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White Paper

Smartphone use transforming with the rise of 4G and Wi-Fi

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Foreword

This discussion paper is the latest in a series on smartphone user trends published by Informa Telecoms & Media in partnership with Mobidia. The aim of this paper, in keeping with the five previous papers – the first of which was published in February 2012 – is to harness Mobidia's mega-panel and extensive global dataset to create groundbreaking new research on smartphone user behavior, particularly in light of the transition from 3G to 4G LTE (identified as 4G in this paper) that is underway in many of the world's leading mobile markets, and the parallel explosion in Wi-Fi coverage globally. The aim is to select the most telling data from Mobidia's vast dataset to detail and interpret this key technology inflection point for the mobile industry, one that has service providers and vendors looking for answers as to how smartphone users are evolving, and what that means for aspects of the industry as varied as 4G and Wi-Fi deployment plans and existing and new mobile revenue streams.

As with previous papers in this series, readers should be aware that the source of the primary usage data cited throughout is the Mobidia My Data Manager application, specifically end-users who have agreed to share their usage data with Mobidia on a strictly anonymous basis. The application has millions of active users across hundreds of countries, and more than half of users have agreed to share their usage data with Mobidia. That has led to a sample size of hundreds of thousands of end-users globally, and tens of thousands across the 10 leading 4G markets covered in this paper: South Korea, Japan, the US, Canada, Germany, the UK, Saudi Arabia, South Africa, Russia and Brazil.

I would like to extend my sincere thanks to the team at Mobidia for their vision and dedication to producing this thought leadership and making it freely available to the industry. In particular, this project would not be possible without the support and expertise of Chris Hill, Eric Eden and Allison Lenters at Mobidia. In addition, I would like to thank Lucy Powell, Robin Marcus and Shalia Mughal at Informa for all of their hard work to create and deliver the final product.

Finally, we welcome feedback on this paper, whether that be questions, comments or suggestions for future topics and trends to explore. The evolution to 4G and parallel expansion of Wi-Fi is a huge transition that is reshaping the mobile industry, and our aim is to contribute to the industry's ability to understand and capitalize on this transition.

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Introduction

4G has quickly established itself as one of the most successful technologies in the history of the mobile industry, and arguably the most successful, based on its record pace in moving from technology standard to mass-market service available in hundreds of markets worldwide. That rapid evolution, supported and enabled by the smartphone revolution, is changing the mobile industry fundamentally, and this research is designed to highlight and detail key aspects of the transformation.

Just as 4G has rapidly become the most successful mobile technology launch, Wi-Fi has cemented its position as the world's most successful wireless technology, judged by its widespread adoption across a host of devices and its role as the dominant carrier of data traffic on smartphones. The roles of 4G and Wi-Fi have been detailed in previous white papers in this series, and analysis of the technologies will be updated and extended to new markets in this research.

In short, this research details how smartphone data usage is changing as 4G services are deployed alongside existing 3G services, and as Wi-Fi coverage continues to expand in homes, businesses and public spaces. Compared to the previous white paper, published in June 2013, which focused on six of the world's leading 4G markets, this research has been expanded to cover 10 leading 4G markets from every major world region, introducing coverage of Russia, Saudi Arabia, South Africa and Brazil, in addition to the six countries covered previously: Japan, South Korea, the US, Canada, Germany and the UK. The current research also includes new analysis of global trends based on a sample of hundreds of thousands of end-users worldwide.

Fig. 1: LTE subscriptions, major markets, Dec-12 and Dec-13 (mil.)

Country	Subs, end-Dec 12	Subs, end-Dec 13	Share of global total, end-Dec 13 (%)
US	38.60	99.40	49.38
Japan	13.19	38.91	19.33
South Korea	15.81	28.45	14.13
Germany	0.79	3.47	1.72
Canada	1.67	3.05	1.51
UK	0.25	1.82	0.91
Germany	0.66	1.80	0.89
Saudi Arabia	0.07	0.99	0.49
South Africa	0.01	0.99	0.49
Brazil	0.01	0.92	0.46
Total	**71.06**	**179.79**	89.32
Global LTE subs	75.19	201.30	
Major markets' share of global LTE subs (%)	94.51	89.32	

Source: Informa Telecoms & Media

The 10 4G markets covered here were among the top 15 4G markets worldwide by subscriptions at end-2013, and were selected to provide – for the first time – insights into actual smartphone usage in all the world's major regions during the evolution from 3G to 4G networks. The 10 markets together accounted for 180 million 4G subscriptions at end-2013, when they accounted for 89% of the world's 201 million 4G subscriptions (see fig. 1).

Although covering new 4G markets and regions provides a more comprehensive view of smartphone-usage trends worldwide, the number of 4G subscriptions is relatively small in the newest markets, namely Saudi Arabia, South Africa, Russia and Brazil. Together these markets had 760,000 4G subscriptions at end-Dec 2012, a figure that rose 520% year-on-year – to 4.7 million at end-Dec 2013 – but still equates to only a relatively small sample size in each market.

This means that usage data from these markets should be taken as illustrative rather than representative, in contrast to the other country markets, which have far larger sample sizes, particularly the US, Japan, and South Korea. These three markets together accounted for 82% of global 4G subscriptions at end-2013, and the US alone accounted for almost half, nearing the milestone of 100 million 4G subscriptions. In this context, it should also be noted that "4G" is used in this research to refer to LTE only, and not to other technologies that are sometimes labeled "4G," such as HSPA+.

Another point on methodology is that the sample for this paper has been limited to smartphone users running My Data Manager on the Android operating system. While there are interesting differences in usage behavior between Android and iOS users, as detailed in previous papers, high-level trends across the two dominant OSes are similar. In addition, the open nature of Android means Mobidia can capture more-granular usage data on Android than on iPhones and other devices running iOS. Finally, Android is now the dominant smartphone OS both globally and in the markets under study: For example, Android smartphones accounted for 70% of global smartphone

shipments in 2013, based on Informa Telecoms & Media data. This makes Android smartphone users even more representative of all smartphone users.

In addition, one of the primary segmentations in this research is to split smartphones by the most advanced mobile network technology supported, namely 3G or 4G. For each type of smartphone, network-usage data is provided for cellular and/or Wi-Fi networks. It is important to note that for most data presented here, cellular data use on 4G smartphones will be a mixture of 4G, 3G and, in some cases, 2G data-network use. Likewise, cellular data use on 3G smartphones will be a mixture of 3G and 2G network use. The exceptions are figs. 11 and 12, which look at 4G smartphones, specifically 4G-network traffic, as a percentage of total cellular traffic on 4G-capable devices.

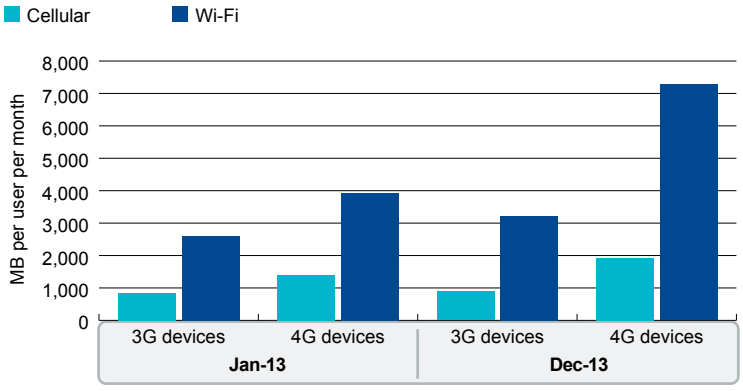
Finally, Mobidia's My Data Manager tracks data usage when end-users are in their home (domestic) market and when roaming, and domestic vs. roaming usage is highlighted in several charts. All other charts in this paper – in other words, all the charts that do not mention domestic and roaming data usage – are based only on domestic data usage.

