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5G in Australia: Evolution not Revolution

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Executive summary

How will 5G impact the nbn?

There has been recent speculation about the impact of 5G on the Australian fixed broadband market, and on the National Broadband Network (nbn) in particular. In Ovum's view, suggestions that 5G will make significant inroads into the fixed user base are highly premature. The death of fixed broadband is much exaggerated, mainly because new and potentially lucrative 5G services still lack a clear business case.

We do expect change. The lower cost of 5G data will make a mobile-only approach more attractive to consumers, all things being equal. However, it is clear that all things will not be equal. 5G will be able to carry more data than 4G, but at a cost to operators and hence to consumers.

Fixed technology is not standing still, either. The capacity and efficiency of fixed broadband networks are growing and will continue to do so after 2020. On the demand side, the appetite for data is growing fast. While 5G is a step-wise improvement in mobile data capacity and efficiency, it will not come free, and it will face a tougher and more competitive data environment than any we have seen. In addition, the sheer volume of fixed data growth means that mobile networks cannot economically challenge fixed broadband networks in any plausible scenario.

Initially, 5G will be used to carry data traffic in high-usage areas such as central business districts (CBDs), shopping malls, transport hubs, and sporting venues, where 4G networks are under strain. This use case will generate no significant new revenues, though it will help to manage 4G congestion. New revenues will not appear until well into the 2020s, when new Internet-of-Things (IoT) use cases emerge and the related business models are developed.

At the same time, fast fixed broadband will be available nationally by the end of 2020. Ovum does not expect anything like a national deployment of 5G until the mid-2020s, by which time the nbn will have increased the performance of its networks with technological upgrades to cable, FTTx, and wireless systems. In particular, the limited deployment pattern of 5G into the next decade will exclude many FTTN customers on the urban fringes who are potential mobile-only consumers, giving the nbn extra time to deploy alternatives.

Also, demand for data is rising (faster than the demand for data speed). For example, average nbn data usage has grown to 199GB per month, three times higher than three years ago. This trend is expected to continue as entertainment viewing continues its shift to the internet, average screen sizes grow, and the number of connected devices in the home increases. Fixed broadband also performs more consistently and is more highly regulated, providing consumers with additional performance guarantees. Fixed broadband technology is in a strong position to meet the demand for data and will remain competitive with mobile substitutes.

This does not mean there will be no fixed-to-mobile substitution at all. Ovum surveys show that 15% of telecommunications consumers currently don't use fixed broadband, but consumer willingness to consider a mobile-only approach remains confined to a subset of the market. Ovum's consumer research shows that by international standards, Australians are not particularly enthusiastic about mobile-only approaches. The impact of 5G on fixed broadband networks in Australia will be somewhat larger than the current impact of 4G, but it is not a game-changer and will not have a significant impact for several years.

It is therefore far too early to write the obituary for fixed broadband. What is more certain is that the rise of 5G requires fixed broadband operators (including the nbn) to respond to the investments being made by mobile operators with their own investments.

National 5G rollout depends on new business models

There are other as-yet-undeveloped use cases for 5G, which may generate additional revenues for mobile operators:

- Ultra-reliable, low latency, and redundant wireless communications designed for critical industrial and medical applications, where high performance is a must.

- Massive machine-type communications (MTC) designed for wide-area mass-market applications such as smart grids and smart city applications, where coverage and large numbers of connections are key.

However, these use cases are still vague. In the absence of business cases for these ultra-reliable and MTC applications, operators will need to rely on enhanced mobile broadband (eMBB) as their sole justification for 5G investment to begin with.

For these reasons, there will be no wide-area deployment of 5G in the initial years. In 2020, the 5G network will have a limited footprint and will look and feel very much like the existing 4G LTE network.

National-scale 5G networks will not emerge until the middle of the next decade. Investment on this scale depends on the development of more solid business cases for these new 5G use cases. As these emerge, coverage expansion will require access to and support for numerous new cell sites, which will also take time and expense to organize. This will take several years, by which time the fixed broadband industry and consumer demand will have both advanced to offer new challenges to fixed-to-mobile substitution.

