NZIER
NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

Mobile industry in New Zealand

Performance and prospects

NZIER report to Spark New Zealand

October 2014

About NZIER

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Each year NZIER devotes resources to undertake and make freely available economic research and thinking aimed at promoting a better understanding of New Zealand's important economic challenges.

NZIER was established in 1958.

Authorship

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Key points

Challenging times ahead for the NZ mobile industry

All over the world mobile providers are facing a major challenge in terms of accommodating exponentially growing data demand and managing transitions to new network technologies.

There is a general expectation among consumers and other stakeholders that the mobile industry will deliver data services similar to fixed-line data providers and similar to overseas mobile providers, despite very different economics.

Based on prices and services delivered, the performance of the mobile industry in New Zealand is similar to elsewhere in developed world (OECD)[1] if not better. This is surprising because New Zealand is not similar to the rest of the OECD. New Zealand is small, isolated and sparsely populated and New Zealanders are less wealthy than most of their peers in the OECD.

This suggests to us that current patterns of performance may not be sustainable into the future. Given the importance of the mobile industry to New Zealand's future economic performance, this conclusion raises a number of challenges for the mobile industry and for policy-makers.

NZ is a challenging environment for mobile providers

Size matters a great deal for mobile services. Like most networked services, the average cost of infrastructure falls with every additional customer. So, in general, the more customers there are sharing infrastructure costs the better.

We explored this issue of economies of scale in network costs and found that:

- Network costs in the most sparsely populated parts of the country, by electorate, are on average around 50% higher than the average.
- Network investment in New Zealand includes a sizable cost premium to OECD peers such as the UK – on a per connection basis – for high levels of coverage. Rolling out new generation technology to 97% of the population costs 17% more on average per person in New Zealand than it does in the UK. Coverage of roughly 97% has been targeted by UK regulators.

Yet the industry has performed well compared to OECD peers

The mobile industry has seen major changes in recent years as demand shifts from voice and message services to demand for data.

Yet despite these changes, and despite the network investment disadvantage New Zealand faces, the NZ mobile industry has punched above its weight compared to peers in countries like the UK, Denmark, and Norway.

The performance of the mobile industry in New Zealand is similar to elsewhere in OECD if not better e.g.:

[1] Members of the Organisation for Economic Co-operation and Development (OECD) include developed and developing economies (e.g. Chile and Turkey) but the acronym is conventionally used to describe developed economies.

- 97% of populated areas in New Zealand have access to 3G services, and a similar proportion will have access to 4G services when 4G deployments are completed (50% of populated areas already have access to 4G services)
- prices for mobile services are generally below international averages
- penetration of mobile broadband is higher in New Zealand than the OECD average and higher than in the United Kingdom.

Mobile cannot be expected to offer services comparable to fixed line networks

Data services on mobile networks are at least 8 times more expensive than data on fixed line broadband services. This is a low-end estimate. Actual cost differentials could be several times larger than this. Mobile network owners also have to manage multiple network technologies while anticipating and investing in new sources of demand and balancing demand for capacity with demand for coverage.

Current patterns of performance may not be sustainable

Network operators will have to ask hard questions about where and how much to invest. Prices may need to be set to reflect local capacity and congestion. Investment will need to be prioritised as between coverage and capacity.

Policy-makers will also need to adapt their thinking to reflect the increasing importance of mobile networks to the economy.

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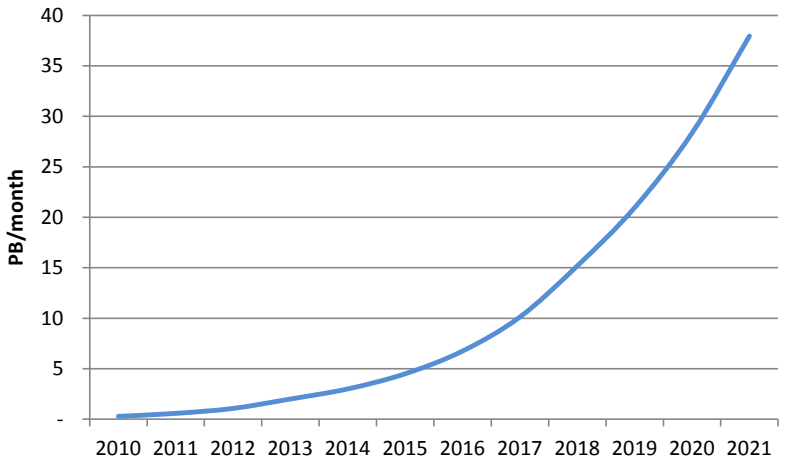
1. Mobile data demand - challenging times ahead for the mobile industry

1.1. Rapid rise in data demand

The mobile industry has seen major changes in recent years as demand shifts from voice and message services to demand for data. In the past four years mobile data use grew by more than 600%.[2] That was from a low starting position but the rapid growth is expected to continue. Data demand in New Zealand is expected to grow by 50% per year over the next 4 years – according to global network company *Cisco*.[3]

Figure 1 Mobile data demand in NZ

Petabytes per month



Source: NZIER

1.2. Fuelled by data-driven living

Demand for data is being fuelled by:

- cheaper and faster smartphones and tablets
- rapid increases in data speeds from fibre and 4G.
- integration of the internet into virtually every aspect of life.

Growing demand for mobile data is in some respects a simple matter of time. By 2013 at least of half of all New Zealanders were born into or grew up using the internet and mobile phones. Now that technology brings these things together it is no wonder that data demand is on the rise.

2 Commerce Commission (2013) monthly data use per connection.

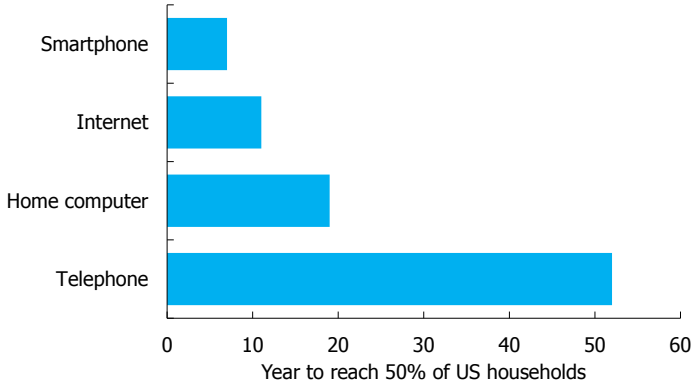
3 New Zealand is no exception. Developed world data demand forecasts are typically measured in terms of multiples of 10-fold increases. One recent study in UK used a 23-fold increase in data as its low-end estimate of demand growth – the high end was a 296-fold increase.

The ubiquity of smart phones and the speed of change in technology has been remarkable. More than half of mobile devices in New Zealand are now smart phones. According to a Google survey:

> *"smartphones have become so important to consumers that 30% would rather give up tv than their smart phone"*
>
> *Our Mobile Planet, 2013*

Figure 2 Technology adoption rates speeding up

Example of adoption rates in the US



Source: Asymco

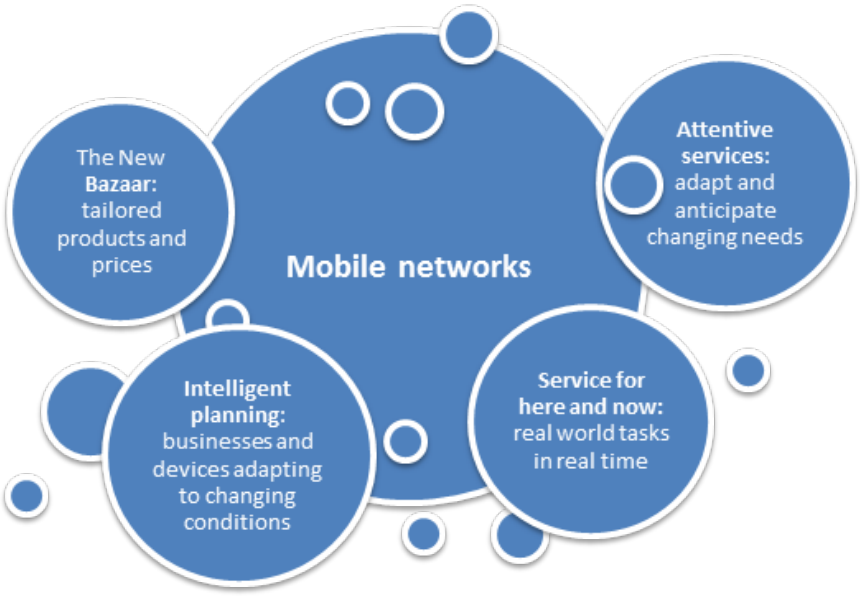
1.3. And data-driven innovation

Data-driven innovation is an increasingly important aspect of data demand and is likely to be more so in future.

There is considerable scope for productivity gains and new products and services from data driven innovation. For some sectors this will mean more efficient use of existing infrastructure and functions; such as in transport and infrastructure monitoring and investment (see Figure 3 for a classification of the different aspects of data driven innovation expected to be of importance in coming years).

The agricultural sector already benefits from access to information on e.g. weather and pasture conditions via mobile platforms.

Figure 3 Mobile at the heart of data-driven innovation



Source: Adapted from Analysys Mason, 2014[4]

1.4. Economics of mobile make it difficult to meet expectations

1.4.1. Speed of technology change is a factor

The speed of change in communications infrastructure technologies has been increasing – from 1G to 2G to 3G mobile devices and now into 4G (LTE)[5]. Rising demand for data will combine with ongoing technological change to drive ongoing investment in mobile infrastructure. Managing this transition is a challenge.

