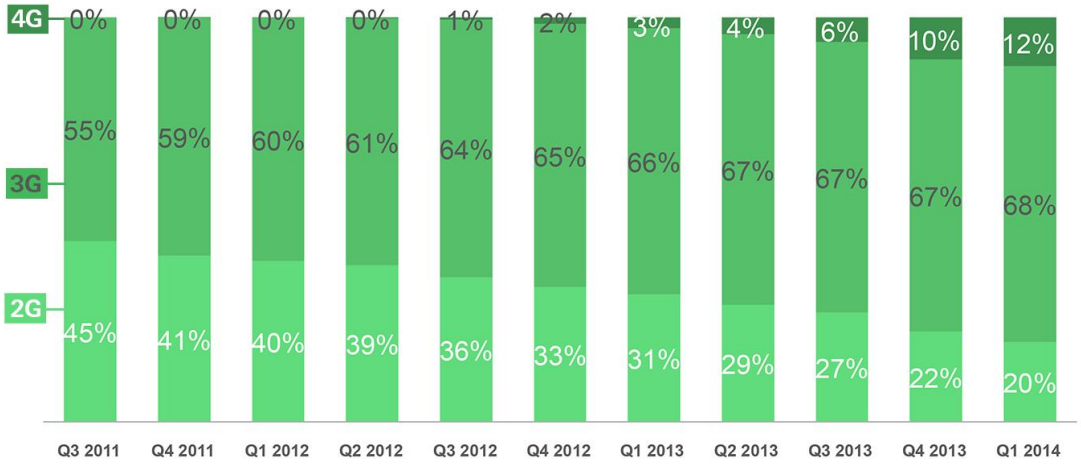


Source: comScore MobiLens, Quarterly data represented by 3-month average

[6] In the US, 97% of 4G is LTE. The remaining 3% is WiMax. Similarly, in Canada and Italy, 99.8% of 4G is LTE, while 0.2% is WiMax. In France, Germany and the UK, the ratio is 99.9% LTE to 0.1% WiMax. In Japan, 91.6% of 4G is LTE, 4.1% is WiMax, and 4.3% is AXGP.

In contrast to the gangbusters early growth in the US, Italy didn't have its first 4G LTE network launched until November 2012, with coverage only available in Rome, Milan, Turin and Naples. The country then languished at less than 10% until the fourth quarter of 2013 as more places in Italy were covered and more operators launched their networks, until finally inching up to 12% in the first quarter of 2014 (see Exhibit 22).

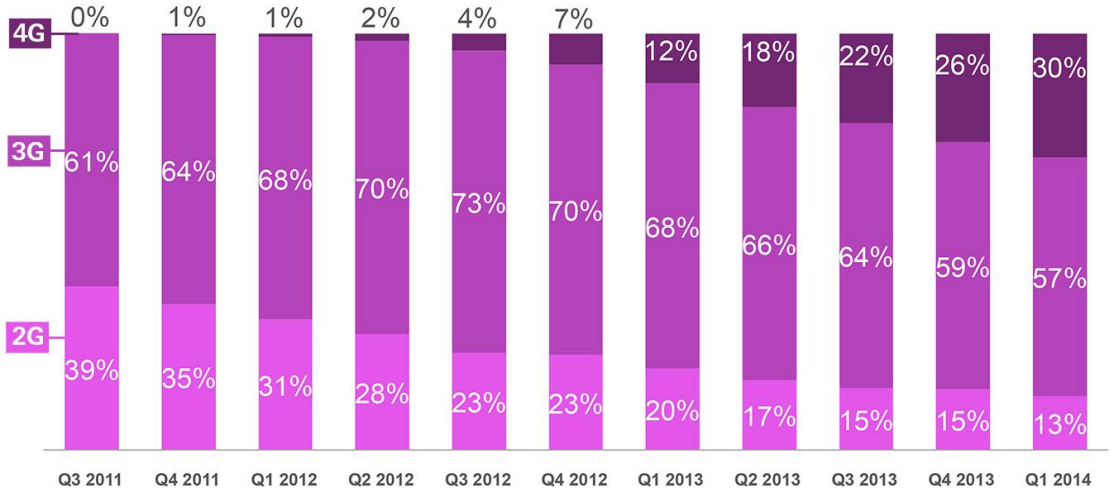
Exhibit 22: Mobile Penetration in Italy by Network Capability of Phone, Q3 2011 – Q1 2014



Source: comScore MobiLens, Quarterly data represented by 3-month average

In Canada, 4G adoption started in Q4 2011, but didn't see double digits until Q1 2013 (see Exhibit 23).