The success of 4G and Wi-Fi in boosting smartphone data usage

4G has been a success in terms of speed of deployment and subscriber adoption globally, but Mobidia's data points to another clear result of 4G services: a dramatic increase in monthly cellular data usage compared with 3G services. Based on a sample of hundreds of thousands of Android smartphone end-users worldwide, those with 4G devices had average monthly cellular data usage of 1.4GB in January 2013, more than 500MB or 68% higher than the 838MB average monthly usage of those with 3G devices (see fig. 2). What's more, the gap between 3G and 4G smartphone monthly usage widened by December, when average monthly usage for 4G devices stood at 1.9GB, over 1GB more than the 894MB average monthly usage of 3G devices in the same period. This leap in 4G usage is clear proof of the benefits of 4G services for subscribers and operators.

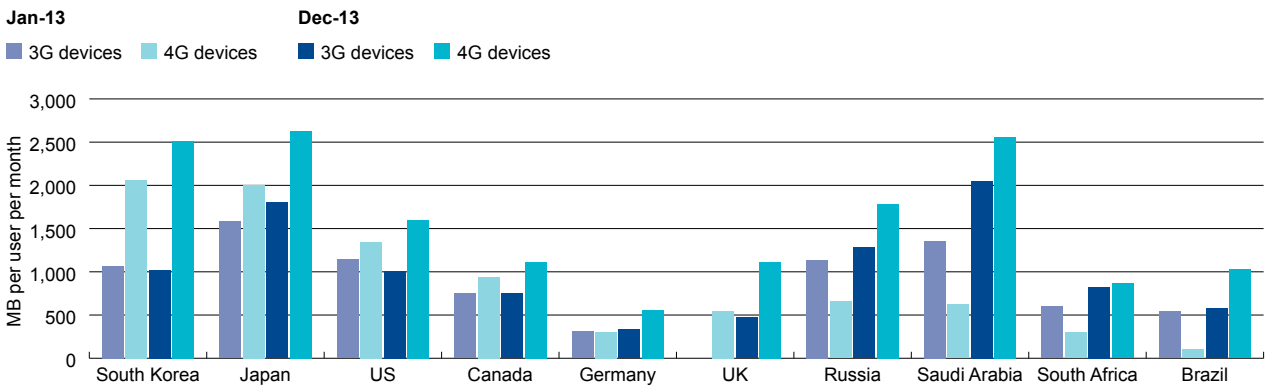
In fact, the trend for cellular usage on 3G and 4G devices becomes even clearer when we look at data for the leading 4G markets in each major region. Cellular traffic on 3G devices declined in 2013 in leading 4G markets such as South Korea and the US, and was flat overall across the top six 4G markets combined – South Korea, Japan, the US, Canada, Germany and the UK (see fig. 3). Although cellular traffic on 3G devices increased in 2013

Fig. 2: Global, average monthly cellular and Wi-Fi data use of Android 3G and 4G smartphone users, Jan-13 and Dec-13



Source: Mobidia

Fig. 3: Android 3G and 4G smartphone users, average monthly cellular data use per month, by country, Jan-13 and Dec-13



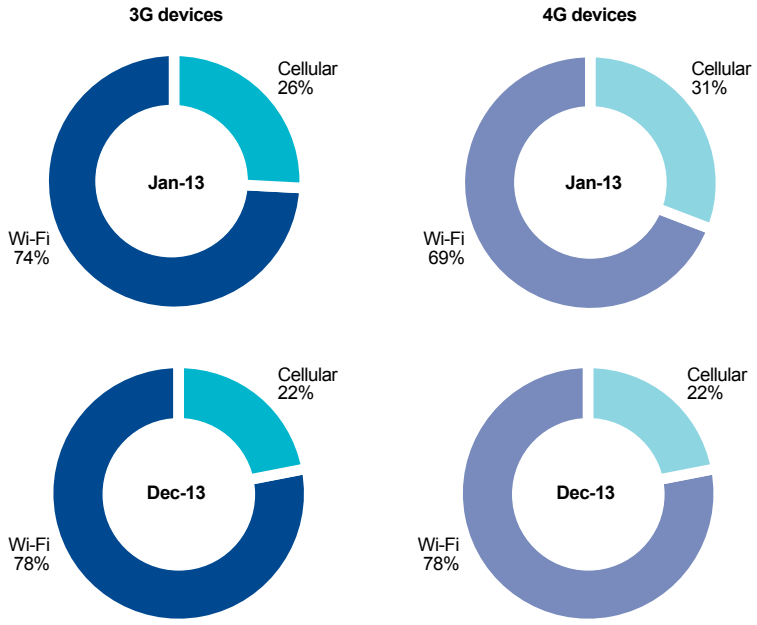
Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

in the other four markets, on average across the 10 markets it increased only 12%, compared with a 78% increase in cellular traffic on 4G devices. The clear implication is that once 4G services are launched, they quickly take over as the growth engine for the mobile industry.

But what does increasing cellular-data use on 4G devices mean for Wi-Fi use? Is 4G with superior mobile connection rates crowding out Wi-Fi, as some have suggested? The answer is a clear no, with actual usage data showing that Wi-Fi continues to strengthen its position as the dominant bearer of data traffic on smartphones. In fact, usage data suggests that 4G and Wi-Fi are complementary to a degree, with 4G devices seeing higher monthly use of both 4G and Wi-Fi, rather than one technology cannibalizing the other.

However, it is also true that monthly Wi-Fi data usage is much greater than cellular usage on 3G and 4G smartphones, and is growing much faster. Wi-Fi monthly use on 3G devices increased 24% between January and December 2013, to 3.2GB, but jumped 86% on 4G devices over the same period, to 7.3GB, which is more than 5GB higher than cellular use on 4G devices. In part, this points to the diverging roles of Wi-Fi and mobile access on smartphones, with Wi-Fi increasingly used for "automated" services such as cloud synchronization and backup of smartphone pictures, along with data-intensive end-user services such as YouTube, Netflix and other video services in the home. Mobile access, in contrast, and as its name implies, is typically focused on casual use and less-data-intensive activity initiated by end-users while on the move. Of course, Wi-Fi is also dominant partly because it is often free or at least perceived as free, particularly in homes and businesses, where the majority of smartphone Wi-Fi usage takes place. This offers both a challenge and opportunity for operators. The challenge is to prevent Wi-Fi from eroding the mobile data business model, and the opportunity is to better integrate Wi-Fi with other mobile and fixed broadband networks to provide an improved end-user experience.

