1. Summary

a. I have been asked by InternetNZ, TUANZ, and Consumer NZ to address the suitability of LTE and LTE-Advanced as a substitute for fixed line broadband within the UFB footprint. I have set out my experience at the end of this report.

b. In summary, my conclusions are that LTE is a suitable substitute for fixed line broadband for at least 50% of households, and that faced with increasing fixed line costs, carriers are incentivised to migrate users on to substitute products.

2. Fixed Mobile Substitution

a. Fixed Mobile Substitution (FMS) is the concept of replacing fixed telecommunications lines with mobile technologies.

b. In Europe[i] between 2006-2011 the number of households without fixed lines increased from 18% to 27%, while broadband penetration continued to increase.

c. Grzybowski cites evidence of substitution both in developing markets and in developed countries in the mature years of mobile telephony.[ii]

d. In Austria, "under current market circumstances for residential customers, mobile broadband is a substitute to fixed broadband services, despite possible technical or capacity constraints".[iii]

e. In Italy, where 32% of households are mobile-only, the dominant carrier Telecom Italia suggests FMS will be further accentuated as LTE networks allow for higher speeds.[iv]

f. In October 2012 Telecom Italia began a rollout of LTE products specifically designed for home users with Personal Computers.[v]

g. To date FMS has not gained traction in New Zealand from a consumer standpoint potentially due to the high cost of mobile data.

h. In their Communications Outlook 2013[vi], the OECD singles out New Zealand as having the most expensive 5 gigabyte basket of mobile data.

i. Were mobile data costs in New Zealand closer to the OECD median, Fixed Mobile Substitution might become more prevalent.

3. Long Term Evolution

a. Long Term Evolution (LTE) is the first cellular mobile technology designed primarily to deliver high speed data. Cellular operators deploy LTE to relieve data congestion on their voice-centric 2G and 3G networks, and to enable lower cost, higher data cap plans. Its data-centric design enables performance equivalent to or better than fixed line ADSL2+ connections..

b. LTE networks in New Zealand can operate in a number of spectrum bands, including 700, 1800, and 2600 MHz.

c. All of these bands are in the growth plans of local Mobile Network Operators.

d. LTE can be added to existing towers by introducing new transmitting equipment and replacing existing antennas with new ones that support multiple frequency bands. By choosing to replace antennas instead of adding new ones, a carrier can avoid costly resource consent issues.
e. Nearly all mobile towers in urban and suburban areas are fibre fed, with backhaul that is highly scaleable without additional cost.
f. LTE-Advanced builds on LTE, enabling higher speeds via spectral efficiency gains, plus the concept of spectrum aggregation. This allows the network to use several spectrum bands in tandem to increase speeds, in addition to spectral efficiency gains.
g. In New Zealand, LTE is currently offered by Vodafone, and is treated as a premium product available at an additional monthly cost.
h. When other MNOs start offering LTE, it is likely to become the baseline product for mobile data, and will be priced as a commodity.

9. Broadband Traffic Use

a. The Commerce Commission states that in June 2012 the average New Zealand household consumed 19 gigabytes of traffic each month.[vii]
b. Statistics New Zealand reports that in 2012 "The average subscriber uses an estimated 16GB of data per month".[viii]
c. Cisco reports that in 2012, the average Internet user generated 13.3 gigabytes per month of traffic, and the average Internet household generated 30.8 gigabytes per month of traffic.[ix]
d. A conservative approach to network modelling will consider the Cisco figure.

10. Heavy Users and Light Users

a. It is useful, when assessing how LTE can handle broadband, to split users into "heavy users" and "light users".
b. Cisco[x], Sandvine[xi], and several academic papers[xii][xiii] report that a small percentage of heavy users on the Internet are responsible for the majority of Internet traffic use.
c. According to Sandvine's 2013 report, the top 20% of subscribers who make the most use of a network's resources typically consume 70-80% of all traffic, as measured across multiple markets including North America, Europe, and Asia Pacific.
d. Conversely, "the network's lightest 50% of users account for only 6.4 % of total monthly traffic" in North America, and 6.7% of total monthly traffic in Asia Pacific.
e. It is reasonable to assume that half of all Internet households in New Zealand are light users.
f. A conservative approach to modelling light users will assume their traffic consumption is no more than 40% of the mean.
g. Given Cisco's 2012 statistics, we will assume a light user household in 2012 consumed less than 12.3 GB/month.

11. Broadband Traffic Growth

a. In order to understand the capability of LTE to provide for FMS over several years, we need to consider traffic levels at a point in the future.
b. Cisco's VNI predicts traffic growth in New Zealand to be 16% compounding annually for the period between 2012 and 2017.
c. They predict the average Internet household in 2017 will consume 65 GB/month.
d. We will assume a light user household in 2017 will consume 26 GB/month.