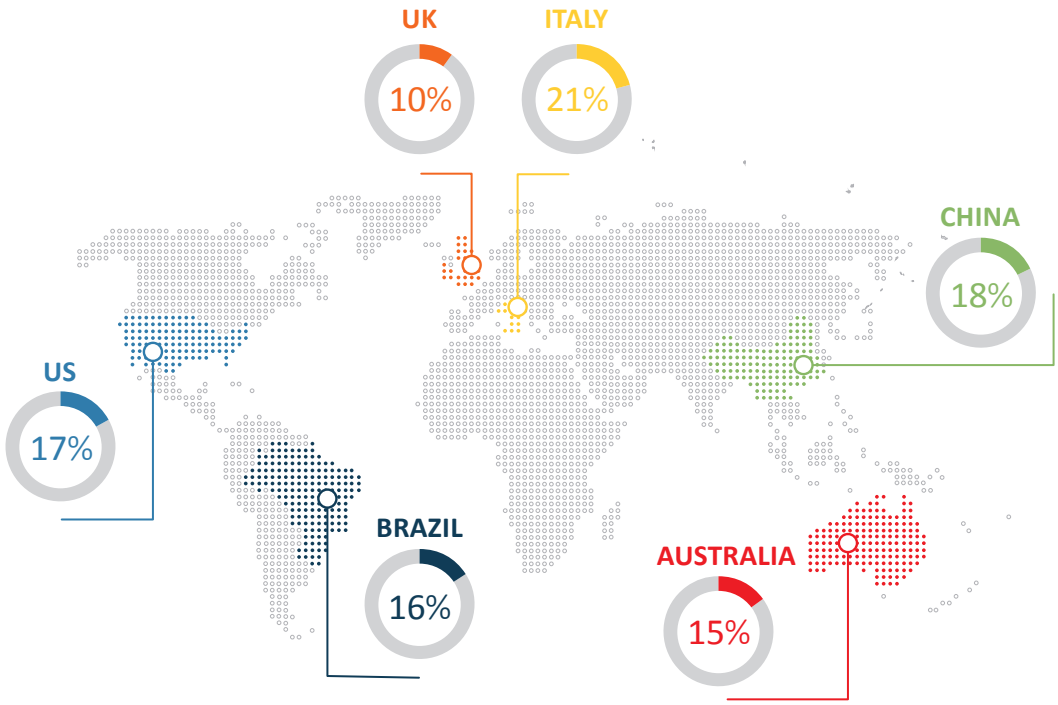
5G rollout timetable and impact

5G rollout drivers

Given the investment in 5G that Australian operators plan to make, is it possible that fixed wireless connections provided through 5G could become an alternative to fixed broadband, and the nbn in particular?

First, it is important to note that this has already happened, to some extent. There are already mobile-only broadband consumers in Australia. In Ovum's 4Q17 global survey of consumers, we found that mobile-only consumers made up 15% of telecommunications users in Australia, which is consistent with nbn corporate planning. This is also consistent with survey data from the Australian Bureau of Statistics (ABS), which shows that fixed broadband household penetration has plateaued in Australia at around 86%. As shown in Figure 1, that ranks Australia as having the second-smallest percentage of mobile-only consumer respondents out of six countries we surveyed.

Figure 1: Mobile-only respondents by country



Source: Ovum's Digital Consumer Insights: Multiplay and the Mobile-Only Consumer survey

The relevant question is whether there is scope for much more fixed-to-mobile substitution beyond the current 15% (by Ovum's estimate). This depends on a balance of forces: the extent to which mobile is becoming more attractive, the extent to which fixed broadband is also improving, and the way in which usage and demand are evolving.

Considering this balance of forces, it is important to recall that 5G faces constraints. The final version of 5G has not yet been standardized, so deployments before 2020 will lack some of 5G's most unique features. There is still no business model for 5G beyond eMBB and fixed wireless. The new, advanced applications of 5G being touted are still vague and have no business model. As a result, 5G deployments will be confined until the 2020s to high-traffic areas such as CBDs, shopping malls, transport hubs, and sporting venues, where 4G networks are under strain.

Ovum does not expect national deployments until the mid-2020s, when the economics of 5G have been improved by the successful launch of these new applications.

Before that, there are still technical issues to be resolved. 5G is ultimately targeting latency of less than 1ms and per-customer speeds of greater than 1Gbps. Through the use of various technologies such mmWave radiocommunications (above 24GHz), massive MIMO, network virtualization, and artificial intelligence, 5G can (theoretically) outperform LTE by an order of magnitude. Ovum estimates that initial 5G services will achieve hundreds of megabits of throughput on a 5G-enabled smartphone. This would be higher for a fixed wireless 5G service, such as that being planned by Verizon, which could achieve 1Gbps to the home, with 28GHz mmWave spectrum.

However, this high-performance version of 5G is not yet standardized. The current version of 5G, so-called "Non-standalone (NSA) 5G," relies on existing 4G core network. It will expand aggregate capacity in high-demand areas and allow users to receive faster services. As an example, 5G's eMBB will mean less buffering for the broadcasting of live-streamed video on a 5G smartphone. This version of 5G can also support faster fixed wireless services, offering a potential threat to existing fixed broadband offers.