Fig. 4: Global, Wi-Fi and cellular share of monthly data use, Android smartphone users, Jan-13 and Dec-13



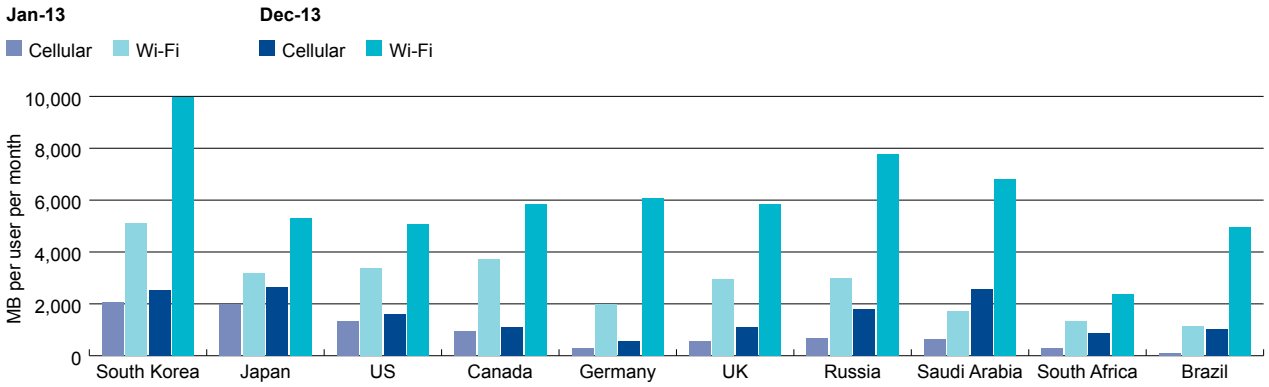
Source: Mobidia

The potential for this approach is clear, given that Wi-Fi accounted for 74% of total data traffic on 3G devices in January 2013, compared with 26% for cellular, and Wi-Fi's share increased to 78% in December. On 4G smartphones, Wi-Fi accounted for 69% of monthly data traffic in January 2013, increasing to 78% in December (see fig. 4). That level and share of data traffic is simply too large for services providers to ignore, if they want to acquire, retain and delight their customers.

But do we see the same trends when we move from global level to country level? Looking at data for average 4G and Wi-Fi monthly usage from the leading 4G country markets in each major global region, the answer is an emphatic yes, though there are naturally differences by market. Common trends that stand out across 10 ten markets for 4G smartphones are: Wi-Fi usage that is significantly higher than cellular usage, and significant increases in both Wi-Fi and cellular over the course of 2013 (see fig. 5).

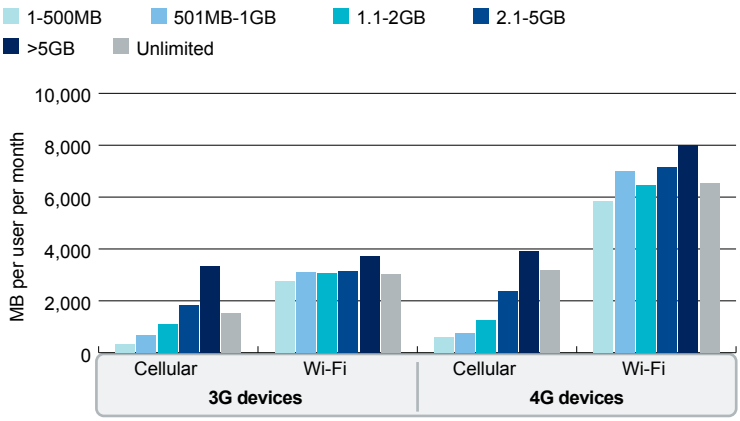
Beyond these high-level trends, there are significant variations by market, with average cellular usage on 4G Android smartphones ranging from a low of 103MB in Brazil, where the first 4G network launched in December 2012, to a high of 2.1GB in South Korea, one of the world's most mature 4G markets. Likewise, there is significant variation in the growth of cellular usage over 2013, with Brazil seeing cellular usage grow nearly tenfold, to 1GB in December, compared with more modest growth of 22%, to 2.5GB, in South Korea. There is also a range of Wi-Fi usage across markets, partly due to the varying levels of Wi-Fi coverage, which in turn relies on fixed-broadband coverage, ranging from a high of nearly 10GB average Wi-Fi usage in South Korea in December to a low of 2.4GB in South

Fig. 5: Android 4G smartphone users, average monthly data use by country, cellular and Wi-Fi, Jan-13 and Dec-13



Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

Fig. 6: Global, Android 3G and 4G smartphone users, average monthly cellular and Wi-Fi data use by data-plan size, Dec-13



Source: Mobidia

Africa in the same month. The increase in Wi-Fi monthly usage in 2013 is higher in new 4G markets, with a likely key reason being a rise in penetration of 4G smartphones with better support for data-intensive services such as video, and improved support for accessing Wi-Fi networks easily and automatically. A related factor is increasing Wi-Fi-network coverage, particularly in emerging markets such as Brazil.

Given these trends in cellular and Wi-Fi usage on smartphones, and the dramatically different business models backing the two systems – namely that cellular data is typically expensive and Wi-Fi data is perceived as free, particularly in the home – it will be interesting to explore how cellular and Wi-Fi usage varies depending on the cellular data plan of the end-user, specifically the amount of cellular data use included in their monthly plan. For example, one theory would be that end-users with relatively small monthly cellular data buckets would have relatively large monthly Wi-Fi usage, since users in this segment might be cautious with cellular data use and wait for Wi-Fi coverage whenever possible. However, this would require widespread Wi-Fi coverage, which is the case in many developed markets but in relatively few emerging markets. A related point is that end-users often perceive Wi-Fi access to be free, but in reality it typically relies on a fixed-broadband service with a monthly fee.

Global end-user data paints a different picture, with cellular usage increasing along with the size of monthly cellular data plans but with Wi-Fi usage remaining remarkably consistent regardless of cellular-plan size (see fig. 6). This suggests that there is a reasonably "natural" level of monthly data usage that end-users gravitate toward when they are not limited by price, which is often the case for Wi-Fi access, where the majority of usage is in homes and businesses. If this theory is correct – and there other possible interpretations, particularly since this is global-level data – it is obvious that this "natural" level of usage is substantially linked to the limitations of smartphone technology, which would help explain why Wi-Fi monthly usage on 4G devices is more than double that on 3G devices across all cellular-plan sizes. Another point to note is that cellular usage is higher for 4G devices than 3G devices across all plan sizes, for example increasing from 344MB for 3G smartphone users with plan sizes of 1-500MB per month to 589MB for 4G users with the same plan size. Clearly, many 4G smartphone users with 1-500MB monthly plans have an incentive to move to a larger monthly data plan.

The state of data roaming on smartphones

Given all the good news about 4G driving significant increases in data usage, is there a chance it is having the same impact on data roaming? Although data and other forms of roaming have long been severely restricted by sky-high prices, the situation has started to change in recent years, particularly in Europe, where EU regulations have led to substantial reductions in roaming rates.

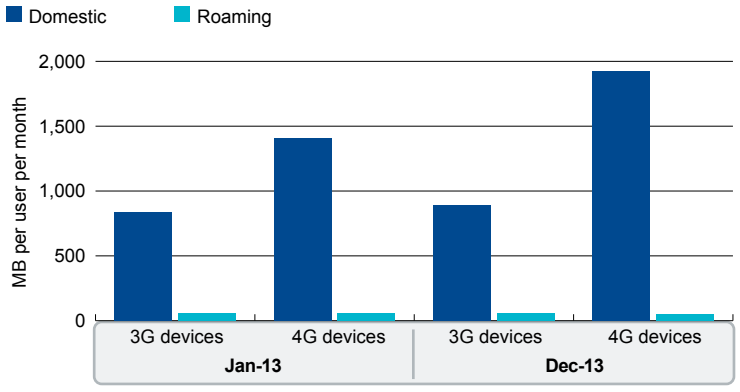
Although some progress has been made on roaming rates in some regions, at the global level, Mobidia's data reveals that data-roaming usage remains a drop in the bucket compared with domestic usage. For example, for Android 3G smartphones globally, average domestic monthly cellular use increased from 838MB in January 2013 to 894MB in December, while average cellular roaming use on the same devices was only 60MB in January 2013, increasing marginally to 61MB in December. The move to 4G smartphones led to a huge increase in domestic cellular usage but a decline in cellular roaming usage, falling from 54MB in January to 53MB in December (see fig. 7).