12. Committed Bandwidth and Peak Time Traffic Utilisation

a. Carriers can only provide adequate quality of service if they take into account peak time utilisation of their networks. They need to set aside committed bandwidth on a per-user basis to protect against congestion in the peak time.
    i. Chorus provides 45 kilobits per second (kbps) of committed capacity per user for its regulated UBA service and 96 kbps of capacity per user for its wholesale VDSL2 service.
    ii. Vodafone's Rural Broadband Initiative Fixed Wireless Service provides a committed capacity of 45 kbps per user.
    iii. Base level UFB services provide 2,500 kbps of committed capacity per user.
b. A simple model can be made to determine the committed bandwidth required to satisfy the needs of a light user in New Zealand in 2017
    i. Google's Transparency Report indicates that peak time in New Zealand is between 8-10 PM, and that 18% of all user traffic is consumed those hours.[xiv]
    ii. Translating a Light User's 26 GB a month of traffic in 2017 into a peak time throughput for a low user could be done this way:
        1. 26,000 MB/month * (12 / 365) *.18 = 154 Megabytes
        2. 154 MB * 8 bits per byte / 7200 seconds = 171 kilobits per second (kbps)
c. To provide adequate quality of service for a light user in 2017, a network will have to have at least 171 kbps of committed capacity available for each user.
d. Committed rates required for light users in 2017 are lower than will be offered by the UFB, but greater than what are currently offered by copper broadband products or RBI Fixed Wireless.

13. Can a Telco Provide Good Service via FMS?

a. In late 2012, a Mobile Network Operator (MNO) licensed[xv] 7 sites for LTE in Lower Hutt, with coverage of 13,200 households. It's not clear whether they have yet deployed the technology, but their planning can be used to evaluate whether FMS can be used to provide a good broadband service for Light Users.
    i. The technology licensed was LTE at 2.5GHz with a 20MHz channel, which has peak speeds of 150mbps per sector.
    ii. Most cellular towers are configured with three sectors each, so the peak rates from these towers could be 450mbps.

iii. Real-world throughput, which accounts for a blend of fixed and mobile users at varying distances from the tower and levels of obstruction, should be 23% of peak speeds.[xvi]

iv. Each tower could likely have an aggregate real-world capacity of 103mbps.

b. With the MNO's configuration, we can calculate the amount of users each tower will be able to support at peak time like this:

i. 103 Mbps / 171 Kbps = 602 users

c. The network of 7 towers will be able to provide good service to 4,216 Light Users, which is nearly 32% of all households in the coverage area.

d. This assumes that the LTE network currently planned is rolled out and not changed. However, the MNO can be expected to expand capacity by upgrading to the LTE-A standard, particularly as demand expands.

e. Upgrading to LTE-A, likely a software upgrade, could double or triple available bandwidth, enabling either higher committed rates per customer, more customers per tower, or some combination of the two.

14. Will Telcos Provide Fixed Mobile Substitution Services?

a. Pricing inputs and carrier expansion plans suggest that telcos can provide affordable and profitable services via Fixed Mobile Substitution

b. One of the significant price inputs into residential broadband is the tail circuit. If a telco can use LTE instead of ADSL or Fibre as a tail circuit, they have the potential of providing FMS at a far lower cost than fixed line broadband.

c. FMS terminals are self-install & cost less than an ADSL truck roll. For pre-pay customers they can be sold just as a phone is, enabling residential broadband without a fixed term contract.

d. Considering the inputs discussed, the additional or variable cost in supplying customers via LTE should be marginal. The telco therefore has considerable incentives to transition suitable users such as Light Users from fixed-line broadband products to LTE.

e. The telco could encourage transition by marketing broadband plans that meet the needs of FMS suitable users, such as low-cost, low-cap plans, pre-pay plans, and plans that are transportable across any urban or suburban area.

f. Heavy users could be encouraged to stay on fixed line plans through the enforcement of data caps and over use penalties. In this way the MNOs can readily triage users into those suitable for LTE and those not suitable.

g. Faced with high ADSL costs from fixed network operator Deutsch Telekom, Vodafone Germany asked users to migrate onto an LTE based network. By the end of 2012 they had migrated 283,000 users to LTE-based FMS products.[xvii]

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12/2010 - Present - Telco2 Limited - Wellington, New Zealand

Consultant

Telco2 consults on wide area network strategy and design to users, providers, and policy makers in the telecommunications space. Current engagements are focused on rural and remote communications in agriculture, energy, and maritime safety. Other work undertaken includes radio licensing, device certification, tactical radio linking, and training. An InternetNZ funded paper on IEEE'a 802.22 standard for cognitive radio in TV Whitespace has been presented at several international conferences in 2013.