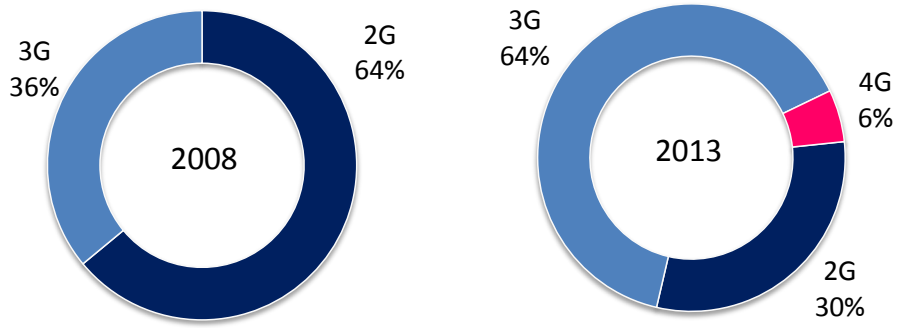
Better network technologies and data-hungry devices inevitably open the door to higher demand. They don't necessarily result in an increased willingness or ability to pay for new network capacity.

4 http://www.analysysmason.com/About-Us/News/Newsletter/Data-driven-innovation-Singapore-Apr2014/

5 In this report we refer to 4G and LTE (Long term evolution) interchangeably. We do this to ensure the report is readable to a reasonably general audience.

Figure 4 Rapid shifts from 2G to 4G technology in NZ

Market shares by technology (shares of number of connections)



Source: GSMA

1.4.2. Ultra-fast broadband creates expectations of cheaper, unlimited mobile data

Alongside changes to mobile technology, fixed line ultra-fast broadband is being rolled out rapidly throughout New Zealand. This investment in ultra-fast broadband will be more robust to future technological change than mobile infrastructure investments and comes at a much lower cost – per unit of data – than mobile.

Mobile infrastructure performance and pricing in New Zealand is often criticised for not providing cheaper access to unlimited data, as now happens on fixed networks.

These challenges are not unique to New Zealand. They are common to mobile markets around the world. In the UK in the 2000s, for example, competition for customers caused retailers to offer unlimited data bundles at lower and lower prices. This proved unsustainable. In the past few years, providers have had to begin capping these so-called 'unlimited' data plans as data demand has grown and capacity has not been able to keep up.

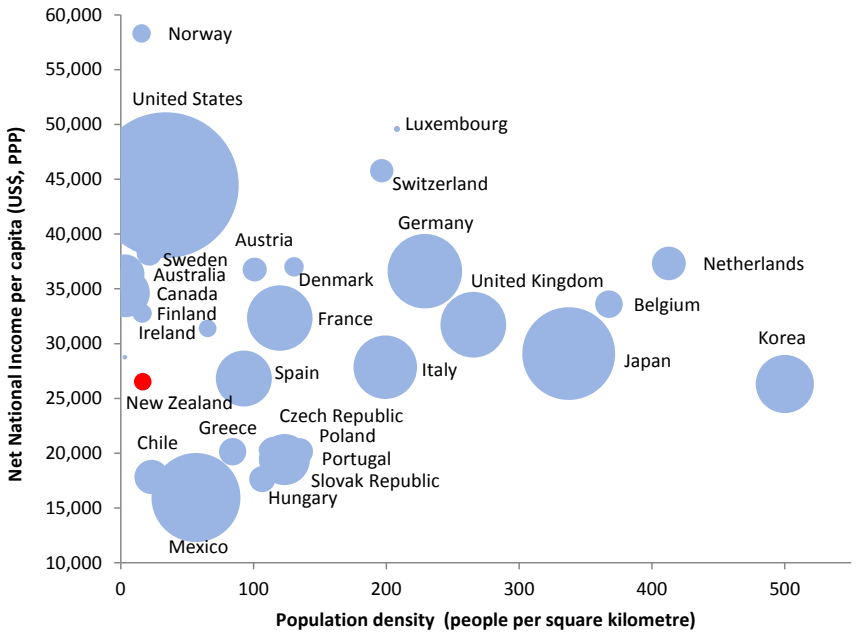
That said, New Zealand's mobile industry faces additional challenges that many others we like to compare ourselves against, do not.

2. Mobile in NZ faces a higher cost to serve

Based on prices and services delivered, the performance of the mobile industry in New Zealand is similar to elsewhere in developed world (OECD)[6] if not better (see below). This is surprising because New Zealand is not similar to the rest of the OECD. New Zealand is small, isolated and sparsely populated and New Zealanders are less wealthy than most of their peers in the OECD (see Figure 5).[7]

Figure 5 New Zealand's position within the OECD

Bubble size is population size



Source: NZIER

- Size matters a great deal for mobile services. Like most networked services, the average cost of infrastructure falls with every additional customer. So, in general, the more customers there are sharing infrastructure costs the better.
- Geography, customer density, and sparseness of the population also affect the economics of mobile by increasing the amount of network infrastructure required to ensure wide levels of coverage.
- Income matters because wealthy users and businesses are more likely to be willing and able to bear the costs of wide and networks and high levels of capacity, compared with less-wealthy users.

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6 Members of the Organisation for Economic Co-operation and Development (OECD) include developed and developing economies (e.g. Chile and Turkey) but the acronym is conventionally used to describe developed economies.

7 Similar to many other OECD countries, New Zealand has highly concentrated urban populations which make up the bulk of the population. Where New Zealand's population distribution is most distinctive is in its long tail of very sparsely populated areas.

- A smaller and less wealthy population does not affect prices paid for network equipment. Networks are capital intensive and network equipment is traded internationally.

Thus, all these factors suggest we should expect the mobile industry in New to perform less well, on average, than its peers in the OECD. New Zealand is likely to be more costly to serve so we would expect service quality to be lower, or prices to be higher, than what we observe elsewhere in the OECD.

Figure 6 Widespread network coverage

Spark New Zealand's network, heat map based on count of cell sites within suburbs

Source: NZIER, Spark New Zealand

2.1. Low population density increasing cost to serve

Market size – number of consumers and consumer disposable spending – is clearly a factor in determining the revenue that can be earned in a market and hence investment and innovation in infrastructure related services. What is less clear is the extent to which a lack of scale affects network costs per unit of service. Intuitively, we would be expect network services to be subject to economies of scale, whereby average costs decline as customer numbers increase.

We explored this issue of economies of scale in network costs and found that network investment in New Zealand includes a sizable cost premium – on a per connection basis – for high levels of coverage.

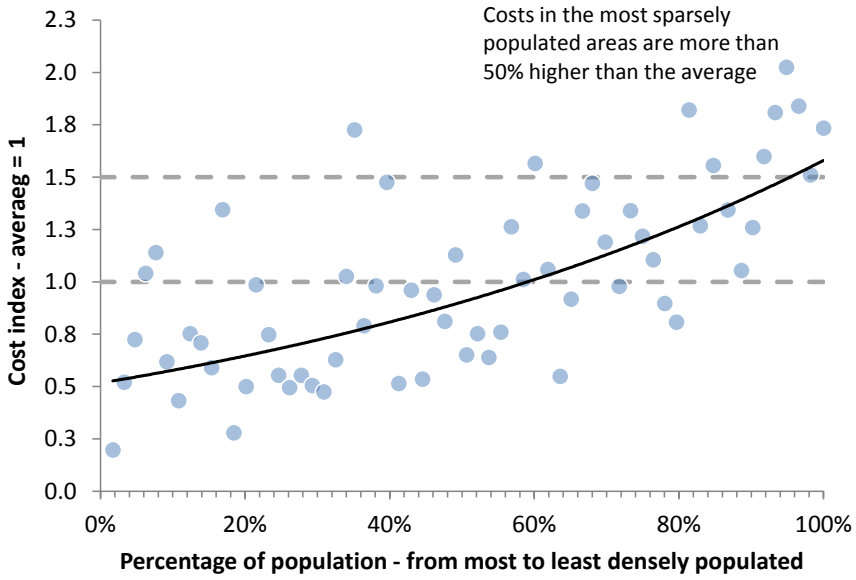
To explore this cost issue we used results from a model of network investment and costs. The model takes demand and technology forecasts for the next decade and calculates investment costs for a mixture of 3G and LTE sites and equipment.

The model results we used were capex and opex profiles for site level spending over the next ten years. These cost profiles are then aggregated to the electorate level and converted into per capita equivalents according to electorate populations.[8]

The main results of the analysis are shown in Figure 7 with costs shown as an index which rises as coverage extends to cover less densely populated parts of New Zealand. Network costs in the most sparsely populated parts of the country are on average around 50% higher than the average. We define 'most sparsely populated' as electorates in the lowest quintile (20th percentile) for population density. Our unit of account is electorates as these are roughly normalised for population size.

Figure 7 Network costs given coverage and population density

Observations by electorate in NZ. Costs are an index of costs per capita.



Source: NZIER

There is of course considerable variation around the cost trend which we observe – reflecting a range of considerations including variation in density within electorates. A case in point is the Auckland Central electorate which is the only data point to be adjusted in the data. We excluded the islands of the Hauraki gulf from the analysis of the electorate. The costs per capita of sites on Great Barrier and Waiheke islands are 12 times larger than costs in mainland Auckland Central and caused Auckland Central to be a significant outlier. The need to adjust the data goes to support the overall results shown in Figure 7 regarding non-linear network costs relative to population density.