Given low cellular-roaming usage, it does not come as a surprise that roaming penetration is also low, with only 11% of 3G smartphone users and 8% of 4G smartphone users roaming on cellular networks in December. What's more, Wi-Fi roaming is not taking up the slack, given its penetration of only 10% of 3G smartphone users and 7% of 4G smartphone users in December.

Although cellular data roaming is clearly in its infancy globally, it is worth looking at country-level figures to see if there are exceptions. 4G roaming in particular is still at an early stage, and any early upticks in usage would probably be seen in large 4G markets with the highest penetration of 4G subscriptions, and with operators that have announced 4G roaming agreements. The world's top three 4G markets – South Korea, Japan and the US – meet those criteria, by having the majority of the world's 4G subscriptions and relatively high penetration of 4G subscriptions at end-December: 52%, 28% and 28%, respectively (see fig. 8). In addition, major operators in these markets have announced 4G roaming agreements. For example, South Korea's SKT announced its first 4G roaming agreement in early 2013, and now has deals in place with Globe Telecom in the Philippines, CSL in Hong Kong and SingTel in Singapore.

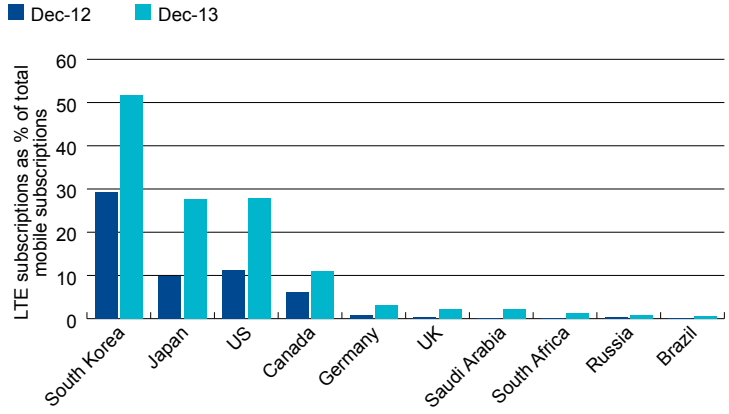
However, looking at usage data for the top two operators in each of the world's three largest 4G markets, it is clear that cellular roaming on 4G smartphones has not taken off. While there is no doubt that 4G roaming is at an early stage, and still faces technology and integration hurdles, initial signs are that it remains something of an afterthought for operators, similar to 3G data roaming. Although the operators saw domestic cellular usage in December of 1.4-2.5GB, cellular roaming usage ranged from 15-77MB in the same month (see fig. 9). Only time will tell whether the mobile industry will use the transition to 4G as an opportunity to introduce innovative data-roaming services that boost data-roaming usage, and thus potentially increase data-roaming revenues.

Fig. 7: Global, Android 3G and 4G smartphone users, average monthly cellular data usage, domestic and roaming, Jan-13 and Dec-13



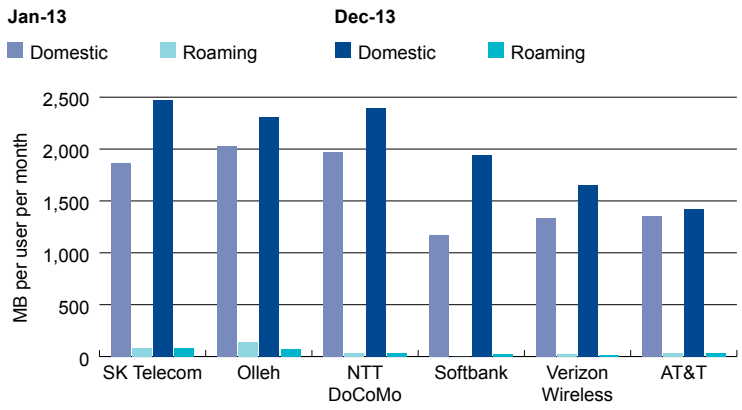
Source: Mobidia

Fig. 8: LTE subscriptions as % of total mobile subscriptions, major markets, Dec-12 and Dec-13



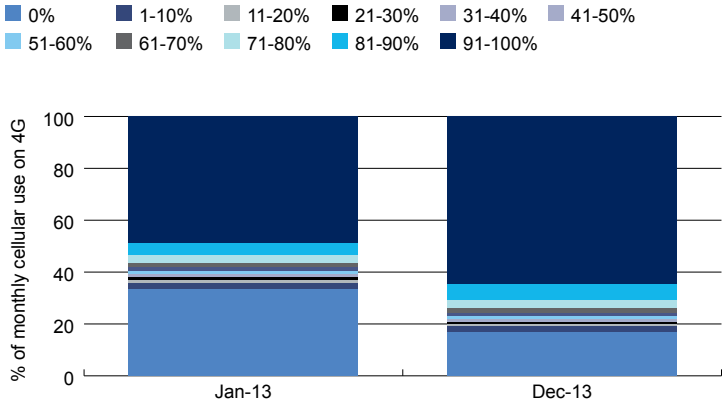
Source: Informa Telecoms & Media

Fig. 9: Android 4G smartphone users, average monthly data use, domestic and roaming, selected operators, Jan-13 and Dec-13



Source: Mobidia

Fig. 10: Global, Android 4G smartphone users, share of monthly cellular data use on 4G, Jan-13 and Dec-13



Source: Mobidia

How much 4G data do 4G smartphones actually use?

Mobidia's dataset provides insight into another key question for 4G operators, namely how fast 4G usage is likely to ramp up in their market. Of course, there are certain fundamental constraints for 4G usage, including 4G coverage, which is in turn often defined at least in part by 4G-spectrum assets. Operators are well aware of the key limiting factors for 4G rollouts but are often less aware of actual 4G-usage levels, at least before they launch 4G services. Even once they have launched, operators and vendors need to benchmark their 4G usage levels against others in their market and globally, to gauge the success of their rollout strategy.

With that in mind, we look at monthly 4G data use as a percentage of total cellular data use for 4G Android smartphones globally. The data is interesting, in that for both January and December 2013, the vast majority of 4G smartphone users globally use 4G for either 91-100% of their monthly cellular usage, or 0%. Specifically, 49% of 4G smartphones used 4G for 91-100% of their cellular data usage in January, increasing to 65% in December (see fig. 10). That aligns well with the general global trend of rapidly expanded 4G coverage, and the more specific fact that the vast majority of 4G subscriptions globally are in South Korea, Japan and the US, where 4G population coverage is above 90% and nearing or surpassing 3G population coverage.

On the other end of the spectrum is the fact, more troubling at first glance, that 33% of 4G smartphone users did not use 4G services in January 2013, though the better news is that this figure declined to 17% in December. This is actually a relatively normal feature of new mobile technology rollouts, given that operators typically deploy in major urban areas first, and then expand into suburban and rural areas over time. In other words, many carriers are expanding 4G population coverage gradually, so use of 4G networks is increasing over time as coverage expands. Another major constraint is 4G spectrum, with high-frequency spectrum typically leading to slower coverage rollouts, including 2.5GHz spectrum in Europe, which has a shorter range than lower-frequency spectrum, and thus costs more for a given amount of coverage. The result is that 4G coverage in markets with high-frequency spectrum is typically lower than in markets with low-frequency spectrum, such as the US, assuming comparable rollout timelines. There are exceptions, of course, including relatively small and densely populated countries, such as South Korea and Japan, where network economics support rapid expansion of new mobile services even with relatively high-frequency LTE spectrum, and where 4G population coverage is approaching 100%.