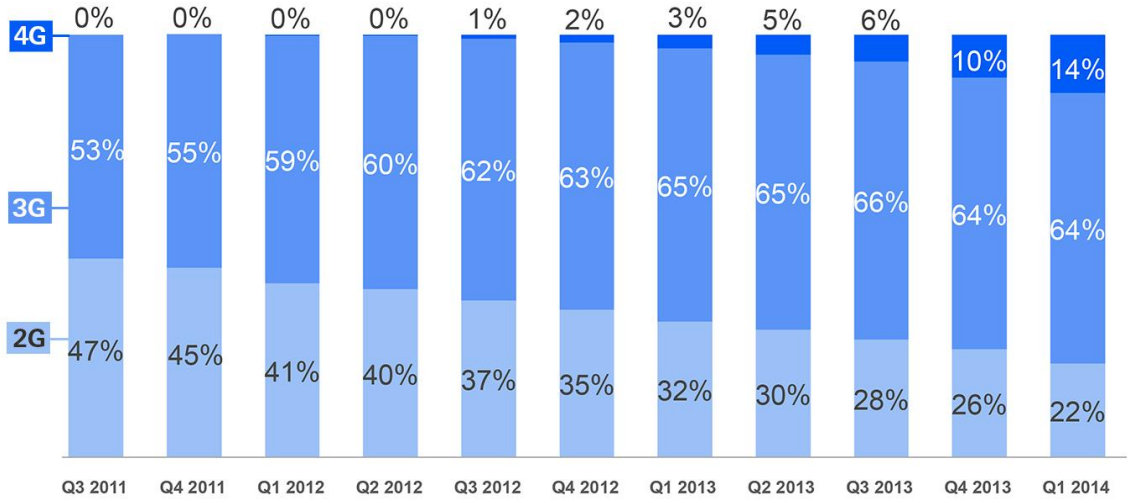
Exhibit 23: Mobile Penetration in Canada by Network Capability of Phone, Q3 2011 – Q1 2014



Source: comScore MobiLens, Quarterly data represented by 3-month average

Adoption of 4G in France has been slow to gain traction—only reaching double digits in the fourth quarter of 2013 (see Exhibit 24).

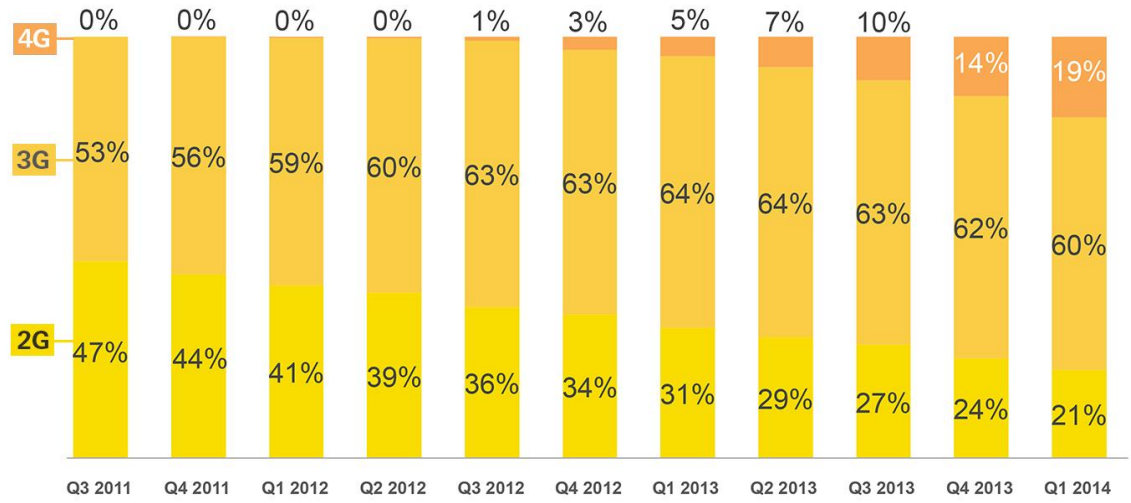
Exhibit 24: Mobile Penetration in France by Network Capability of Phone, Q3 2011 – Q1 2014



Source: comScore MobiLens, Quarterly data represented by 3-month average

Germany has seen only slightly faster 4G adoption than France; it reached double digits in the third quarter of 2013 (see Exhibit 25).