[8] Population numbers were the maximum of day or night-time populations – to take account of service required to cover e.g. the Auckland Central electorate's day time population. Analysis was also conducted at the suburb level and the key results were broadly similar to electorate level results. Electorate results are presented here because these were used for subsequent comparison with the UK and because suburb level analysis is subject to boundary issues in terms of people in one suburb being served by sites in a nearby suburb – in other words assigning expenditure to a customer base requires stronger assumptions.

Our simple analysis was also tested with a more complex model of costs accounting for income, land area, population density, and forecast LTE traffic. This analysis was used to explore whether the results of our cost analysis changes once we account for ability to pay and expected demand. It may, for example, be that costs are explained by an expectation that some less densely populated areas will have higher demand than other areas and thus weaken the explanatory power of density found in the simpler descriptive analysis.

The more complex model confirmed the findings in Figure 7 and provided further evidence for the (non-linear) shape of costs as a function of population density. Results are summarised in Appendix B.[9]

2.2. Case study of coverage costs versus UK

To put these network investment costs into some context we compared these costs, given population density, with population densities in the UK.

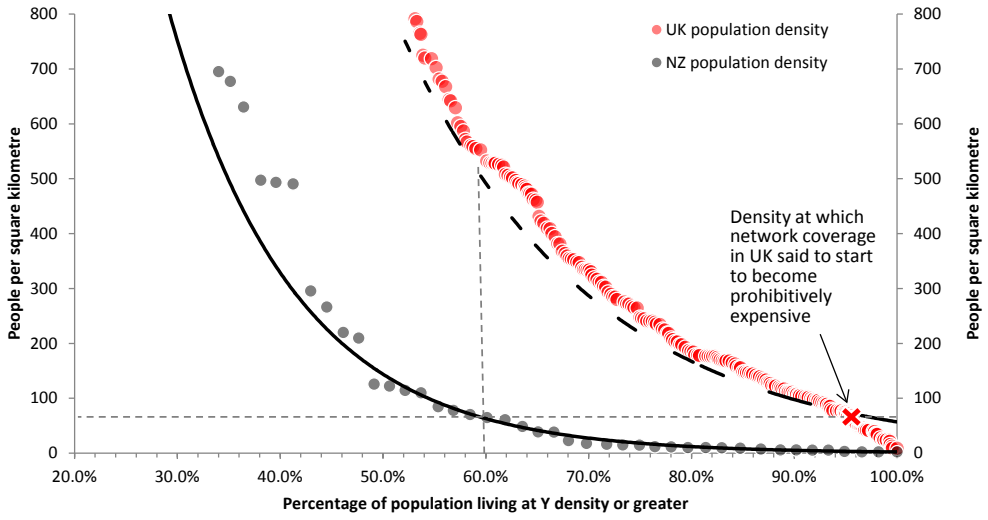
We chose the UK as a comparator because:

- it is roughly the same size in land area as New Zealand (NZ is ~10% larger)
- NZ mobile market prices and offerings are often compared to the UK in New Zealand media
- detailed census population data is accessible.

The relative population densities of the two countries are summarised in Figure 8.

Figure 8 Relative population densities, NZ vs UK

Census populations: UK 2011; NZ 2013.[10]



Source: NZIER

[9] We chose not to present this here as the results are less transparent.

[10] UK unitary authorities and metropolitan districts. NZ electorates. The x-axis has been truncated to focus on less dense areas.

The Figure shows, for example, that around 60% of the UK population is in areas which contain 500 or more people per square-kilometre. In New Zealand only 38% of the population lives at densities larger than 500 people per square-km.

Figure 8 also shows that share of the New Zealand population that would receive LTE coverage if New Zealand aspired to the levels of coverage targeted and debated in the UK. This is the horizontal dashed line which sits at approximately 97% of the UK population by density. The 97% line was selected to approximate the kinds of levels of coverage required by the regulator in the UK.

In recent years there has been debate in the UK over reasonable levels of 'coverage' which should be provided by successful winners of spectrum auctions. The debate focussed on the last 5% of the population with some claiming that over 95% was not economic and others pushing for 98-99% coverage (depending on indoor versus outdoor).

The UK regulator settled on coverage that was 98% of the UK and 95% of each of the UK nations – giving network owners flexibility as to the level of coverage offered in some of the more 'difficult' parts of the UK population to serve.

Scotland, for example is generally deemed more costly to serve than England. A 2014 study into mobile network coverage in Scotland concluded that expanding coverage beyond 97% of the population is challenging as costs rise dramatically due to lower population density.[11]

To gauge how much coverage would be achieved in New Zealand with an equivalent level of obligation we selected the 97th percentile of the UK population, found the population density at that percentile – seeing as density is what drives cost – and calculated the equivalent population percentile for New Zealand.

The UK is so much more densely populated than New Zealand that if New Zealand's mobile network owners kept coverage inside the same population density as the 97th percentile of the UK population, only 60% of New Zealand's population would have network coverage.[12]

The corollary of serving lower densities to achieve equivalent population coverage is that costs must be higher for an equivalent level of coverage. Using our estimated cost curve we find that the average cost premium for coverage to be lifted from 60% to 97% of the population is 17% per person. The rationale for this calculation is demonstrated in Figure 9 building on the preceding analysis.[13]

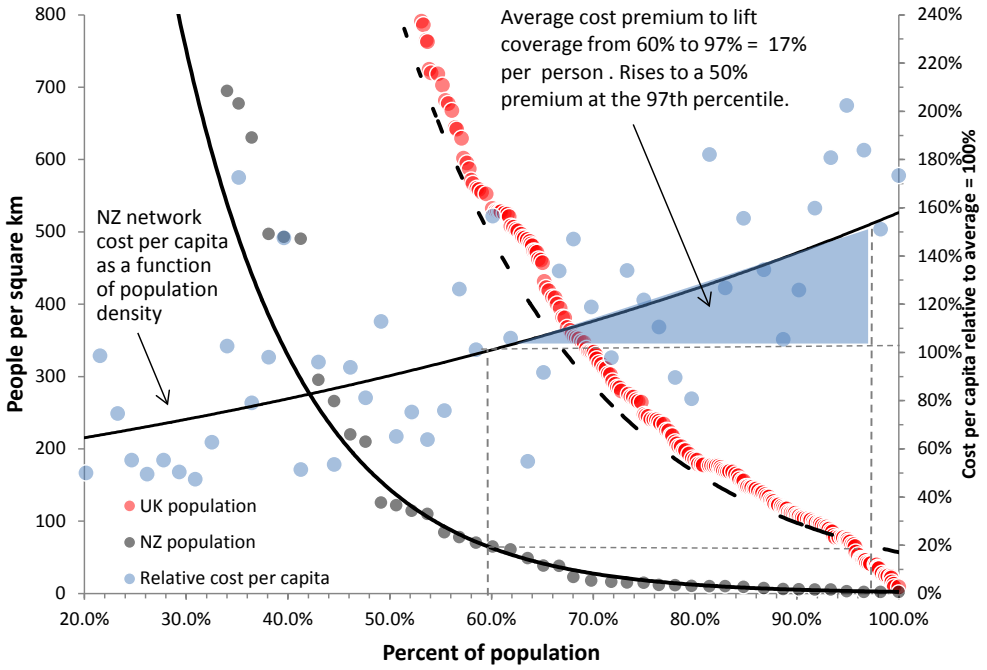
The curve in Figure 9 which slopes upwards left to right depicts reflecting NZ network cost per capita as a function of population density. As coverage rises beyond 60% the cost of coverage starts to rise. The blue shaded area shows the average additional cost per person from moving coverage from 60% of the population to 97% of the population. At the 97th percentile a new customer costs 50% more to serve.

[11] RealWireless (2014) "Economic Impacts of Mobile Communications in Scotland", The Scottish Government, March 7 2014.

[12] This 60% number is based on maximum day-night populations for New Zealand for comparison with cost numbers. The unadjusted results are that only 50% of the New Zealand population would receive coverage if set at UK mandated levels of coverage by density.

[13] The calculation is $\int_{0.6}^{0.97} 0.5116e^{1.1179x}dx - (0.97 - 0.6).(1 - 0.2) = 0.167$.

Figure 9 Network cost vs density



Source: NZIER

It is hard to know precisely the full extent to which network costs in New Zealand might be different to the UK due to, for example, lower costs of labour. However offsetting any labour cost advantage is the fact that network equipment is shipped long distances to New Zealand from Europe, Asia and North America. There will be other factors which would cause our estimates of New Zealand's coverage premium to be higher and smaller than shown here.

Regardless, it is apparent that achieving similar levels of performance to the UK – in terms of coverage – is a challenging task to say the least. It is thus surprising that the New Zealand industry does perform well in comparison to the UK.

This raises a question as to why New Zealand has the level of service that it does and, in the face of rising data demand, whether this is sustainable.

This is not a question which can be answered definitively here but rather it is the challenge which the industry itself is facing and which only the industry can answer.

Certainly a simple incremental cost analysis can't tell the full story. Mobile network investment decisions are contingent on more than simply incremental costs of each piece of network. Strategic positioning, general network effects and consumer demand may all require sinking investment into areas that have a low(er) pay back. We observe that network owners have traditionally competed on speed, quality, and coverage as ways of distinguishing themselves in the New Zealand market.