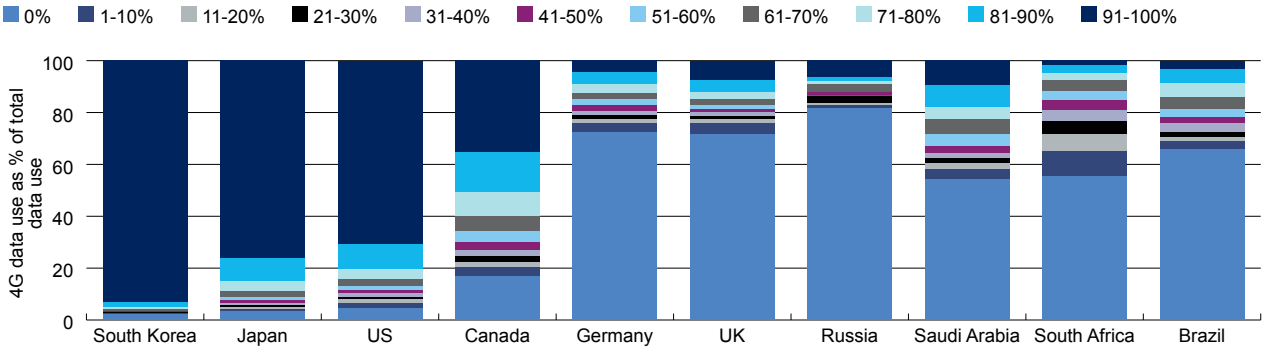
These trends are illustrated with country-level data, which shows that 4G-network usage is highest in the more mature 4G markets with high 4G population coverage, led

by South Korea, where 4G-network usage accounted for 91-100% of total cellular usage for 93% of 4G Android smartphone users (see fig. 11). Next is Japan, where 76% of 4G smartphone users had 91-100% of their cellular usage on 4G in Dec-13, followed by the US, where 71% of users had that level of usage in the period. After those major markets, there is a steep drop to Canada, where 35% of 4G smartphone users saw 91-100% of cellular usage on 4G. For the remaining markets under study, the majority of 4G smartphone users did not use 4G networks, ranging from 54% of 4G smartphone users in Saudi Arabia to 72% in the UK and Germany to 81% in Russia. Another reason for this phenomenon, apart from limited 4G coverage, is that once 4G services launch in a market, certain end-users go for the latest and greatest 4G smartphones regardless of the extent of 4G coverage.

Similar trends hold for different operators in the same market, with key variables being 4G-spectrum frequency, network- launch dates and levels of investment. For example, in the US, Verizon was the first major operator to launch 4G (in December 2010), and has the advantage of low-frequency spectrum in the 700MHz band. Those factors, along with massive investment to deploy a nationwide 4G network, help explain how Verizon leads the US field, with 92% of its 4G smartphone users having 91-100% of cellular use on 4G in January 2013, increasing to 95% in December (see fig. 12).

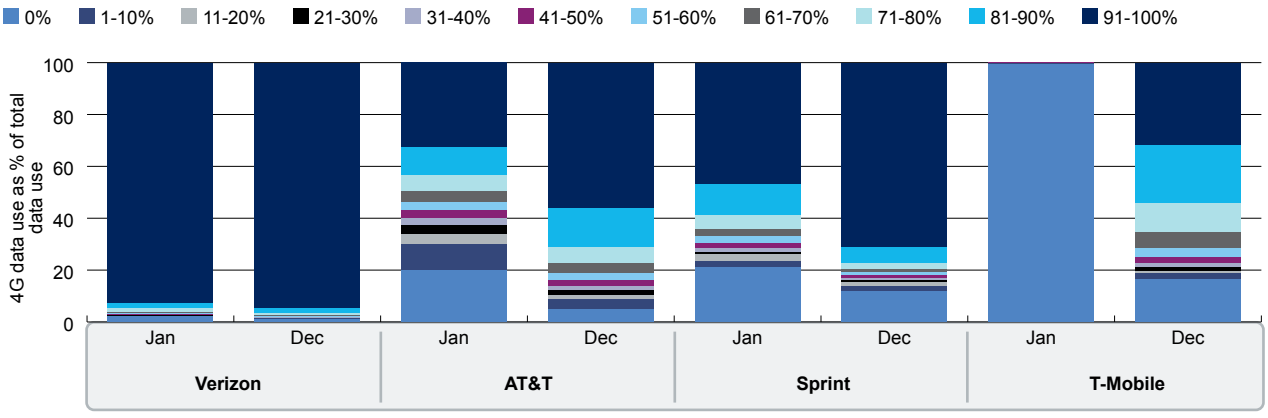
More surprising at first glance is the comparable figures for AT&T, the second-largest 4G operator in both the US and the world by subscriptions, behind Verizon. AT&T has a far smaller share of 4G smartphones with 91-100% of usage on 4G, at 33% in January

Fig. 11: Android 4G smartphone users, share of monthly data use on 4G, by country, Dec-13



Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

Fig. 12: US, Android 4G smartphone users, share of monthly data use on 4G, by major operator, Jan-13 and Dec-13



Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

2013, increasing to 56% in December. In addition, AT&T has more 4G smartphone users spread across the range of 4G-network usage, including 20% o who did not use 4G in January 2013, though this figure declined to 5% in December.

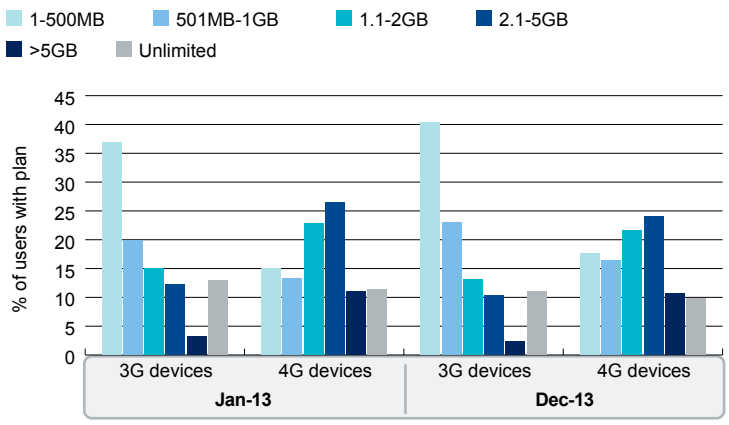
Verizon's head start over AT&T on 4G might help explain the operators' different 4G-usage profiles, but it is not the only explanation, particularly given that AT&T had 95% population coverage for 4G at end-2013, compared with Verizon's 97%. The main reason for AT&T's different 4G-network usage profile is the simple fact that it also has nationwide HSPA+ coverage, and HSPA+ can provide a similar or better experience than 4G, depending on network and other conditions. Verizon, in contrast, does not have the luxury of a fallback network that can offer an end-user experience comparable to 4G, given its relatively uncompetitive CDMA EV-DO network. This explains both Verizon's early launch of 4G and its rapid migration of 4G-smartphone usage to 4G once coverage was widespread.