However, 5G in this first iteration will not enable lower latency or some "smart" network control technologies. In order to get lower latency, traffic needs to move closer to the edge of the network, and that functionality will not be standardized until 2019 for 2020 deployment, in so-called "Standalone (SA) 5G," which uses a dedicated 5G core network. SA 5G will offer low-latency connections across the board, but the lowest-latency services will come at a higher cost than "best-efforts" services and will be aimed at critical industrial communications, not consumers.

Are there better prospects on the cost side? 5G promises to make significant inroads into mobile data costs. Ericsson, for example, has estimated that the cost of operating a 5G cell site will be one tenth of the cost of an LTE site, providing a cost benefit to operators. However, this cost benefit will be eroded as data traffic grows. And 5G is no panacea: the high frequencies at which 5G operates (3.6GHz, initially, in Australia) mean that 5G cells will be small and will require more base stations and backhaul, pushing up both capital and operating costs.

The total cost of ownership (TCO) is a more comprehensive measure of network cost than the cost of moving data, and recent analysis by McKinsey has shown that the TCO of mobile networks is likely to increase significantly as mobile data traffic grows and big 5G (and also 4G) investments are needed. In modeling for one European market, McKinsey found that the TCO for a mobile network would grow 60% if mobile data growth continued at 25% per annum. If it rose to 35% per annum, then the TCO would be expected to increase 110%. If mobile data growth stayed at the upper end of a historic range, at, say, 50%, then the TCO would increase 300%.

This underlines the fact that the data-carrying capacity of mobile networks is limited and will remain so. Actual traffic levels depend on the willingness of operators to invest in mobile infrastructure and

of customers to pay for it. In particular, operators will need to weigh up the costs and benefits of 5G investment compared to fixed broadband. Mobile technology is improving, but mobile data isn't free, and it never will be.

Initial 5G rollout

Operators in the US, Western Europe, and developed markets in Asia-Pacific are planning to launch NSA 5G in the next two years. Early global front-runners will deploy 5G for different strategic reasons, but most launches will offer full mobility (as opposed to just fixed wireless implementation).

Operators report that initial 5G rollouts will be limited to hotspot areas to begin with, as expected. There is still underutilization of LTE networks located outside these areas (this is the case in Western Europe when 5G launches, for example), reducing the incentive for a wider 5G rollout. As noted above, Ovum does not expect to see national-scale 5G rollout until the mid-2020s.

In Korea, China, and Japan, operators view 5G as a full-mobility service and do not plan to launch fixed wireless in competition with their existing fixed broadband networks. In other cases, including in Australia and the US, operators will launch a combination of full-mobility and fixed wireless 5G.

In the US, Verizon plans to launch both types of 5G by late 2018. Its fixed wireless service will be rolled out in up to five cities. The first launch is planned for a city which is not covered by Verizon's residential fiber network, as Verizon's business case for fixed wireless 5G is to generate new revenues from fixed customers.

Australia will be an early adopter of NSA 5G. Australia's largest two mobile operators – Telstra and Optus – will debut 5G services in 2019 (see Table 1), with Vodafone expected to follow shortly thereafter.

Table 1: Australian commercial 5G launch timetable and strategies

Operator	5G launch	Type	Ovum comments
TELSTRA	2019	Full-mobility and fixed wireless	Launch full-mobility 5G in major cities and some regional centers in 2019. Also launch fixed wireless 5G in the same year to potential target of 1 million homes and businesses.
OPTUS	1Q19	Fixed wireless in key metro areas.	Followed by full-mobility 5G.

Source: Ovum

Optus intends to launch 5G in January 2019, starting with a fixed wireless service. The service will be an extension of its existing 4G fixed wireless service (which uses TDD spectrum at 2.3GHz), which is available in all capital cities. Similar to the LTE service when it first launched, the 5G fixed wireless service (which will utilize 100MHz of 3.6GHz spectrum that Optus owns) will not be a mass-market offering. Rather, it will initially attack the nbn at the edges, targeting nomadic users, such as those with vacation homes or students that need to take a modem with them as part of their lifestyle choice. Typically, this user base does not require high data allowances and is price-sensitive.

Fixed wireless 5G is not a national mass-market service – it would cost too much, given the amount of fiber required (e.g. fiber to the tower, and fiber to a neighborhood of nearby small cells). This kind of dense network architecture is more typical in metropolitan areas, and it can be leveraged to make the fixed wireless service business case add up in those places.