Regardless, some serious strategic decisions and commercial bets will need to be made in coming months and years which could see a change in the current model of service.

3. Yet NZ industry performance ranks alongside much richer countries

3.1. Broad coverage, comparable to most Western European countries

The number of mobile connections in New Zealand is similar to the OECD average, with more than 1 connection per person. This reflects widespread use of mobile networks facilitated by broad network coverage.

Around 97% of populated areas in New Zealand have access to 3G services which is comparable to the coverage achieved in most Western European countries.

3.2. High performance in new networks and data services

Uptake of newer technologies shows patterns of above average access and use. Penetration of mobile broadband is higher in New Zealand than the OECD average and higher than in the United Kingdom (Figure 10).[14]

Average mobile broadband speeds are faster than in Switzerland[15] and mobile data traffic is similar, per user, to Australia.[16] Both these countries are in the top half of the OECD ladder in terms of GDP per capita, where New Zealand aspires to be.

Measures of mobile traffic – voice and text messaging (SMS) – show New Zealand has low rates of conventional use (low voice traffic) but high rates of messaging.

This fact has often been a cause of consternation for market-watchers who suppose that this may reflect a combination of unaffordable pricing and relatively low incomes. This stands to reason intuitively but it is not confirmed by data. For example, Germany which is much richer than New Zealand, has similar voice traffic volumes per connection.[17]

This suggests an important role for different social norms and consumer preferences, as much as price or income effects, for explaining low levels of conventional traffic in New Zealand compared to other countries.

[14] Figure 10 shows fixed and mobile broadband penetration. Although mobile broadband can be a substitute for fixed line broadband – and vice versa – there is generally a positive relationship between the two. This indicates that increased use of fixed line broadband may be an important driver of demand for mobile broadband. This has implications for NZ where the government is subsidising the roll out of ultra-fast broadband.

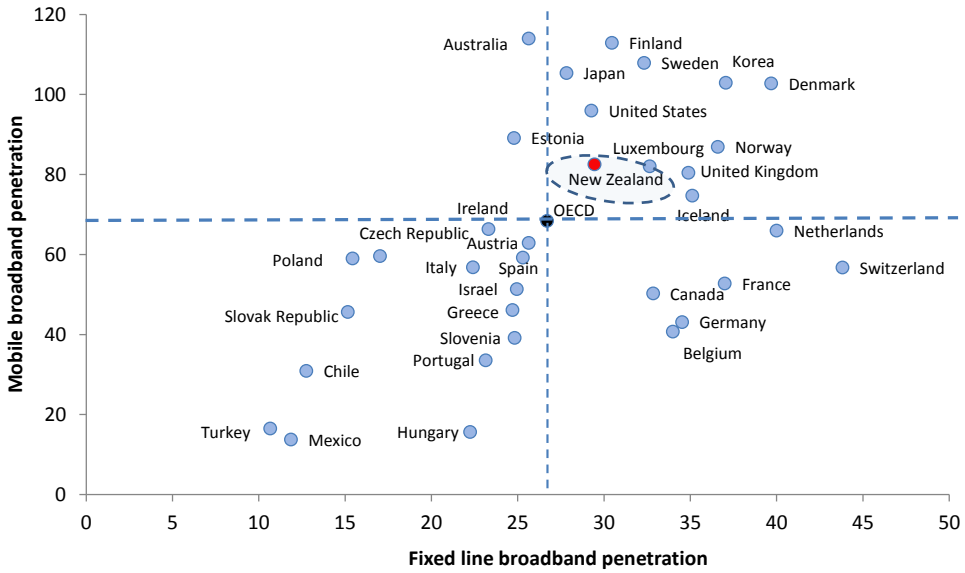
[15] Fig 4.17, OECD Communications Outlook 2013.

[16] Comparing average GB of data per mobile user in the Commerce Commission's (2014) Annual Telecommunications Monitoring Report 2013 with average GB of data per mobile connection in the OECD Communication Outlook 2013.

[17] OECD Communications Outlook 2013.

Figure 10 Broadband penetration top half of OECD

Connections per 100 inhabitants



3.3. Prices below OECD averages

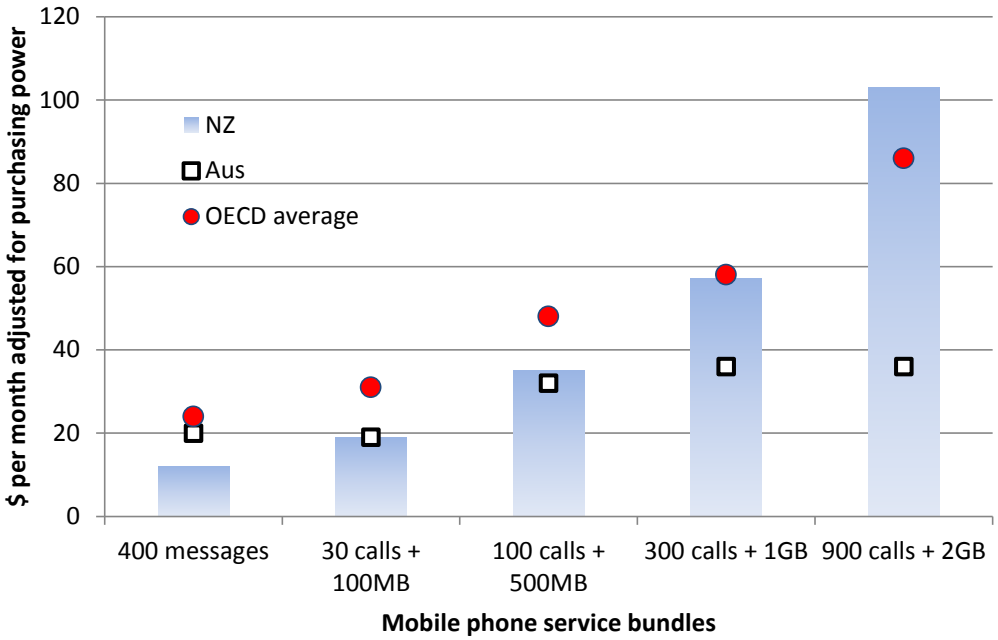
Prices for mobile services in New Zealand are generally below average by OECD standards. Prices are especially low for low calling and low data plans. All prices have been declining.

Data reported by the Commerce Commission (in Figure 11) suggests that prices at high ends of the usage-spectrum are above the OECD average. This sort of information needs to be treated with caution. Price snapshots and averaging across providers can obscure important market-specific interactions between companies and customers. In some countries companies might compete on voice call charges, for example, while in others data might be the most important margin to compete on. It all depends on the history of the market, number of competitors, level of service, and income and what local consumer's like.

An example of the difficulty in comparisons and in variations within and across markets are summarised in Figure 12. This high level analysis shows high and low end mobile plan prices based on a sample from an internet-based price search (see Appendix C for details). The prices shown in Figure 12 suggest that, at least at the time of this snapshot, the UK is an outlier in terms of high-end mobile data plan pricing with extremely low prices. The US, on the other hand, is an outlier in terms of having expensive pricing at the lower end of data use, while New Zealand, Australia and the UK all have fairly similar prices for lower levels of data use.

The sample pricing plans shown in Figure 12 suggest a tendency for greater variation across high-end plans than across low-end plans. This may be attributable to wider variations in high-end customer characteristics across markets or other market characteristics such as customer density and scale. That said, this sample is from a single point in time so one shouldn't read too much into the precise price levels. Companies frequently engage in promotions or adjust their general offerings in response to customer demand or changes to other companies' offerings.

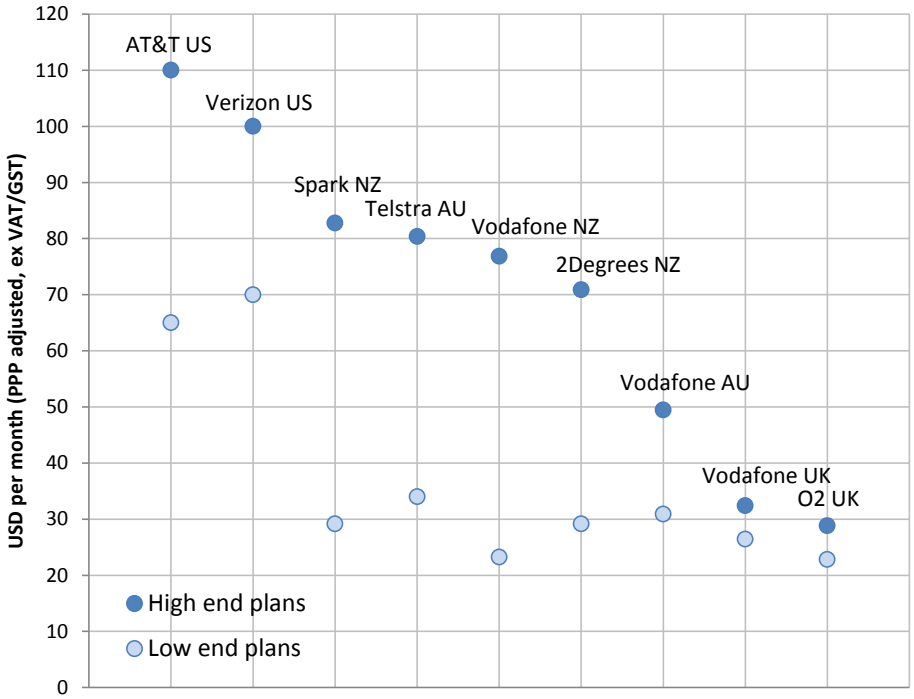
Figure 11 Prices are below average on most plans



Source: NZIER, Commerce Commission

Figure 12 Wide variations in plan prices across and within countries

High end plans ~5GB & unlimited voice. Low end ~1GB & some limits on voice. All plans have unlimited SMS. See Appendix C for further details.