Likewise, Sprint launched 4G 10 months after AT&T, in July 2012, but already had a larger share of 4G smartphone users in the highest tier of 4G usage by January 2013, at 47%, compared with AT&T's 33%. This can also be largely explained by Sprint's relatively weak 3G EV-DO network, which encourages a faster migration to 4G usage compared with AT&T's HSPA+ network. Similarly, the more balanced 4G usage profile of T-Mobile USA is due to its nationwide HSPA+ network, while its relatively low share of smartphone users largely reliant on 4G is due to its relatively late launch in March 2013 and lower 4G coverage.

The impact of 4G on data-plan size distribution

Many mobile operators globally have used the transition to 4G as an opportunity to move away from monthly data plans with unlimited usage and toward a tiered portfolio of plans with higher prices for higher levels of data usage. In fact, this trend is one of the key reasons for the success of Mobidia's My Data Manager application, given that it helps end-users manage their monthly cellular data usage to stay within the limits of their data plan and avoid expensive overage charges.

Fig. 13: Global, Android 3G and 4G smartphone users, monthly data-plan size distribution, Jan-13 and Dec-13



Source: Mobidia

To do so, end-users enter details about their monthly cellular data plan into the application, which then provides alerts and recommendations as users approach their monthly data limit. In addition, for end-users who give Mobidia permission use their plan and usage data, the app provides insight into how data-plan sizes are changing with the transition from 3G to 4G, and over time.

In previous sections, we have seen that the transition from 3G to 4G smartphones leads to an increase in monthly cellular data usage, but Mobidia's dataset can also provide insight into how this overall trend is changing the distribution of smartphone users by data-plan size. In one of the most striking findings of the research, data at the global level reveals how operators are using the transition to 4G to drive huge improvements in data-plan distribution.

For example, in January 2013 the percentage of end-users with smaller data packages – specifically, monthly data plans up to 1GB – was 56% for those with 3G smartphones, compared with 28% for 4G smartphones (see fig. 13). That is nearly reversed for monthly data plans larger than 1GB (excluding unlimited plans), which account for 61% of 4G smartphone users, compared with 31% of 3G smartphone users. There is also a slight improvement in the unlimited category, with 11% of 4G smartphone users globally in the category, compared with 13% of 3G smartphone users. In addition, the distribution of 4G relative to 3G devices is similar in December, when the majority of 4G smartphone users and a minority of 3G smartphone users had monthly data plans larger than 1GB.

A different picture emerges when looking at trends over time. For example, between January and

Fig. 14: Android 3G and 4G smartphone users, monthly data-plan size distribution, major markets, Dec-13

	South Korea		Japan		US		Canada		Germany	
Data-plan size	3G	4G	3G	4G	3G	4G	3G	4G	3G	4G
1-500MB	57%	8%	36%	13%	23%	15%	39%	26%	76%	56%
501MB-1GB	20%	19%	11%	4%	5%	6%	32%	31%	10%	23%
1.1-2GB	5%	16%	5%	4%	33%	34%	9%	13%	2%	5%
2.1-5GB	2%	29%	6%	24%	23%	30%	6%	11%	3%	5%
>5GB	2%	17%	6%	35%	2%	5%	8%	14%	1%	1%
Unlimited	14%	10%	36%	19%	15%	9%	6%	5%	8%	10%

	UK		Russia		Saudi Arabia		South Africa		Brazil	
Data-plan size	3G	4G	3G	4G	3G	4G	3G	4G	3G	4G
1-500MB	57%	25%	46%	35%	23%	22%	65%	62%	60%	44%
501MB-1GB	29%	41%	8%	7%	16%	17%	16%	20%	11%	8%
1.1-2GB	4%	12%	7%	5%	33%	37%	8%	9%	9%	18%
2.1-5GB	1%	7%	15%	32%	15%	13%	2%	2%	5%	14%
>5GB	1%	5%	5%	2%	5%	3%	1%	1%	1%	3%
Unlimited	8%	10%	20%	19%	9%	8%	8%	6%	14%	13%

Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

December 2013, there was a 4% decline in 4G smartphone users with monthly plans above 1GB and a 6% increase in those with plans up to 1GB, though this is offset somewhat by a 2% decline in users with unlimited plans.

What could be driving this? A clue comes via the trend for 3G smartphone users over the same period, which is similar to 4G: a 7% increase in plans up to 1GB, a 5% decrease in plans larger than 1GB and a 2% drop in unlimited plans. This suggests a fundamental driver, such as ongoing reductions in device costs and prices for both 4G and 3G smartphones, which helps make mobile devices affordable for those with lower incomes, which in turn leads to a gradual shift toward smaller and lower-cost data plans over time.

Next we look at data-plan distribution for 3G and 4G smartphones in the 10 leading 4G markets in each major region in December 2013 (see fig. 14). While the trends are similar across the markets, with more 4G smartphone users on larger data-plan sizes than 3G smartphone users, there are significant differences by market. For example, the advanced 4G market of South Korea shows the largest difference in penetration of 1-500MB plans, with only 8% of 4G smartphone users on the plans in December, compared with 57% of 3G smartphone users. Given these figures, it is understandable that South Korea has one of the biggest swings in large-plan segments, with 29% of 4G smartphone users having 2.1-5GB plans, compared with only 2% of 3G users.

At the other end of the spectrum are the newer 4G markets of Russia, Saudi Arabia, South Africa and Brazil, where data has to be interpreted with caution because the number of end-users is relatively small, in some cases in the hundreds rather than thousands. With that qualification in mind, all of the newer 4G markets show a shift in users toward larger data plans, though the shift is less pronounced than in more mature 4G markets. For example, the difference in take-up of 1.1-5GB plan sizes among 4G smartphone users compared with 3G users ranges from a low of 1% in South Africa to 18% in Brazil.

Drilling down to the operator level, the general trend seen at global and country levels is maintained at most leading operators in each major 4G market, in that 4G smartphone users are significantly weighted toward larger plan sizes relative to 3G smartphone users (see fig. 15). There are exceptions, of course, such as Mobily in Saudi Arabia, which saw 22% of 4G smartphone users with 1-500MB plans, compared with 17% of 3G smartphone users. However, this trend could simply

Fig. 15: Android 3G and 4G smartphone users, monthly data-plan size distribution, major operators, Dec-13

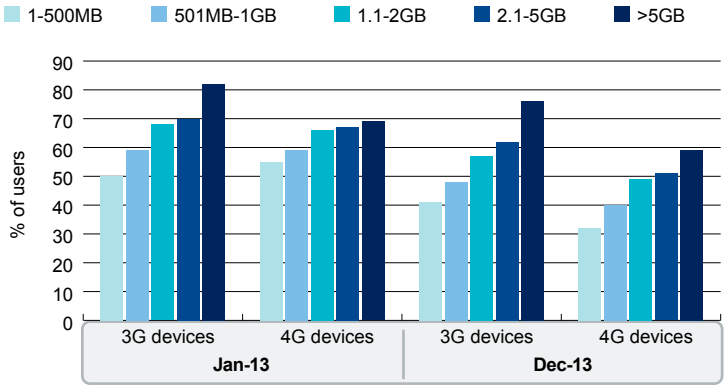
	SKT		NTT DoCoMo		Verizon Wireless		Rogers		T-Mobile	
	South Korea		Japan		US		Canada		Germany	
Data-plan size	3G	4G	3G	4G	3G	4G	3G	4G	3G	4G
1-500MB	54%	10%	44%	17%	24%	6%	46%	27%	74%	45%
501MB-1GB	16%	17%	12%	5%	8%	9%	24%	26%	13%	33%
1.1-2GB	8%	17%	6%	5%	42%	47%	8%	13%	1%	2%
2.1-5GB	3%	30%	3%	28%	11%	22%	9%	15%	3%	5%
>5GB	1%	15%	4%	26%	2%	8%	10%	16%	1%	2%
Unlimited	17%	11%	31%	19%	12%	8%	3%	4%	8%	12%