For its part, Telstra is expected to start with full-mobility 5G at 3.6GHz (125MHz of 3.6GHz spectrum will be auctioned in October 2018) in hotspot areas. The rollout can leverage existing towers. Generally, the 3.6GHz 5G business case does not require small cells from the start, but these can be added to drive capacity at a later stage.

Achieving complete wide-area coverage for 5G will require many new sites, so operators will incrementally grow their 5G networks over time. Capex will shift from earlier network generations to 5G-only over time, so it will increase somewhat. Base stations for 5G will initially cost more (10–20% more, or US$25–30,000 per site) than LTE base stations, but that will improve. Furthermore, in metropolitan areas, 5G opex will be a lot lower because of higher fiber availability for backhaul.

Ultimately, operators must generate a commercial return on their 5G investment. Voice and text were commoditized when operators introduced big buckets of minutes and texts in response to over-the-top (OTT) competition. To avoid the same thing happening to data, data must be monetized through multiple price plans to suit different segments.

Post-2020 rollout

As noted above, initial 5G deployments in Australia starting in 2019 will focus on offering eMBB services in high-traffic areas. This 5G overlay will generate no significant new revenue (although data packages will increase, and operators will sell 5G handsets), restricting the appeal of wide-area deployment of 5G in the initial years.

In 2020, the resultant hybrid 4G/5G mobile network will still be based on NSA 5G. It will look and feel very much like the existing LTE network, but it will be able to deliver more data in areas that would otherwise be congested.

Taking 5G beyond this limited overlay network to a national-scale network requires solving some significant technical and commercial problems. The Standalone mode is scheduled for finalization in September 2018 and will include the 5G core network architecture. As noted, commercial deployments of SA 5G will not happen until 2020. After that, the larger challenge of finding a business case for investment in national-scale 5G must be addressed. In the absence of new revenue from eMBB, the costs of 5G rollout outside high-traffic areas can only be justified by new kinds of revenue. Telecommunications equipment vendors argue that these new revenues can be raised by new kinds of services.

Some of these possibilities are documented below. However, as yet, none of these proposed new services has a business model. In fact, it is still unclear how these services will operate and raise revenue.

Fixed broadband capacity will grow

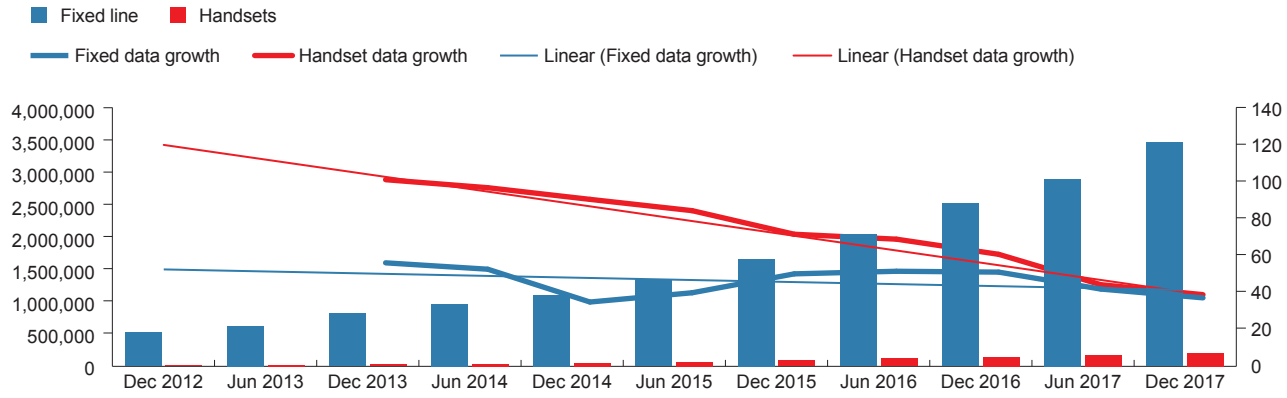
Fixed broadband offers much better value for money for high-bandwidth, high-usage applications such as video. Importantly, the price of fixed broadband increases much more slowly with usage than the price of mobile broadband. For operators with only unlimited plans, increased usage literally costs the customer nothing. In contrast, the relationship between mobile prices and data allowances is more linear, and prices rise much more steeply with usage.

As a consequence, fixed broadband is currently winning the battle to carry data. Figure 2 shows ABS statistics for fixed broadband data usage (xDSL, cable, and FTTx) compared to handset data usage (constituting the bulk of mobile broadband customers). Clearly, fixed broadband carries much more data than mobile networks are delivering to handsets: over 17 times more in the quarter ending December 2017.