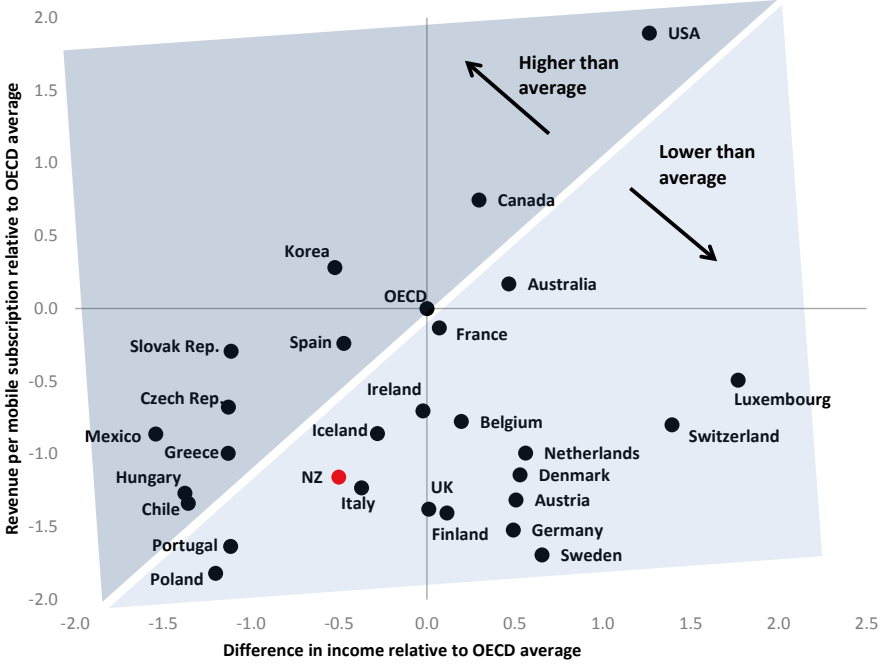


Source: Spark New Zealand

Higher prices for higher use sometimes draw criticism in New Zealand but an analysis of operating costs and industry margins does not indicate excessive pricing. If consumers were being fleeced by higher prices for higher use then we should expect higher revenue in the industry than we do. Industry revenue, per user, is below the OECD average even after accounting for New Zealand's lower income levels. This is shown in Figure 13 which benchmarks average revenue per mobile subscription relative to the OECD average (left axis, OECD average set at zero) alongside average income relative to the OECD average (bottom axis, OECD average set at zero).

Figure 13 Mobile industry revenue is low

Net national income per capita, revenue per subscription, differences relative to OECD average[18]



Source: NZIER, OECD, WorldBank

The overall financial and operating performance of the New Zealand industry indicates consumers are well served. The industry operates margins that are at the OECD average and low compared to many of the smaller OECD countries with similar drivers of capital to operating cost ratios (see Figure 14).

Figure 14 charts operating costs per connection (on the bottom axis) against the ratio of operating costs per connection over revenue per connection (left axis), which we term the "Opex ratio per connection". Costs per connection are an indicator of operating efficiency. Opex ratios per connection are an indicator of profitability. These are only indicators and are incomplete. Denser networks or networks with high traffic volumes can be expected to have higher operating costs relative to capital costs than less dense networks. Whether or not these different cost structures translate into lower or higher profitability will depend on

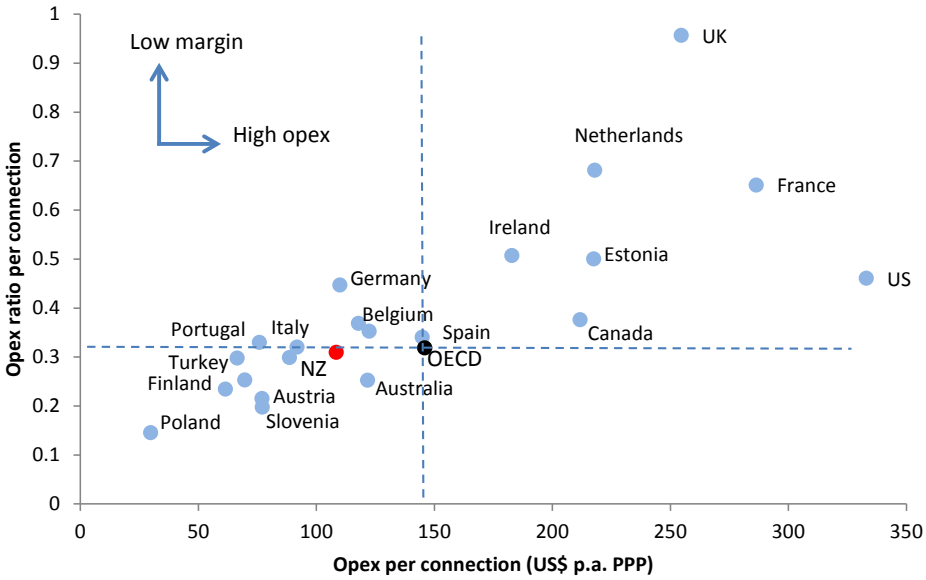
[18] Differences are deviations from OECD average 'normalised' by number of standard deviations from the average. Revenue per subscription in NZ is 1.2 standard deviations below the OECD average and net national income per capita is 0.5 standard deviations below the OECD average. Note that Norway (below average) and Japan (above average) are extreme outliers and do not appear on this chart for presentational purposes.

factors such as the business cycle, the state of competition in the industry, and any changes to consumer demand.

Nonetheless it is important to note that New Zealand operating costs are below average. Given revenue is not large by OECD comparison this suggests that profitability in New Zealand has been supported by sound management.

This contrasts with the UK, for example, where margins are being squeezed but this could be due to inefficient operation with operating costs making up a much larger share of revenue than the OECD average.[19]

Figure 14 Average margins and sound cost control



Source: NZIER, OECD, GSMA

On the face of it, New Zealand's distinctive differences and disadvantages should restrict options for consumers of mobile services compared to their peers in larger and wealthier markets. Yet they don't seem to have.

There can be only 2 reasons for this:

- the mobile industry in New Zealand has been more nimble than its overseas counterparts and its consumers better served, or
- New Zealand's distinctive differences are not as big a barrier to performance as one might think.

If New Zealand's distinctive differences were not a barrier to performance we would expect New Zealand's performance to rank alongside a mixture of countries from across the economic spectrum. This turns out not to be the case.

[19] It could also reflect the nature of competition and regulation in the UK. Either way, the UK appears to be an outlier on this and other cross-country indicators of mobile industry performance.

3.4. Performance which is comparable to much richer countries

Performance of the New Zealand industry ranks with higher income countries such as Norway and Belgium. This is despite New Zealand national incomes being closer to that of emerging European countries.

This conclusion is based on identifying groupings of countries (clusters) across a range of indicators of mobile industry performance (see Appendix A for more information about this analysis). This 'grouping' based approach is useful because no single indicator, such as 3G penetration, suffices for measuring performance results across countries. Performance across measures is simply too varied.

The cluster analysis is based on four metrics of mobile industry performance. The measures we chose were:

- mobile connections per capita (2011)
- penetration of mobile broadband (2013)
- mobile revenue per mobile connection (2011)
- fixed-line broadband penetration (2013)

Rather than emphasise one single indicator or another we have used correlations across different scores to segment countries into similar groups. Results from this analysis are shown in Figure 15.

In Figure 15 each country is identified as belonging to one of three groups of countries with similar levels of mobile industry performance. The group New Zealand belongs to (Cluster 1) is marked with red dots.

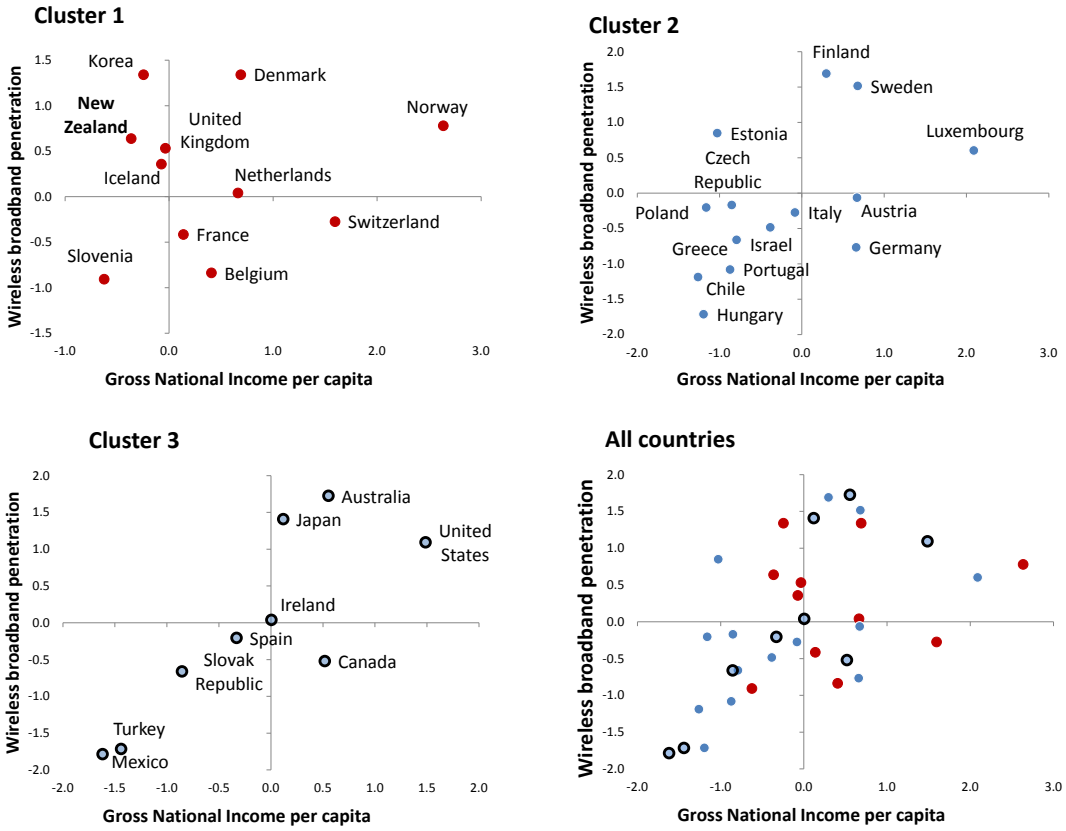
When grouping countries based on the metrics above, New Zealand's mobile network is shown to perform at a similar level to countries including the United Kingdom, the Netherlands, and Denmark.