	EE		Megafon		Mobily		Vodacom		Vivo	
	UK		Russia		Saudi Arabia		South Africa		Brazil	
Data-plan size	3G	4G	3G	4G	3G	4G	3G	4G	3G	4G
1-500MB	52%	24%	52%	41%	17%	22%	67%	59%	55%	34%
501MB-1GB	34%	39%	3%	0%	11%	7%	16%	23%	17%	13%
1.1-2GB	4%	14%	4%	7%	43%	51%	7%	9%	10%	23%
2.1-5GB	1%	10%	15%	33%	15%	12%	2%	2%	5%	13%
>5GB	1%	5%	8%	0%	7%	3%	1%	0%	1%	6%
Unlimited	8%	8%	18%	19%	8%	5%	6%	6%	12%	10%

Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

be due to the relatively small sample size of 4G smartphone users for the operator in December. Another factor is likely to be Mobily's 4G network, which is based on TD-4G rather than the mainstream FDD-4G system, and on more-niche 4G spectrum at 1800MHz, both of which restrict the availability of leading smartphones. That has limited the migration of high-end users to 4G, which in turn limits adoption of larger data plans by 4G smartphone users.

Fig. 16: Global, share of Android 3G and 4G smartphone users using 0-50% of monthly data limit, by plan, Jan-13 and Dec-13



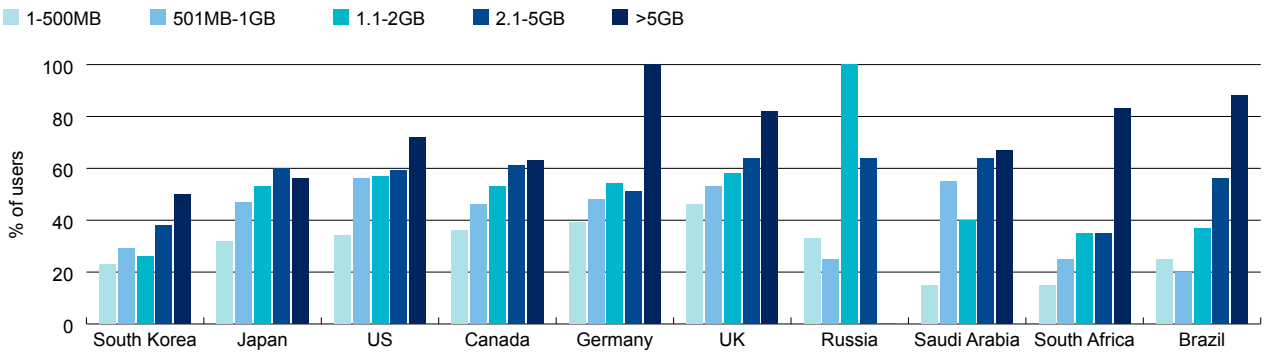
Source: Mobidia

Trends in data-plan consumption for 3G and 4G smartphones

Having looked at how the transition to 4G is changing data-plan distribution, we turn to data-plan usage, specifically the extent to which 3G and 4G smartphone users actually consume the amount of data included in their monthly plan. Although previous sections suggest that operators have been skillful in designing plans that encourage end-users to move to bigger data plans as they migrate to 4G, it is also true that tiered data plans are still relatively new in many markets, and there is a risk that end-users will downgrade to smaller plans as they learn more about their monthly usage, for example via applications such as Mobidia's Mobile Data Manager.

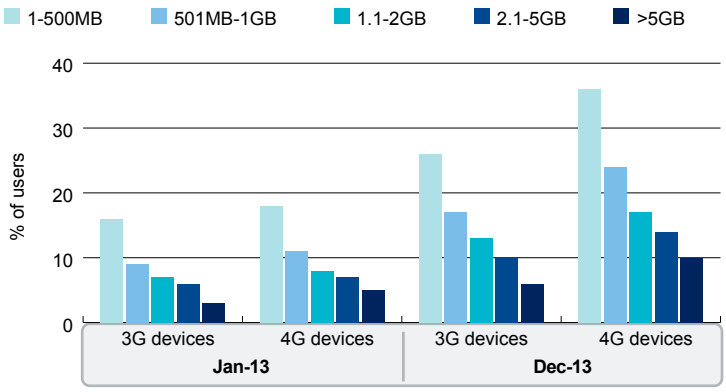
Data for 3G and 4G Android smartphone users globally suggests that this is a real risk, given that more than half of end-users used 0-50% of their monthly data plan in January 2013, across all data-plan sizes and for both 3G and 4G smartphones (see fig. 16). Understandably, the figures increase with data-plan size: Fifty-five percent of 4G smartphone users with 1-500MB plans used 0-50% of their data plan, compared with 69% for those with plans over 5GB.

Fig. 17: Share of Android 4G smartphone users using 0-50% of data limit, by plan, major markets, Dec-13



Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

Fig. 18: Global, share of Android 3G and 4G smartphone users using >100% of monthly data limit, by plan, Jan-13 and Dec-13



Source: Mobidia

The good news for operators is that the share of those using half or less of their data plan had decreased significantly by December, particularly for 4G smartphone users. In that month, 32% of 4G smartphone users with 1-500MB plans used 0-50% of their data plan, increasing to 51% for those with 2.1-5GB plans and 59% for those with monthly plans including more than 5GB of data.

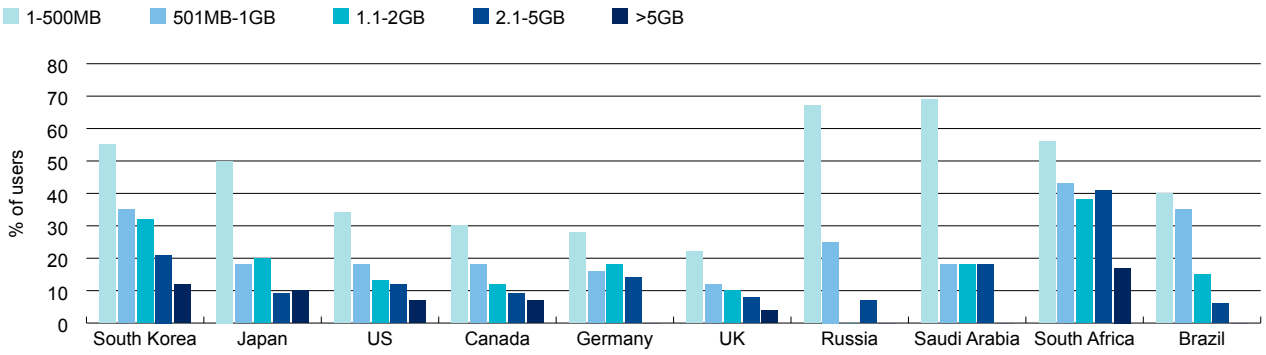
Turning to country-level data for 4G smartphone users in December, the share of those using half or less of their data plan declines as data-plan size increases (see fig. 17). Given that the data for newer 4G markets is illustrative rather than representative due to relatively small sample sizes, it is interesting to note that the newer 4G markets with relatively large samples, such as the UK, tend to have a higher percentage of those using only 0-50% of data plans, while the most mature 4G market, South Korea, has the lowest share of users with 0-50% usage of monthly data plans across all plan sizes. It is understandable that more-mature 4G services drive higher monthly 4G usage and consumption of data plans, but it is also true that on average most 4G smartphone users with 1.1GB or higher plans across the 10 markets used 0-50% of their data plan in December, which means that operators have to be aware of the risk that subscribers will downgrade from larger data plans.