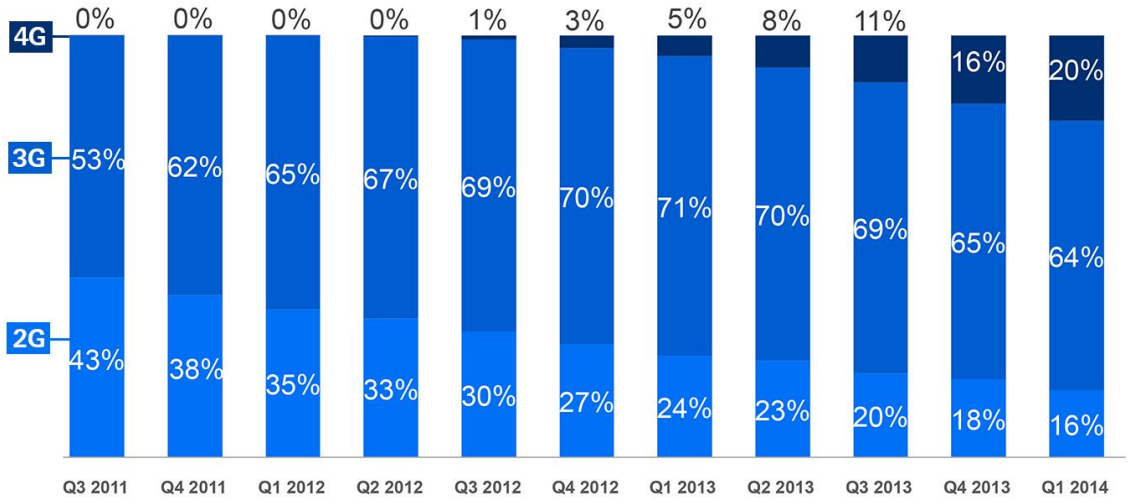
Exhibit 25: Mobile Penetration in Germany by Network Capability of Phone, Q3 2011 – Q1 2014



Source: comScore MobiLens, Quarterly data represented by 3-month average

In the UK, 4G adoption started in the third quarter of 2012, but it only reached double digits in the third quarter of 2013 (see Exhibit 26).

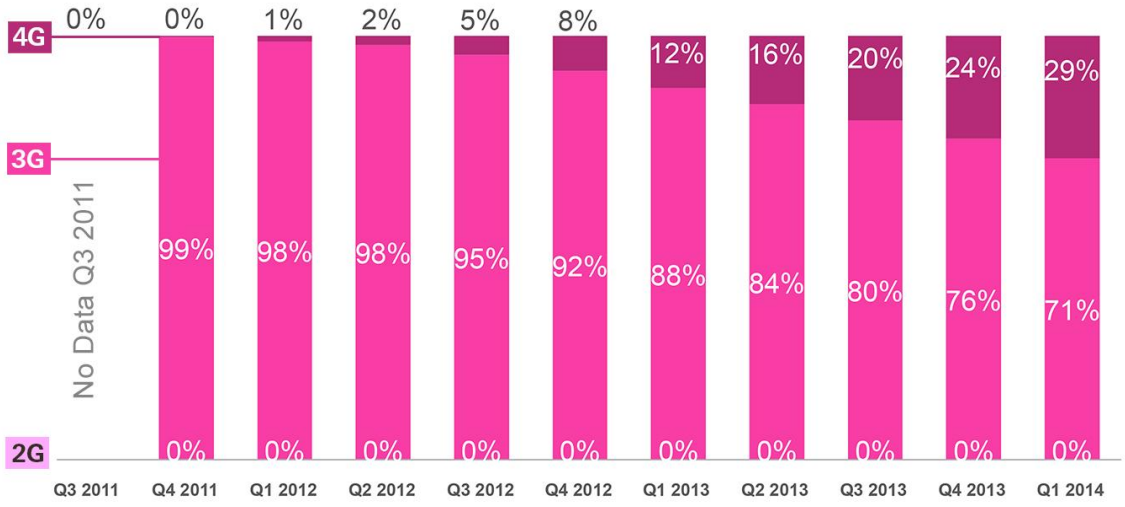
Exhibit 26: Mobile Penetration in the UK by Network Capability of Phone, Q3 2011 – Q1 2014