Countries in the same performance cluster do not necessarily sit next to each other in Figure 15. This is because relative incomes, which are not part of the grouping criteria, have been included to show the extent to which countries with similar levels of mobile industry performance span different income levels (GNI per capita relative to the OECD average).[20]

[20] It is also because the chart includes only one measure of mobile performance (mobile broadband penetration).

Figure 15 NZ performance ranks alongside wealthier countries

Clusters of correlated scores across 4 mobile performance measures. Left axis is a sample mobile performance measure (broadband penetration). Bottom axis is income per capita. Values are distance to the OECD average.



Source: NZIER

The results of this analysis change only a little if we extend the grouping criteria to include similarities in income and population density. New Zealand industry performance still sits alongside wealthier, predominantly Western European and Nordic, countries. Indeed New Zealand is the least wealthy and amongst the most sparsely populated of all the countries New Zealand ranks alongside in terms of mobile performance. New Zealand is, however, no longer clustered with the UK once we account for geography and income. That is, while New Zealand's mobile industry performance correlated reasonably closely to that of the UK its economy and geography are too different for the countries to be considered, statistically, part of the same country grouping.

These sorts of comparisons are useful as much for what they do not say as what they do. There is, for example, no evidence New Zealand's mobile industry is performing poorly relative to countries we like to compare ourselves with.

4. Mobile faces challenges not found in fixed networks

4.1. Rapid technology transitions

Mobile network owners need to keep moving with constant technological changes. These affect both network infrastructure and devices which use that infrastructure. A careful balance has to be struck in matching network technology with technology used on devices connecting to the network. This is not a significant issue for fixed networks.

Transitions from one technology or protocol to another can bring benefits – to both provider and consumer – but the balance of benefits depends on careful management of the cost of change and minimising the need to operating multiple networks.

Technological changes present significantly greater economic challenges to mobile networks compared with fixed networks. Once a fixed network (copper or fibre) is in place, the cost of new technologies that improve capacity and speeds is usually a very small increment to the original capital cost of the network.

4.1.1. Benefits from transition to 4G

The main benefit to consumers from 4G – or more appropriately the Long Term Evolution (LTE) standard – is much greater capacity to handle and move data compared with 3G technologies.

An additional benefit is that LTE is better and cheaper than 3G. For example, LTE combined with lower frequency spectrum – like the 700MHz freed up by digital switchover – provides better service at longer ranges. This means fewer sites can serve more people. In other words, potentially better quality of service and wider coverage lower cost.

4.1.2. But investment in 3G needs to continue for some time

The option of installing LTE is attractive in and of itself but it will be some time before every handset and device is LTE capable. This means it is not a question of 3G or LTE. It is a question of how much LTE and how much 3G. In fact 2G is unlikely to be phased out altogether any time soon. Herein lies a challenge for mobile network operators.

The LTE challenge facing investors is akin to building a high-speed motorway while most of the population are on bicycles. Fast cars can use motorways or local roads. Cyclists can't use the motorways. Similarly, 4G capable handsets can use 4G networks, but 3G capable handsets can't. You need both. So what you end up with is altogether more infrastructure as opposed to simply new infrastructure.

This is made more challenging by the fact that with only some users on LTE capable devices and enjoying LTE speed much of the enormous future data demand growth will be due to the activity of a subset of high-use consumers while network needs to be rolled out for wider use. This raises difficult questions about how to price services to maintain a return on investment.

Providers are going to need to keep investing in older generation (3G) technology for quite some time. They will be faced with increasingly risky investments with potentially short pay-back periods.

This problem is particularly challenging in small economy like New Zealand – where there are far fewer consumers across whom to defray the costs of investment.

4.1.3. Rolling out new technology is always a risky venture

Investment in networks needs to take place in lumps (clusters) and in a small market investment needs to be much lumpier than what might be feasible elsewhere. The lumpier the investment the greater the risk that demand and revenue will not meet expectations and the more circumspect investors are likely to be.

Investors are also likely to be circumspect in the face of rapid technological change. Technology can move against investors and can do so reasonably rapidly. This can be seen in the difficulties that Telecom faced after adopting CDMA (a 3G technology) over the GSM standard adopted by Vodafone. CDMA was a superior technology on some dimensions but was not supported by a sufficient variety of handsets. The network was not successful and was turned off in 2012.

The move into LTE raises the risk of early retirement of 3G investments that have not yet provided a payback to investors. Even LTE is not immune to technology change.

4.2. Evolving demand for coverage

Unlike fixed networks, mobile operators need to anticipate and investment in meeting demand for data services outside the areas where people live. As data demand continues to evolve we can expect demand for coverage and capacity for data services to continue to change.

Providers need to decide how to balance provision of capacity in areas where people live most of the time with the extent of coverage outside the area where people live. Moving perfectly in step with customer expectations is an impossible task.

Providing wide coverage with multiple networks means much higher costs, over time, in mobile services than in fixed services. The precise difference depends on how demand evolves. Our most optimistic assessment is that costs of mobile data infrastructure are 8 times larger than the costs of providing fixed line ultra-fast broadband – per MB of data. Less optimistic assessments suggest cost differences are several times larger.[21]

[21] Order of magnitude estimates based on Spark New Zealand data for expected data costs for LTE and fixed costs of UBA access per connection per month of $10- $15 (see CEG report for Chorus at http://www.chorus.co.nz/file/48905/Cost-drivers-for-UBA-pricing.pdf) divided by average monthly data use in 2013 of 26GB per month per connection.

5. Difficult decisions to be made

The industry has performed well through a period of major technological change but the coming challenges combine both rapid technological change and rapid growth demand for network capacity from exponential growth in data demand. This means the coming challenge is altogether unprecedented.

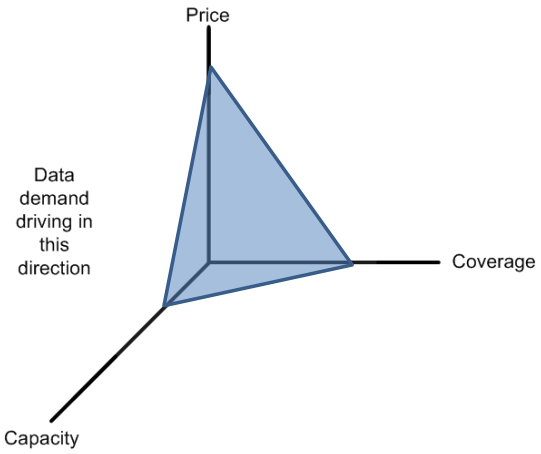
It is hard to know how this will pan out except to say that the roll out of 4G – including pricing – will be of key strategic importance and the subject of major commercial bets, not unlike the CDMA-GSM bets made in the mid-2000s.[22]

It would not be at all surprising if major strategic bets made in the coming years change the landscape of the mobile industry. This should be expected for any competitive market selling rapidly developing technology products and services.

Network owners will be making trade-offs across three broad areas:

- extent of access or coverage requiring breadth of investment
- capacity and speed of network requiring intensive investment in areas of high demand
- prices which encourage efficient access and use and yield return on investment.

Figure 16 Performance trade-offs



Source: NZIER

There are also more options in densely populated areas to invest in a mix of network technologies to increase service and keep costs down – such as mixtures of small cell sites and more opportunity for WiFi off-load.

5.1. Consumers can have it all but prices will rise

If consumers are willing to increase their spending and to bear high prices then the optimal strategy is to pursue both coverage and capacity – to build intensively everywhere. But it seems unlikely that consumers will be willing to bear that cost. At least there is

[22] Although not necessarily related to network technologies per se.

nothing to suggest that they would be willing to pay a great deal more for mobile data. Perhaps times will change.

5.2. Serving cities will be less of a challenge

Many of the challenges facing mobile are likely to be less of an issue for New Zealand's major urban markets – mainly Auckland. Auckland's market gets close to having the kind of market scale necessary to ensure investment recovery and to reduce the lumpiness of investment required to expand into LTE.