Also of interest to operators is the percentage of smartphone users exceeding their data-plan limits, since this gives an indication of those likely to upgrade to a larger plan size. Apart from the obvious point that the share of users exceeding their plan limits is higher for smaller plan sizes, the trends in global data are positive for carriers in at least two ways: first, because the share of users exceeding their plan limit was higher for 4G smartphones than for 3G smartphones across all data-plan sizes in both January and December 2013 (see fig. 18); and second, because the share exceeding their plan limit increased for both 3G and 4G smartphone users between January and December, across all plan sizes.

Country-level data for 4G smartphone users in December shows an opposite trend to the 0-50% usage data explored earlier, in that the share of users exceeding their monthly plan limits increases as 4G penetration increases. South Korea leads the field, with an average 31% of users across all plan sizes exceeding their monthly data limit, ahead of Japan, with 21%, the US, with 17%, Canada and Germany, with 15% each, and the UK, with 11% (see fig. 19).

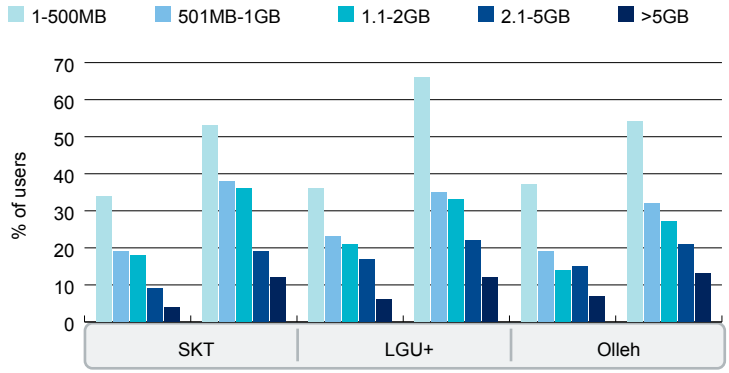
Finally, we provide similar data for 4G smartphone users in December for

Fig. 19: Share of Android 4G smartphone users using >100% of monthly data limit, by plan, major markets, Dec-13



Note: 4G user base is limited in Russia, Saudi Arabia, South Africa and Brazil.
Source: Mobidia

Fig. 20: South Korea, share of Android 4G smartphone users using >100% of monthly data limit, by plan and operator, Jan-13 and Dec-13



Source: Mobidia

the three major operators in South Korea, which illustrates that all saw significant increases in the share of users exceeding their data plan limit between January and December 2013, across all data-plan sizes (see fig. 20). That bodes well, indicating that 4G smartphone users in the country are likely to continue upgrading to larger and more expensive monthly data plans in future.

Conclusions

- 4G smartphone users have dramatically higher monthly data use than 3G smartphone users, and the gap is increasing over time, proving the value of 4G services for both end-users and operators. In fact, in December, average monthly cellular traffic on 4G Android smartphones globally was more than twice that on 3G smartphones, with 4G devices using 1.9GB, compared to 894MB for 3G devices. This global trend was mirrored in the 10 leading 4G markets, where cellular traffic on 4G devices outpaced that on 3G devices across the board. A notable difference in the 10 markets was that cellular traffic on 3G smartphones actually declined in 2013 in two of the world's three largest 4G markets, South Korea and the US, and in the UK, while in other markets it increased but at a much lower rate than cellular traffic on 4G devices.
- Wi-Fi traffic continues to explode on smartphones, significantly outpacing growth of cellular traffic on 3G and 4G devices. In December, Wi-Fi accounted for 78% of data traffic on both 3G and 4G Android smartphones globally, with cellular accounting for the remaining 22%. In January, Wi-Fi accounted for 74% of total data traffic on 3G Android smartphones globally and 69% on 4G Android smartphones. In other words and as detailed in this research, monthly Wi-Fi data usage is much greater than cellular usage on 3G and 4G smartphones, and is growing much faster. This offers both a challenge and opportunity for operators. The challenge is to prevent Wi-Fi from eroding the mobile data business model, and the opportunity is to better integrate Wi-Fi with other mobile and fixed broadband networks to provide an improved overall end-user experience.
- Wi-Fi traffic on 4G smartphones is remarkably consistent regardless of the size of the cellular data plan of the end-user, and the same trend is seen on 3G smartphones. This suggests that there is a reasonably "natural" level of monthly data usage that end-users gravitate toward when not limited by price, which is often the case for Wi-Fi access. This level of usage is

obviously substantially limited by mobile technology, with Wi-Fi monthly usage on 4G devices more than double that on 3G devices across all cellular-plan sizes.

- Although domestic cellular traffic is exploding on 4G smartphones, data-roaming traffic is going nowhere either globally or for leading 4G operators, following the trend established on 3G smartphones. While there is no doubt that 4G roaming is at an early stage, and still faces technology and integration hurdles, initial signs are that it remains something of an afterthought for operators, similar to 3G data roaming. Only time will tell whether the mobile industry will use the transition to 4G as an opportunity to introduce innovative data-roaming services that boost data-roaming usage, and thus potentially increase data-roaming revenues.
- For 4G smartphone users, the amount of monthly data traffic on 4G compared with other cellular networks varies dramatically by market based on 4G-service maturity, spectrum frequency and levels of investment. Another key variable is 3G mobile network technology, with CDMA EV-DO operators such as Verizon Wireless and Sprint seeing a faster migration to 4G network use than operators with HSPA+ networks – such as AT&T – which deliver a better user experience than CDMA EV-DO networks. Operators and vendors can use these findings to forecast take-up of their existing or planned 4G services based on their 4G spectrum, launch dates, investment levels and existing 3G technology.
- In one of the most striking findings of the research, data at the global level reveals how operators are using the transition to 4G to drive huge improvements in data-plan distribution. Put more simply, 4G smartphone users typically have bigger data plans than 3G smartphone users, with obvious benefits for operator ARPU and results. A related trend is that the share of end-users on unlimited plans is smaller on 4G smartphones than 3G smartphones. These findings are nothing less than a confirmation of the heart of the 4G business case.
- The transition to 4G smartphones is also increasing usage of data plans, which decreases the risk that users will downgrade to a smaller data plan. In addition, it is increasing the share of users who exceed their data-plan limit, which is a leading indicator for migration to a larger plan size with a higher monthly fee. This is another strong confirmation of the 4G business case.

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mobidia

ABOUT MOBIDIA

Mobidia is a leading mobile analytics provider with the largest global sample of smartphone and tablet users. Mobidia's mobile analytics and metrics platform provides unique insights into mobile usage trends on mobile applications and mobile networks. Real usage from real users on both cellular and Wi-Fi networks provides a comprehensive and unique understanding of what people do and value in the mobile world.

Mobidia is headquartered in Vancouver, British Columbia with local presence in the U.S. and Europe. For more information, visit www.mobidia.com or call +1-604-304-8640