Source: comScore MobiLens, Quarterly data represented by 3-month average

In Japan, 4G penetration has been slightly faster than other G7 countries (with the exception of the US). After seeing initial movement in the first quarter of 2012, Japan reached double digits in the first quarter of 2013 (see Exhibit 27).

Exhibit 27: Mobile Penetration in Japan by Network Capability of Phone, Q4 2011 – Q1 2014

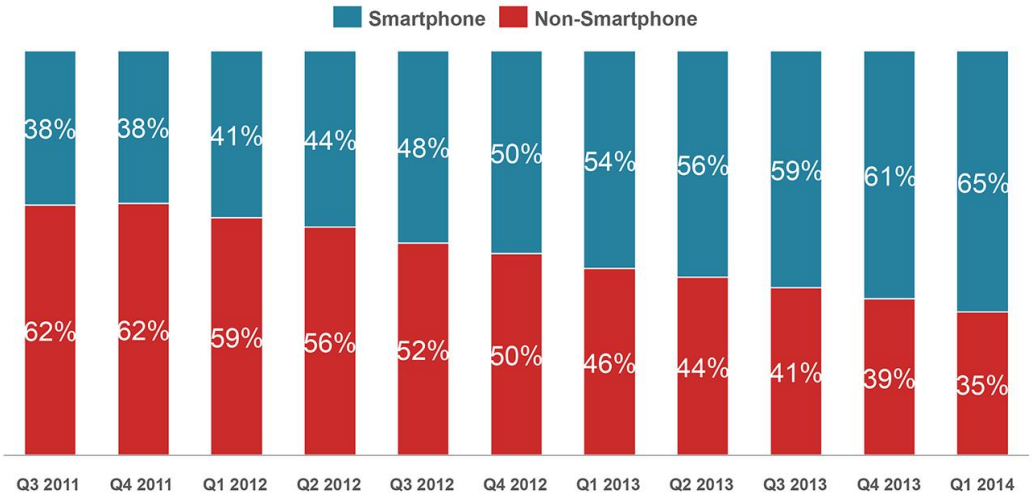


Source: comScore MobiLens, Quarterly data represented by 3-month average

While other G7 countries did not launch 4G service until several years after the US, it is fair to ask whether their adoption or conversion rate will soon accelerate beyond that of the US. Notably, hand in hand with the launch of 4G LTE networks, G7 smartphone penetration has been growing steadily since the third quarter of 2011 as feature phones waned in popularity. Increases in smartphone utility and capabilities, combined with a decrease in price, have made them the natural choice for most people who get a new phone, especially since LTE is becoming increasingly a standard feature on smartphones. In the third quarter of 2011, 38% of phones were smartphones, while 62% were non-smartphones. Since then, the ratio has been turned on its head. In the first quarter of 2014, 65% of phones in the G7 countries are smartphones and 35% are non-smartphones (see Exhibit 28).