Auckland is also an area with a reasonably young and wealthy population. These are no doubt reasons why competition in urban markets has become quite heated – with 2 Degrees investing in small pieces of network but not in less populated parts of the country.

5.3. But broad coverage remains important

Providing broad coverage as well as capacity will be important for support emerging uses of data and data driven innovation. This might include: more intensive use of data in logistics chains or monitoring of machinery and asset performance or other remote data collection in real time and in far flung or places or on mobile machinery and transport equipment.

As every day devices and equipment becomes more intimately connected with the internet - the so-called 'internet of things' – the cost of capacity 'black spots' will begin to increase due to devices or equipment 'falling off the network'.

New Zealand's mobile network will, eventually, need to include both sufficient capacity for high-data demand and broad coverage to ensure data can be used to its best benefit.

5.4. Policy needs to adapt too

Just as firms will be adapting, policy-makers will need to adapt their thinking to reflect the increasing importance of mobile networks to the economy. Positive performance by the mobile industry suggests policy has been good. It remains to be seen whether those policies can deliver in future and ongoing high levels of performance should not be taken for granted.

Appendix A Cluster analysis

International comparisons and benchmarks are fraught exercises. It is extremely difficult to compare like with like. One way to look at it is piece by piece via several indicators.

Germany, for example, has above average mobile connections per capita and below average revenue per connection but mobile broadband penetration well below the OECD average. This is despite the fact that Germany has above average fixed-line broadband penetration.

In contrast, Norway has above average mobile broadband penetration but below average mobile connections per capita and higher than average revenue per user. Fixed-line broadband penetration is above average.

Given this kind of variation, the performance assessments can vary depending on which measure is chosen to make the assessment.

Alternatively cluster analysis, which allows comparisons of countries that share commonalities amongst certain metrics, gives a more useful analysis of the relative performance of a network. .

Mobile connections per capita indicate the extent to which the mobile industry provides sufficient infrastructure at prices capable of supporting widespread use and ownership of mobile devices. A low score on this measure is almost unambiguously bad – except perhaps to the extent that a country's overall level of development and income is very low.

Penetration of mobile broadband is used to reflect industry performance in terms of innovation, investment and affordability. That is, it reflects the extent to which the mobile industry has invested in sufficient new infrastructure and network technology to support widespread uptake of data-capable devices. It also partially captures the extent to which pricing of 3G services is sufficiently affordable to support take-up of new devices.

Mobile revenue per connection reflects a combination of industry pricing decisions, consumers' demand and willingness to pay for new services and the range of services provided. This measure is highly context-specific as it may reflect a range of influences including social trends and norms. It is, however, a very useful performance comparator. A low score on this measure alongside high scores for the connections and 3G penetration measures is a strong indication that an industry is delivering value to its consumers.

Fixed-line broadband penetration is included as a communications network industry performance comparator and to help capture some of the differences in consumer preferences across countries. Broadly speaking high fixed-line broadband penetration reflects relatively high rates of innovation and investment

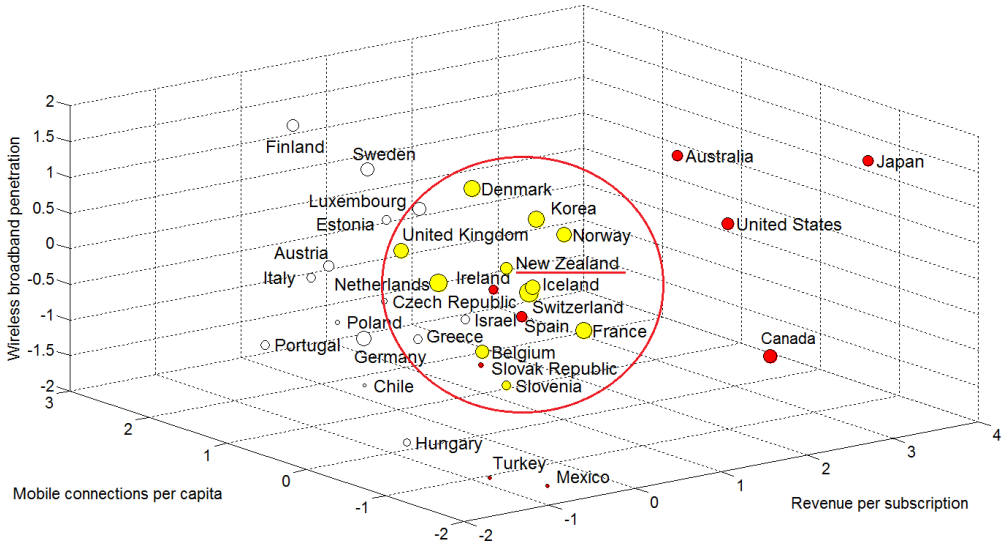
These were chosen because they are:

- widely measured – so the broad cross-country comparisons can be made
- recently measured, so speak to current market conditions,
- measured over similar time frames
- compiled by a single agency (the OECD) which is expert in cross-country data collection
- complementary in terms of differences in one measure holding information about what we should expect on other measures.

Performance across each of these measures across each OECD country is summarised in Figure 17. The data is normalised with 0 indicating that country is average and positive (negative) values indicate above (below) average scores.

Figure 17 Cluster analysis – mobile performance measures

Colours reflect clusters of countries most like each other across all measures. Bubble size reflects relative size of fixed line broadband penetration.



Source: NZIER

The first thing which stands out in the chart is that there is enormous variation across countries depending on which measure of performance is considered. Germany, for example, has above average mobile connections per capita and below average revenue per connection but mobile broadband penetration well below the OECD average. This is despite the fact that Germany has above average fixed-line broadband penetration. In contrast, Norway has above average mobile broadband penetration but below average mobile connections per capita and higher than average revenue per user. Fixed-line broadband penetration is above average.

New Zealand has below average connections per capita, above average mobile and fixed line broadband penetration and below average revenue per connection.

Wide variation across each of the performance measures makes it difficult to discern industry performance in Figure 17. In and of itself this illustrates that no single measures suffices for measuring performance - results across industry performance measures are simply too varied.

To distil performance across different measures Figure 17 includes 3 clusters of like countries. These clusters are formed based on statistical analysis of correlations in scores.[23]

[23] Specifically k-means clustering with the number of clusters tested and 3 shown to be 'optimal'. The distance score used was simply correlation though the numbers of clusters was not very sensitive to choice of distance measure used (we tested cosine and squared-euclidean distance measures). However, the clusters identified were sensitive to choice of distance measure and alternative cluster methods (we also tested a Gaussian mixture model method). This sensitivity reflects the variation in the data and in our view it suggests that there is no international empirical 'norm' against which performance can be measured.

The cluster in which New Zealand resides tends to sit around the middle across all scores. This performance cluster is predominantly made up of Western European and Nordic countries. It shows, for example, that the performance of the New Zealand industry is more closely associated with the United Kingdom than with many similar sized countries or with its closest geographic neighbour Australia.

A second group, which includes Germany, Portugal and Chile is a group characterised by its high number of mobile connections per capita and below average revenue per capita.

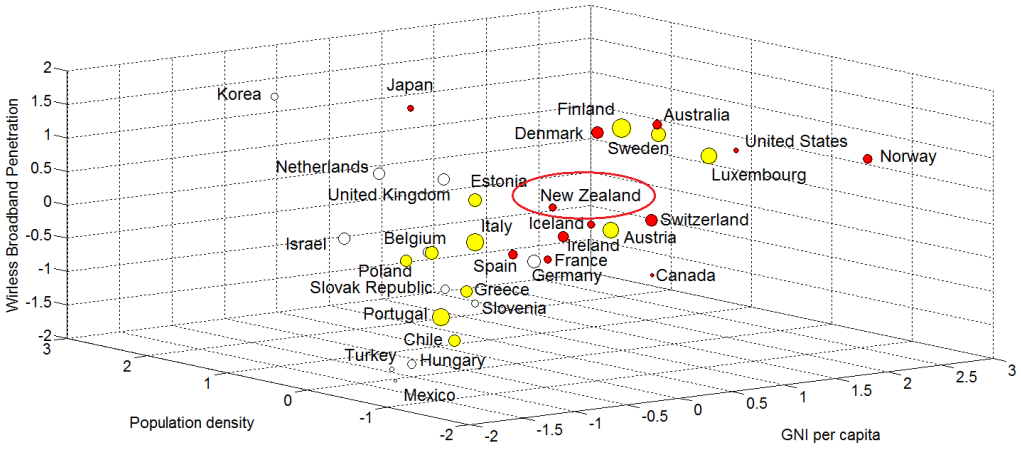
Countries with well-above average revenue per subscription and typically low connections per capita stand out as another group. This group includes Australia, USA, Canada, and Japan as well as low income OECD countries of Turkey and Mexico.

The clusters contain countries which are different in some very fundamental ways. In Hungary is in the same group as Germany despite German national income per-capita being double that of Hungary and Germany being the most populous country in Europe. This suggests that industry service, innovation and revenue cannot be reasonably measured without reference to other considerations.

When we include income and population information in the clustering, the clusters change. This can be seen in Figure 18. The Figure shows relative positions in terms of income, population density and wireless broadband penetration and the bubble sizes reflect relative number of mobile connections per capita; though the clusters have been identified through analysis of correlations amongst all measures of performance plus income and population density.

Figure 18 Clusters accounting for size and income

Colours are clusters of countries most like each other across income, population density and mobile performance measures.