Just as importantly, the growth rate for fixed broadband usage is fairly steady, at over 40% per annum. Handset data usage, in contrast, started out growing faster, but its growth rate converged with the fixed data growth rate in 2017. Mobile handset data usage is no longer growing faster than fixed data usage, which means that fixed broadband will continue to dominate data usage going forward.

Could 5G change all of this? 5G will make mobile data usage more affordable. In combination with 5G's higher data speed, it is possible to envisage a 5G fixed wireless service providing high-definition (HD) video services, for example.

Figure 2: Data usage (TB) and annual data growth rates (%) by access type, 2012–2017



Source: ABS

If nothing else were to change, then that shift would tip the balance toward mobile broadband and away from fixed broadband. However, there are other factors at play. Differing price structures give fixed an advantage over mobile as data traffic grows. And those differing price structures reflect underlying cost structures that make it cheaper to haul large amounts of data on fixed broadband networks.

To put this in perspective, the additional data that fixed broadband networks carried in 2017 compared to 2016 was two and a half times greater than all of the handset data carried on mobile networks in the same year. To put it another way, in 2017, fixed operators added to their networks two and a half times more data than that generated by all of the handsets in the country. To make significant inroads into the fixed broadband markets, mobile networks would need to start growing their traffic capacity at these rates. Plainly, this is not economically feasible.

In addition, fixed broadband technology is not standing still any more than mobile technology is. Initially, fast fixed broadband will be available nationally when the nbn rollout ends in 2020, when 5G will still be confined to a small footprint. Innovation in FTTx technologies such as G.fast and in DOCSIS cable broadband standards is improving the speed and traffic capabilities of fixed broadband all the time. By the mid-2020s, Ovum expects that the nbn will have increased the performance of its networks with technological upgrades to cable, FTTx, and wireless systems in response to competition from mobile 5G and, in some places, fixed alternatives. In addition, fixed broadband will benefit from many of the same core and backhaul technologies that drive 5G performance. Software-defined networks, network virtualization, and artificially intelligent networks with faster and more efficient routing will also contribute to improved fixed broadband performance.

In summary, the pressure from 5G on fixed broadband will be geographically limited until 5G networks achieve significant coverage toward the mid-2020s. In particular, the limited deployment pattern of 5G into the next decade will exclude many FTTN customers on the urban fringes who are potential mobile-only consumers, giving the nbn extra time to deploy alternatives.

For these reasons, it is not possible to conclude that 5G is a significant new threat to fixed broadband, beyond the threat that mobile broadband already poses. What is more certain is that the rise of 5G will force fixed broadband operators to respond with their own investments in faster and higher-capacity networks. In addition, the advantages of fixed broadband over mobile for moving large amounts of data will grow as data usage grows in the future.

The evolution of data demand

The Australian mobile-only consumer and their evolution

In 2017, Ovum surveyed over 1,000 random Australian consumers aged 16 and over. Similar numbers were surveyed in Brazil, China, Italy, the UK, and the US.

We found that the telecommunications service that consumers most often reported access to was fixed broadband (83%). This is broadly consistent with ABS's findings for household penetration of broadband.

We found that Australia had a mobile-only segment (those who buy no fixed broadband service of any kind) of 15% of respondents, compared to an average of 16% across the six countries. Australia had the second-lowest rate of mobile-only consumers, above only the UK, with 10%. The highest was Italy, with 21%. Australia is therefore average as a mobile-only market, not an early or leading adopter.

Nearly 60% of these mobile-only consumers were once fixed broadband users. They tend to be younger and not own their own home, though a higher-than-average number of them are over 70. The proportion of mobile-only consumers varies little between urban and rural areas.

48% of mobile-only consumers claim to be motivated by value-for-money considerations: mobile data is enough for them, is cheaper, or requires less co-investment, for example in routers.

Importantly, 23% of these mobile-only consumers said they were exploiting someone else's fixed connection, possibly at work, at public venues such as cafes, or at family residences. This rose to 39% among under-24s. Though these consumers are not paying for fixed broadband, they are using it and behave similarly to more typical consumers who use both fixed and mobile broadband. If these consumers were excluded from the definition of "mobile-only," then the proportion of mobile-only consumers would be significantly lower than 15%.

But when considering the impact of 5G, it is more important to look at how current fixed broadband consumers might behave. If 60% of current mobile-only consumers report that they once used fixed broadband, then more might follow.