Exhibit 28: Since Q3 2011, Smartphone Penetration has Grown from 38% to 65%

G7 Smartphone Penetration Q3 2011 – Q1 2014

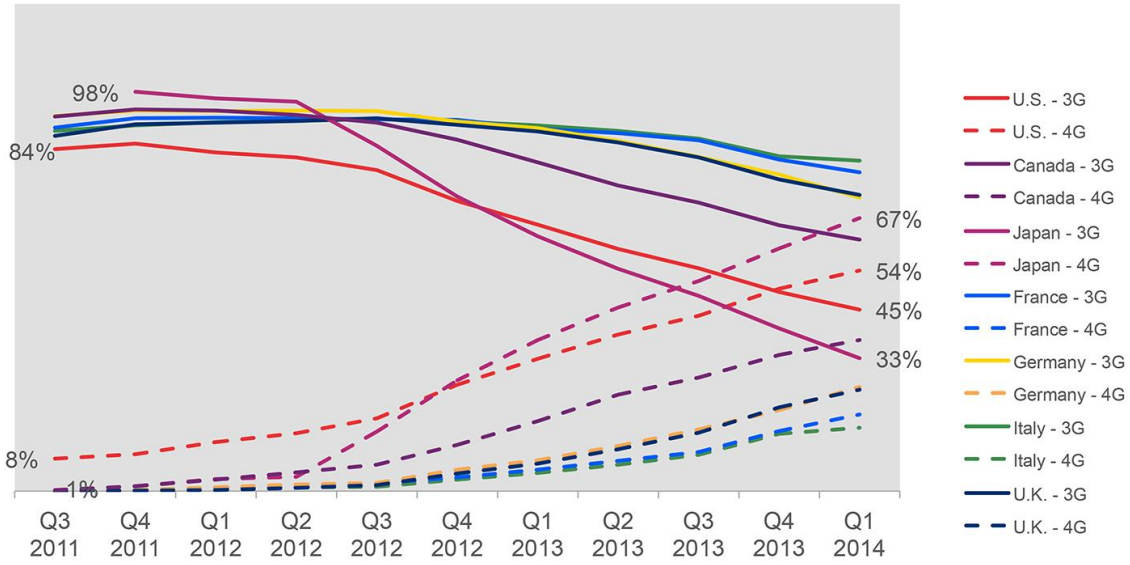


Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Data for Japan first available Q4 2011

Making the shift to 4G takes investment and a commitment on the part of the wireless industry to encourage subscribers to make the move. Part of that involves inspiring a consumer's confidence that their calls won't be dropped and their data connections will be pristine and blazing fast. Looking at smartphone subscribers across the G7, the US and Japan are alone in having more 4G than 3G smartphone subscribers (see Exhibit 29). Canada, the UK, Germany, Italy and France all lag well behind.

Exhibit 29: Data Network Subscribership Among G7 Smartphone Owners

Both the U.S. and Japan now have more 4G than 3G smartphone subscribers



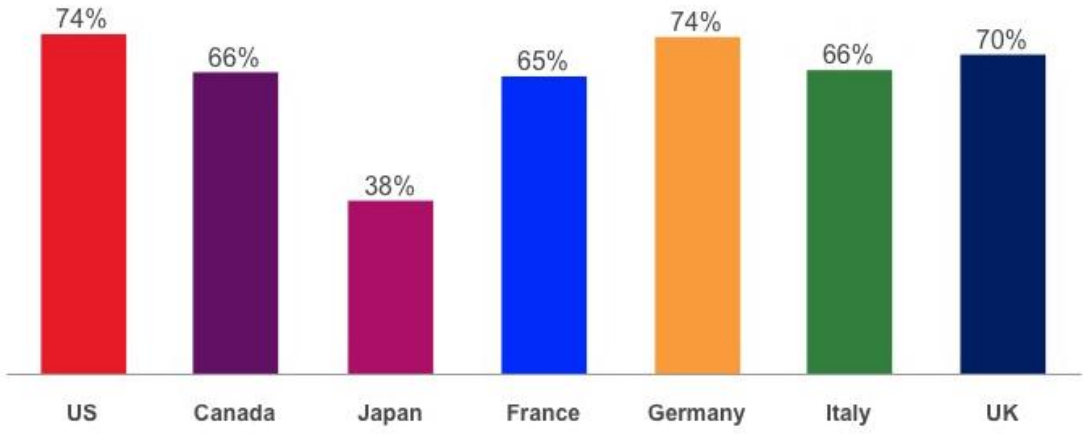
Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Data for Japan first available Q4 2011

Smartphones have swept across the landscape due to improved utility but also driven by broad availability of 4G LTE networks. The network and devices take perfect advantage of each other. One without the other just wouldn't feel right. But, despite the inexorable connection between the fast network and the new devices that take full advantage of the speed, it doesn't mean customers in all of the G7 countries are necessarily happy with those devices.

Here in the US, though, smartphone users are the most satisfied, with 74% of customers saying they are happy with their smartphone (tied with Germany). Meanwhile, the UK (70%), Italy (66%), Canada (66%) and France (65%) lag behind (see Exhibit 30). And off in the distance is Japan, a country in which carriers have invested countless billions, at a surprisingly low 38%.