Source: NZIER

A key result from the analysis shown in Figure 18 is that New Zealand remains grouped alongside countries with which are significantly wealthier. Despite New Zealand national incomes being closer to that of emerging European countries and Korea, New Zealand is grouped with countries such as Australia and the United States and Norway. New Zealand is the least wealthy and amongst the most sparsely populated of all the countries New Zealand is clustered with.

In Figure 18 New Zealand is no longer clustered with the UK. New Zealand's mobile industry performance correlated reasonably closely to that of the UK but its economy and geography are fundamentally different.

A final point to note is that variation of economic circumstances and of mobile industry performance is so wide that there is no precision in these or other cross-country measures of performance. These results are at best stylised and the clusters are only rough approximations to similarity.

These comparisons are useful as much for what they do not say as what they do. There is, for example, no evidence New Zealand's mobile industry is performing badly relative to countries we like to compare ourselves with.

There are 4 aspects to industry performance which we have ignored which deserve mention:

- sustainability of performance over time is not examined due to incomplete data but it is important to bear in mind that, for example, low revenue large demand and high rates of investment and innovation may be economically unsustainable
- actual prices paid for bundles of services are not used because a single comparable set of data is not available and, moreover, is subject to considerable criticism and debate – our analysis here deliberately tries to keep things simple – though we do touch on this issue above because it is considered important
- data speeds and service quality are not included because the data on these measures is incomplete
- traffic volumes are not included because the data on these measures is incomplete and also because, like measures of prices paid for bundles of services, it is not presently feasible to aggregate across services such as text (SMS) and voice services (is a 1 minute voice call worth 1 text?)[24]

[24] We note that it is possible to create an index of 'service' based on reasonable functional comparisons of traffic but to our knowledge this has not been done internationally and is too involved a task for us to address it here.

Appendix B Cost model

Table 1 Econometric cost model parameters

Predicting ln(cost per capita), GLM, Adjusted R-squared = 0.88.

	Coefficient	Standard error	p-value
Intercept	-0.78	2.04	0.22
ln(population density)	-1.12	0.09	0.00
ln(area) (km2)	2.07	0.09	0.00
ln(income)	0.78	0.16	0.06
ln(traffic) (MB)	-0.17	0.06	0.00
ln(Area).ln(income)	-0.18		
ln(population density)^2	0.09		

Source: NZIER

Our econometric model linking investment costs to population density found a 1% increase in density is associated with an approximate 1% reduction in costs of investment per capita, on average, though this effect (via the squared term) gets smaller (larger) as density increases (falls).

The model was fitted using a step-wise procedure involving choices over explanatory variables, interaction terms, and quadratic terms. The final model provided the best overall fit (according to a F-test model comparison).

Appendix C Data Tables

Country	Population	Population density	GNI per capita
	2013	2013	2012
Australia	22,684,000	3	41,590
Austria	8,429,990	103	42,990
Belgium	11,128,250	370	39,870
Canada	34,880,490	4	41170
Chile	17,402,630	24	20,140
Czech Republic	10,509,290	137	24,980
Denmark	5,591,572	130	43,200
Estonia	1,329,301	31	22,900
Finland	5,413,971	18	38,570
France	63,519,080	116	36,690
Germany	81,932,160	233	42,860
Greece	11,092,770	88	25,680
Hungary	9,920,361	110	20,930
Iceland	319,575	3	34,190
Ireland	4,586,897	65	35,090
Israel	7,886,450	372	30,510
Italy	59,539,720	201	34,070
Japan	127,515,000	349	36,440
Korea	50,004,440	517	32,150
Luxembourg	530,946	190	59,750
Mexico	117,053,800	61	15,910
Netherlands	16,754,960	500	42,890
New Zealand	4,433,000	17	30,750
Norway	5,019,000	16	66,220
Poland	38,533,790	125	21,320
Portugal	10,514,840	117	24,750
Slovak Republic	5,407,579	113	24,930
Slovenia	2,057,158	104	27,680
Spain	46,146,570	92	31,140
Sweden	9,519,374	23	43,090
Switzerland	7,955,211	200	53,920
Turkey	75,175,830	99	18020
United Kingdom	63,705,000	263	34,640
United States	313,914,000	35	52,620
OECD average	36,776,677	142.0	35,049

Country	Mobile subscriptions per capita	Mobile revenue per subscription	Fixed-line broadband penetration	Mobile broadband penetration
	per capita	USD	Per 100 inhabitants	Per 100 inhabitants
	2011	2011	2013	2013
Australia	1.11	751	25.6	114.0
Austria	1.55	317	25.6	62.9
Belgium	1.24	408	34.0	40.7
Canada	0.80	705	32.8	50.2
Chile	1.31	196	12.8	30.9
Czech Republic	1.35	278	17.0	59.6
Denmark	1.29	428	39.7	102.7
Estonia	1.39	317	24.8	89.1
Finland	1.67	331	30.5	112.9
France	1.09	517	37.0	52.8
Germany	1.40	267	34.5	43.1
Greece	1.30	308	24.7	46.1
Hungary	1.17	174	22.3	15.6
Iceland	1.08	391	35.1	74.7
Ireland	1.22	414	23.3	66.3
Israel	1.28	408	25.0	51.4
Italy	1.59	306	22.4	56.8
Japan	1.00	1,103	27.8	105.3
Korea	1.06	384	37.1	102.9
Luxembourg	1.51	491	32.7	82.0
Mexico	0.83	209	11.9	13.7
Netherlands	1.31	370	40.0	66.0
New Zealand	1.10	350	29.5	82.5
Norway	1.16	534	36.6	86.9
Poland	1.30	126	15.4	59.0
Portugal	1.59	201	23.2	33.5
Slovak Republic	1.11	295	15.2	45.6
Slovenia	1.06	311	24.8	39.1
Spain	1.14	417	25.3	59.2
Sweden	1.43	302	32.3	107.9
Switzerland	1.29	563	43.8	56.7
Turkey	0.89	132	10.7	16.5
United Kingdom	1.33	298	34.9	80.4
United States	0.94	723	29.3	96.0
OECD average	1.23	392	27.6	64.8

Sample of High End plans by country, company and adjusted for Purchasing Power Parities (Sampled in September 2014)

Country	Company	List price	VAT/GST	PPPs	Price for comparison	Text	Mins	Data	Notes
New Zealand	Spark NZ	$139 (inc GST)	15%	1.46	83	Unlimited	Unlimited	5gb	Includes 1gb/day wifi, Spotify Premium, mins to Australia included.
	Voda NZ	$129 (inc GST)	15%	1.46	77	Unlimited	Unlimited	5gb	Includes mins and txt to Aus.
	2Degrees NZ	$119 (inc GST)	15%	1.46	71	Unlimited	Unlimited	5gb	Data and mins carry over, data shared amongst 3 people, text and mins to Aus included.
Australia	Telstra AU	AU$130 (inc GST)	10%	1.47	80	Unlimited	Unlimited	4gb	Includes unlimited MMS, free phone upgrade every 12 months.
	Voda AU	AU$80 (inc GST)	10%	1.47	49	Unlimited	Unlimited	4gb	Currently special offer ending soon gives a bonus 1gb data. Includes 300 international mins.
USA	Verizon US	USD$100 (+ taxes)	0%	1	100	Unlimited	Unlimited	4gb	
	AT&T US	USD$110 (+ taxes)	0%	1	110	Unlimited	Unlimited	4gb	
UK	Voda UK	£27 (inc VAT)	20%	0.694	32	Unlimited	Unlimited	4gb	Includes 500mb wifi, 12 month contract, no phone subsidy, 6 month sub of either netflix, spotify premium, sky sports.
	O2 UK	£24 (inc VAT)	20%	0.694	29	Unlimited	Unlimited	5gb	12 month contract, no phone subsidy.

Sample of Low End plans by country, company and adjusted for Purchasing Power Parities (Sampled in September 2014)

Country	Company	List price	VAT/GST	PPPs	Price for comparison	Text	Mins	Data	Notes
New Zealand	Spark NZ	$49 (inc GST)	15%	1.46	83	Unlimited	400	1.25gb	Includes 1gb/day wifi.
	Voda NZ	$39 (inc GST)	15%	1.46	77	Unlimited	300	1.25gb	Mins and txt to Aus, free weekend on net calling,
	2Degrees NZ	$49 (inc GST)	15%	1.46	71	Unlimited	400	1.25gb	Data and mins carry over, includes mins and txt to Aus.
Australia	Telstra AU	AU$55 (inc GST)	10%	1.47	80	Unlimited	~460	1000mb	Minutes are rated from $550 credit at 99c/min + 40c connection fee, or $2.38 per 2 min call. 500mb included, assuming bonus 500mb taken instead of credit.
	Voda AU	AU$50 (inc GST)	10%	1.47	49	Unlimited	~420	1gb	Minutes rated from $500 credit at 98c/min, 40c connection fee or $2.36per 2 min Call. Includes unlimited on network calls.
USA	Verizon US	USD$70 (+ taxes)	0%	1	100	Unlimited	Unlimited	1gb	
	AT&T US	USD$65 (+ taxes)	0%	1	110	Unlimited	Unlimited	1gb	
UK	Voda UK	£22 (inc VAT)	20%	0.694	32	Unlimited	Unlimited	1gb	Includes 500mb wifi, 12 month contract, no phone subsidy.
	O2 UK	£19 (inc VAT)	20%	0.694	29	Unlimited	Unlimited	1gb	12 month contract, no phone subsidy.