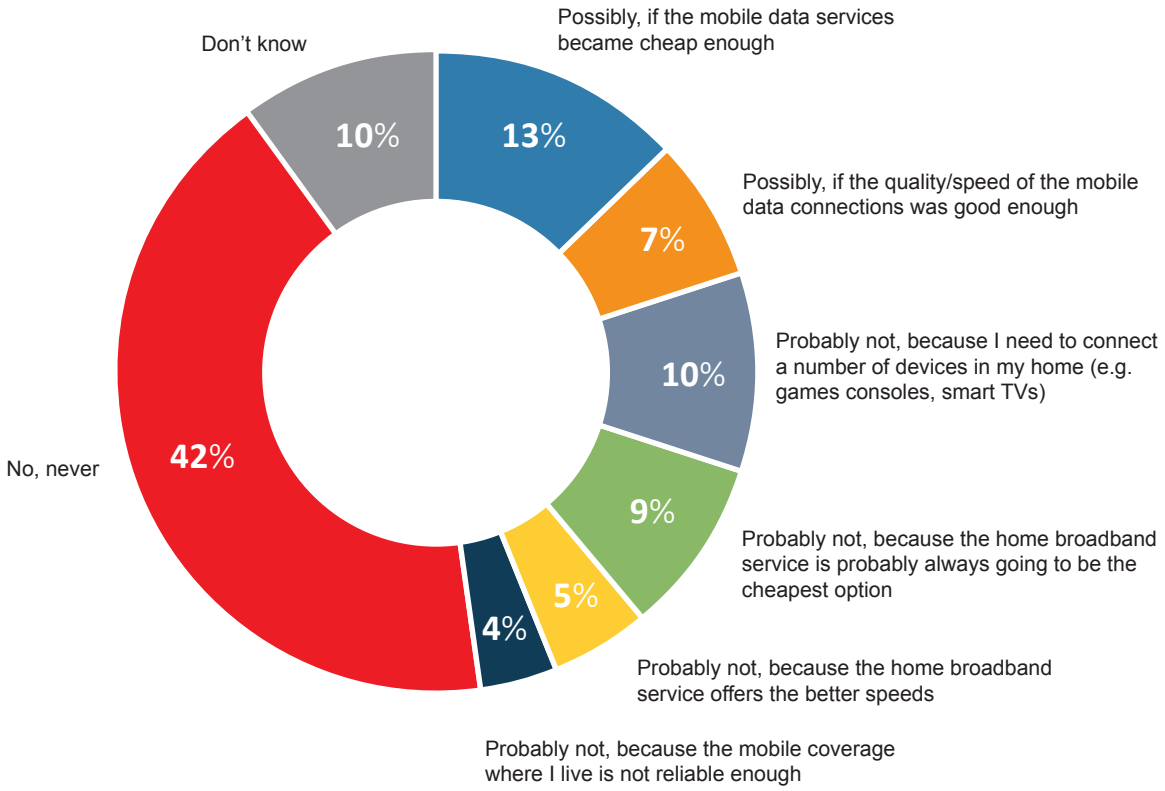
We asked the 83% of respondents who were fixed broadband users whether they would move to a mobile-only option.

- 42% of Australian fixed broadband consumers would never consider moving to mobile-only, compared to 30% globally.
- 28% would "probably not," compared to 33% globally.
- 20% "possibly" would, compared to 29% globally.

The first observation is that Australian fixed broadband users are markedly less willing to say they "possibly" would shift to mobile-only than the average of the countries we surveyed. They were also much more likely than those in other countries to rule it out. Fixed broadband is popular in Australia and fewer want to abandon it. Australia is not an early or leading adopter of the mobile-only option, and it probably will not be.

The second observation is that if 20% of fixed broadband users "possibly" would shift, a smaller proportion *actually* would. If half of those who "possibly" would shift actually did, that is 10% of total fixed broadband users, or 8% of total respondents, so it would only push mobile-only up from 15% to 23%. If a more realistic proportion, say three in 10, of those who "possibly" would shift actually did, that is 6% of total fixed broadband users, or about 5% of total respondents, so it would only push mobile-only up from 15% to 20%. By the same token, if some of those who would "probably not" shift to mobile-only actually did, then the mobile-only figure might be higher, though the lower likelihood of "probably nots" (as opposed to "possibly") actually shifting means this effect would be small.

Figure 3: Would you ever drop fixed broadband for internet access on your mobile devices only?



Source: Ovum's Digital Consumer Insights: Multiplay and the Mobile-Only Consumer survey

These estimates also need to be interpreted in the context of the current telecommunications industry and its evolution. It is important to remember that fixed broadband users who "possibly" would take the mobile-only option could do so right now, but they have not. It is reasonable to assume that something significant would have to change in the balance of fixed and mobile broadband to precipitate a significant shift. On the current 5G rollout timetable, nothing of the kind is likely to happen for several years, so estimates of 20% or 23% mobile-only consumers lie years in the future, and assume that fixed broadband will not also increase its appeal (which, of course, it will).