Exhibit 30: US Smartphone Users Are Most Satisfied with Smartphones

Satisfaction with current smartphone (aggregated high satisfaction ratings of 8, 9, or 10 on a 10 point scale), Q1 2014

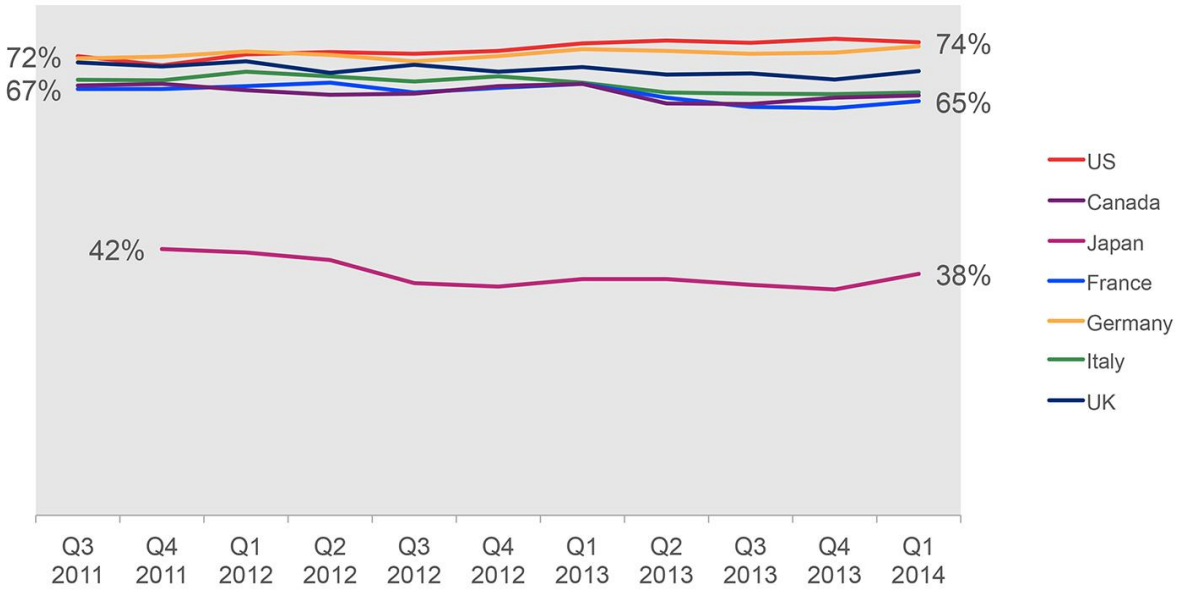


Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter)

The low satisfaction of Japanese smartphone owners is not a recent phenomenon. The trend line is dismal from the third quarter of 2011, when it sat at 42%, while the US was at or near the top for the entire time (see Exhibit 31).

Exhibit 31: Japanese Smartphone Owners Are Consistently Less Satisfied

Satisfaction with current Smartphone (Aggregated high satisfaction ratings of 8, 9, or 10 on a 10 point scale), Q3 2011 – Q1 2014

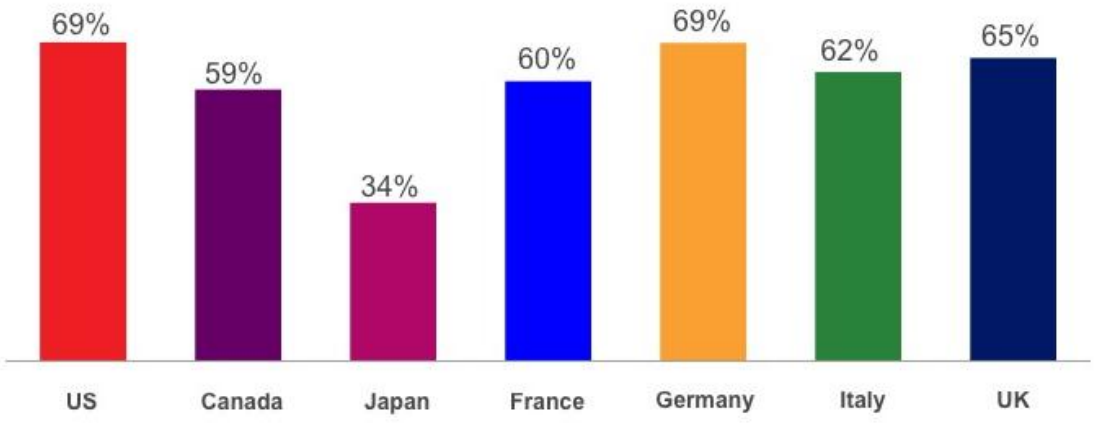


Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Data for Japan first available Q4 2011

The level of consumer satisfaction with their smartphone is fairly well reflected in the level of satisfaction with operators, with only a 5% drop for the US carriers (69%) and similar drops for the other members of the G7 (see Exhibit 32). Startlingly, the dissatisfaction of Japanese consumers continues with the way they feel about their operators; only 34% of Japanese consumers are satisfied with their operator.

Exhibit 32: US Smartphone Owners Are Most Satisfied with Operators

Satisfaction with Current Operator (Aggregated high satisfaction ratings of 8, 9, or 10 on a 10 point scale), Q1 2014

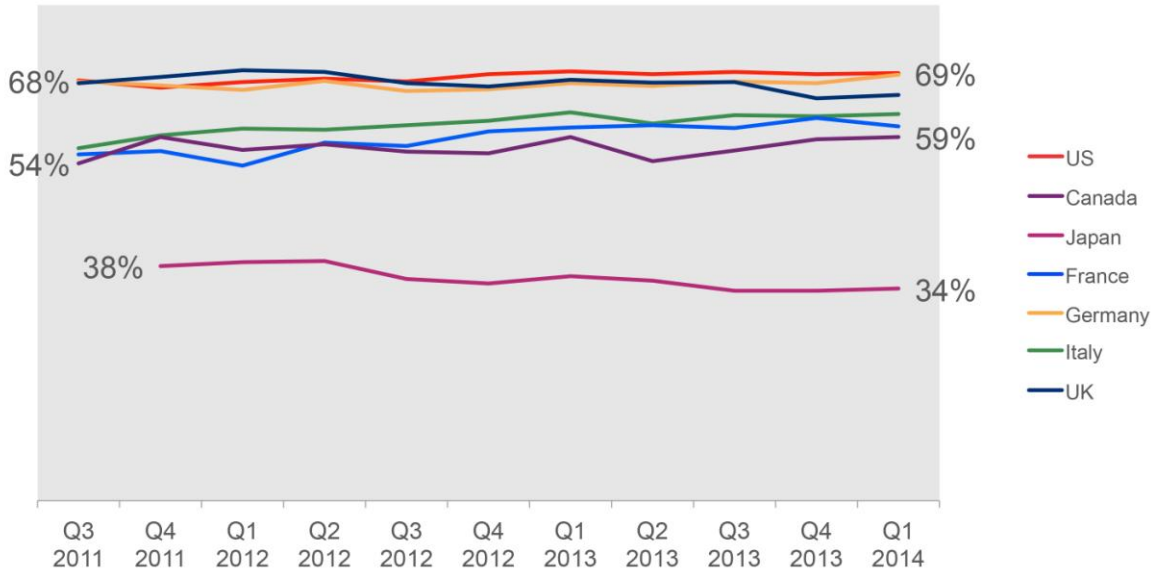


Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter)

Like the low satisfaction of Japanese smartphone owners, the dissatisfaction Japanese consumers have with their operators is something that's been around for some time. But unlike the trend for smartphones, which starts to show a slight uptick in the last quarter, Japanese consumer satisfaction with their operator remains flat at 34%, less than half that of the US and Germany (see Exhibit 33).

Exhibit 33: Japanese Are Least Satisfied with Current Operator

Satisfaction with Current Operator (Aggregated high satisfaction ratings of 8, 9, or 10 on a 10 point scale), Q3 2011 – Q1 2014



Source: comScore MobiLens, Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Data for Japan first available Q4 2011

Why this matters

US wireless customer satisfaction shows that speed is not everything. Customers of US carriers are happy with the services they receive and they like the many things they can do on the network. Indeed, adoption of services that require a high-speed connection and satisfaction levels in the US lead the world. So it is clear that the speed of US wireless networks, which has recently been exceeded by those in some other countries, is not impeding consumers. However, with such high adoption and satisfaction, and the prospects for continued adoption of 4G LTE service (and heavier usage) among the sizable population in the US, it is important to give thought to the future. Smartphone, tablet, and traffic growth projections from Cisco, Ericsson, and other companies underscore the importance of preparing for that imminent future.