Based on our own research and this analysis, Ovum does not agree with suggestions that many consumers will shift to a 5G mobile-only option. Some may do, but a "5G effect" will not be significant for years and will only occur if fixed broadband providers fail to respond.

Trends in data demand

The main driver of demand for household broadband services is video. Video is the main driver of traffic over both fixed and mobile networks, and demand for 4K video will lead video traffic growth over the next five years. A single 4K movie might be around 30GB total, making fixed broadband the technology of choice for video in the future. Ovum forecasts that around 25% of TV households globally will have 4K TVs by 2020. There will be an increase not just in 4K TVs, but also in the average number of 4K screens in the home.

Table 2 summarizes the justifications for fixed broadband even with 5G, including the growth in the number of connected devices per household, which could reach 50 by 2020 in developed countries.

In light of the dominance of video traffic, recent data from Netflix shows that 70% of global subscribers prefer watching the service via a full-sized TV after six months of subscribing, in part to take full advantage of HD video. Only 25% of subscribers sign up via their TV, while 30% sign up via their smartphone, 40% their PC, and 5% their tablet, but the lure of a full-screen TV is powerful: six months after subscribing, only

10% of Netflix viewing is via a smartphone, which is generally not considered desirable for longer viewing sessions (e.g. full HD feature films). This is completely to be expected, as modern entertainment video is an immersive experience best enjoyed on a larger screen.

Table 2: Drivers of the fixed broadband business case for households

Reason	Ovum comments
4K TVs to lead video growth	On a global basis, the average screen size by 2020 will be 48 inches. There will be an increase not just in 4K TVs, but also in the average number of 4K screens in the home. Moreover, 8K TVs are expected to be in shops in Australia by 2019 (but there will be very limited content available at that time).
Big-screen viewing is preferred by users	Netflix claims that 70% of its viewing is done via connected TVs. While users prefer to sign up to Netflix via their PC or smartphone, viewing on the TV is preferred.
Growth in the number of connected devices per household	Common thinking is that this will be about 50 by 2020 in developed countries.

Source: Ovum

All of these arguments point to the need to have a high-speed fixed connection to the home, with an advanced home network inside. It is important to have a good broadband connection in all rooms of the home, as shown by a recent Ovum survey, in which fixed broadband consumers ranked having a "100% reliable broadband service" as the most important differentiating factor, and having "good Wi-Fi signals in every room" in third place.

Customers blame the service provider for quality-of-experience (QoE) issues with applications that run over broadband (such as streaming video), and will churn as a result. Speed is only one factor influencing QoE, but the overall QoE proposition – which includes elements such as latency, picture quality, quality of the content delivery network (CDN), and Wi-Fi interference – is where operators should focus their attention. But even when the customer has bought their own Wi-Fi router, they still consider the operator to have end-to-end responsibility for quality of the broadband service. Operators are therefore investing in advanced Wi-Fi hardware and software to improve the QoE and quality of service (QoS) around home Wi-Fi.

Consumers no longer access the internet on a single device connected to a router, but on a number of devices, many of which are mobile, such as a tablet PC. Home automation will add significantly to the number of devices. It is essential that operators enable a decent broadband connection not just to the home, but to every room of the house. This is one of the key arguments for a fixed connection in the home. Currently, on average, there are about 10–15 connected devices in the home, and this number will increase to about 50 in a few years. Not all of these devices need a high-bandwidth connection, but many do, and can be added to a fixed service without concern because fixed data allowances are so large. In contrast, mobile allowances will always be smaller.

Will 5G disrupt fixed broadband networks?

At the beginning of this report, we noted that the impact of 5G on fixed broadband depends on a balance of forces: the extent to which mobile is becoming more attractive, the extent to which fixed broadband is also improving, and the way in which usage and demand are evolving.

In summary, we conclude that:

- 5G will make the use of mobile broadband more attractive. 5G will deliver data more efficiently, and this will be reflected in bigger data packages. Based on the 4G experience, we think that these will not cost more than existing packages. However, we do not expect these networks to be widely available outside high-traffic areas until well into the 2020s. As a result, the benefits will be muted until national-scale 5G networks are rolled out at that time.
- Fixed broadband is not standing still. Big economies of scale are being captured by fiber-based backhaul. The nbn has already committed to rolling out FTTC to 1.5 million customers. We expect further commitments in the future, particularly after 2020, when the nbn is complete. These factors will put the nbn in a strong position to meet growing data demand.