CONCLUSION

The United States pioneered bringing 4G LTE to a mass audience while continuously increasing average download speeds. Now, however, it has seen three of its G7 compatriots surpass its lead in download speeds. What is at the root of this loss of leadership? How can the US improve its data speeds and improve its results in comparison to other countries?

With great pride and good reason, the US declares itself as the home of the smartphone revolution. Smartphones are now the most popular mobile device and the United States has led the charge. Smartphones began in the United States and, as a result, nobody has higher smartphone ownership than the US among the G7 countries.

Smartphones work better when they're on a faster network, so consumers are increasingly choosing smartphones that have 4G LTE connectivity. This trend is especially strong in Japan and the United States. In addition, Americans are using their smartphones more intensively and have integrated them more into their lives than any other people among the G7 countries. This drives device usage and results in significantly more data usage. In the US, that is especially true because it is one of the few countries that does not charge a premium for 4G access. While this decreases the average speed, at the same time it offers the highest median speed.

This means that data usage in the US is higher than anywhere else with a constraint amount of spectrum. In fact, the US has the least amount of spectrum available per LTE capable device—with only 0.65 Hz/LTE capable device. The next lowest country is Japan, with 2.58 Hz/LTE, which is four times more than the US. Canada provides its citizens with 37 times as much spectrum per person as the United States. Although 4G subscribers and usage have increased rapidly in the US, the availability of spectrum for 4G has been comparatively slow compared to the other G7 countries.

In short, other G7 countries have made significantly more spectrum available for 4G than the United States. The influx of new spectrum, combined with fewer 4G subscribers, has resulted in data speeds skyrocketing in several countries. The only thing that has prevented the US from falling even further behind is the massive capital investments made by the US wireless industry, which are the largest in totality and second largest per person among the G7 countries.

Nothing can be done to undo the effects of agglomeration we described in this report, which makes things more difficult in the US. The considerably less concentrated population in the US (when compared to other G7 countries) makes it more expensive for US carriers to deploy faster networks, and achieve the economies and efficiencies that may be attained in more densely-populated countries.

In spite of these challenges, overall, American smartphone owners, together with German smartphone owners, are the most satisfied, even though neither one of them have the fastest download speeds. Quizzically, at the same time, Japanese smartphone owners, with faster download speeds than Germans or Americans, and despite a large lead in per-capita capital expenditures by carriers, are by far the least satisfied.

Our international comparison shows that more spectrum, especially with wider channels, results in faster download speeds. Faced with the convergence of limited spectrum, dispersed population, and high usage US operators are continuously and consistently pumping massive capital investments into their infrastructures to provide Americans with the best possible networks. As a result, we are seeing data speeds increase. At the same time, other countries have accelerated their download speeds substantially faster because they have considerably more spectrum available and deployed for 4G.

Despite all of this, and as we have previously documented in our report in 2012 (*The Wireless Industry: The Essential Engine of US Economic Growth*), the US wireless operators generate billions of GDP, millions of jobs, and hundreds of millions in tax revenue. The figures we uncovered in that report in 2012 are just as valid today and underscore the importance of the US wireless industry:

- The US wireless industry is responsible for 3.8 million jobs, directly and indirectly.
- The wireless industry retained $146.2 billion in GDP in the US (and generated $195.5 billion in economic activity globally) in the 12 months from July 2010 to June 2011.
- At $195.5 billion, the wireless broadband industry would rank as the 46th largest economy in the world, as measured by GDP.
- The consumer surplus, the difference between what end users are willing to pay and what they have to pay for services, was $502.7 billion in 2010.

It's clear that the economic and social benefits from wireless technology and services are beyond anything we could have predicted even 20 years ago. If the United States quickly allocated more spectrum to wireless operators, in larger contiguous blocks, download speeds would increase more rapidly.