- Data demand and the appetite for networked video is growing and will continue to grow, making the lower per-GB pricing of fixed data more and more attractive relative to mobile data.
- While a proportion of the market appears prepared to consider a mobile-only option, there is a big difference between considering and doing. In practice, the limitations of mobile compared to fixed will make it difficult for mobile operators to market the mobile-only option significantly beyond the low-usage segment it currently addresses.

To all of this must be added the sheer volume of fixed data growth – growth that mobile cannot replicate economically in any plausible scenario.

This does not mean that 5G will have no impact at all. But in the short term, Ovum believes that the footprint of 5G will be too limited to make a significant difference to the national market. In the longer term, the number of mobile-only consumers can grow, but only incrementally, if the economics of mobile operation are to be preserved. We therefore expect that mobile-only operation will remain focused on the low-usage segments, where it is already popular.

Appendix: Long-term 5G development

Key 5G use cases

Several different use cases are emerging as operators test 5G technology and better understand its capabilities:

- eMBB delivers a more efficient and higher-performance version of the existing mobile data connection. This includes the possibility of fixed wireless access in competition with traditional fixed broadband.
- Ultra-reliable, low latency, and redundant wireless communications designed for critical industrial and medical applications, where high performance is a must.
- MTC designed for wide area mass-market applications such as smart grids and smart cities, where coverage and large numbers of connections are key.

These three principal use cases are summarized in Figure 4.

Figure 4: Potential 5G use cases

Enhanced mobile broadband (eMBB, including fixed wireless access)	Ultrareliable, low-latency communications	Massive machine-type communication (MTC, IoT)

• Offers wider bandwidths than LTE
• Uses spectrum above and below 6GHz
• Uses licensed and unlicensed spectrum
• Incorporates technologies such as massive MIMO
• Examples:
  • 3D video/UHD video
  • Rich media and entertainment
  • Augmented reality
	• Supports ultra-low latency transmission (<1ms)
	• Supports highly resilient communications with redundancy
	• Offers reliable device-to-device communication
	• Examples:
	  • Industrial automation
	  • Autonomous vehicles
	  • Telemedicine
		• Evolves out of narrow-band LTE (eMTC/NB-IoT)
		• Has low complexity, and requires low energy
		• Follows the ultra-dense, small cell network model
		• Eventually adds new waveforms and architectures (e.g. multihop mesh)
		• Examples:
		  • Smart grid
		  • Smart cities
		  • Health monitoring

Source: Ericsson

The 5G network can also employ techniques such as "network slicing" to reserve high-performance radio and backhaul capacity for critical applications while allowing noncritical applications to operate alongside. All three of these use cases come in two flavors: full mobility (usually using some mobile device) and fixed/nomadic (which usually requires a router).

These use cases will not be rolled out simultaneously. This is partly because it will take time to develop the end-user technology needed to exploit them: for eMBB, new 5G-enabled routers and smartphone handsets are needed; and both ultra-reliable and MTC applications require specialized terminal equipment, which will appear later. The staggered rollout of different use cases will also be due to the staggered rollout of different parts of the 5G standard.

5G will ultimately include massive IoT and slicing after 2020

Massive IoT and network slicing have the potential to open up new enterprise monetization opportunities for telecoms operators, but they are also complex in terms of business models (which are not yet clearly defined). For example, network slicing can be done according to different service-level agreements (SLAs). At the extreme, a smart factory using networked robotics would rely on the most demanding SLA with the operator. The theory is that the enterprise would be willing to pay a premium for this SLA in order to enhance efficiencies and productivity. Ovum believes operators will slice 5G network into, at most, a handful of use cases.

We are also heading toward a world of massive IoT connections. 3GPP defines "massive" as at least 1 million connections per km2. This world of massive connections will be enabled through different types of cellular connectivity technologies, not by any one single technology, because no single technology will fit the specific needs of an IoT solution or device. Out of these cellular IoT connectivity technologies, LTE-M and NB-IoT are designed specifically for connecting things in low-complexity IoT use cases – those requiring low power, low data rates, and infrequent data transmission (e.g. smoke detectors, street lights, and gas/water/electricity meters). Initially, 5G will concentrate on addressing high-performance IoT uses cases – those with low latency, high data rates, frequent data transmission, and extremely reliable connections. The latter is often also linked to mission-critical use cases, including autonomous cars, remote robotic surgery, and streaming of ultra-HD (UHD) videos for public surveillance.

As these new use cases for 5G emerge, different kinds of network deployment are envisaged. For example, small enterprise-specific base stations (possibly even enterprise-owned) to support machine-to-machine communications within a factory area could be deployed.

ABOUT OVUM

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