Articles first published in Telco2's blog at http://nztelco.com/ have been republished by CommsDay, Computerworld, the National Business Review, and Policy Tracker.

4/2004 - 12/2010 - Araneo Wireless Solutions - Wellington, New Zealand

Founder, Technical Architect, and Managing Director

As the founder and architect of Araneo, an alternative telecommunications provider, I was involved in every aspect of its development. Araneo, now a subsidiary of NZX-Listed TeamTalk Limited, carries layer 2 Ethernet traffic over a national wireless and microwave network for fourteen Internet Service Providers (Including TelstraClear) and New Zealand's largest agribusiness. End users include private and government organizations in Agribusiness, Defense, General Business, Forestry, Energy, Healthcare, Maritime Safety.

Critical to the early development of the company was my ability to acquire and apply technical knowledge of radio and network design. Close work with both the management and technical staff at key customers helped me position the company to supply niche products unavailable from other carriers. Acquiring the skills to manage contractors and employees across diverse fields such as surveying, structural engineering, drafting, construction, network engineering, and support allowed me to scale the company to fourteen employees and millions of dollars of revenue.

Details on some of the innovative projects I led while at Araneo are listed below.

Technical Work Addendum and Radio Work History

General Network Design & Management: I designed Araneo as an open-access broadband carrier. Its first link was a wireless Ethernet service connecting WelTec to ISP DTS, allowing for the offload of NZ domestic Internet traffic from a congested incumbent circuit. In an iterative process over six years I grew the network through a number of low cost routers and technologies. The culmination of this growth process has resulted in a modern Ethernet/MPLS network that has in excess of 800 actively monitored and managed network devices. I was solely responsible for design and management of the company until I hired a network engineer and general manager in 2010.

ANZ Centre, Auckland CBD: I engineered and installed New Zealand's first gigabit wireless link, using "next generation" 60GHz microwave from ANZ to Sky Tower. I worked with equipment vendor Bridgewave, and RSM representatives Alex Orange and Brian Miller from early 2005 for permission for a trial. With installers SACL I configured and tuned the link in September 2006 and it has been in continuous production since. The 60GHz frequency band was subsequently opened up to general use in 2007, and Araneo installed another dozen 100mbps and 1000mbps links in the band.

Industrial Research, Parnell: In 2008 I engineered and installed Zealand's first 70/80GHz gigabit microwave link, from IRL's Balfour Road campus to FX Networks at Sky Tower. This higher frequency link was specified as gigabit connectivity was required, yet the path distance was too great for use of 60GHz. The link has been the primary network connectivity for IRL since installation, and was later supplemented by a diverse path system relaying via Mt. Eden. The success of this system led to the same technology being used to connect the Kapiti Coast Unisys data centre to the Government Shared Network in 2009.

Canterbury Rural Libraries: For the National Libraries Aotearoa People's Network project I designed a system linking ten rural libraries via seven tower sites back to Christchurch. The entire system was built new for the project, and co- sited on existing Chorus (Telecom NZ) towers that did not yet have broadband capabilities. The system, installed Transfield in March 2008, continues to be the highest bandwidth connectivity available to some of the connected communities. Due to the success of this system, National Libraries and specified Araneo for connectivity to libraries in the Waikato, rural Taranaki, and Rodney.

New Zealand Defence Force: In 2009 TelstraClear bid for and won a ten year contract to provide telecommunications services to NZDF. Araneo was a key part of the bid, supplying redundant 100 and 1000mbps links to bases including Burnham, Devonport, Linton, and Waiouru. I provided technical design and project management through the bidding phase then hired and supervised staff to assist with the deployment and management of the network. Key challenges overcome included protracted contractual negotiations with TelstraClear and both policy and technical work on the integration of network management systems, allowing TCL granular look through access to routers and radios on the Araneo network providing service for NZDF. The success of the NZDF project led to TelstraClear bidding for and winning a similar contract for NZ Customs Service. Araneo has since installed microwave links to seven sites for this project.

Propagation Analysis and Associated Radio Network Design Involvement: Using EDX wireless I have produced hundreds of propagation studies, with the majority in the 162MHz, 2.3GHz, 3.5GHz, and 5.8GHz frequency bands. In a submission to the Ministry of Economic Development's Rural Broadband Initiative, I supplied the results of 189 individual area studies for 2.3GHz TDD LTE coverage in ESRI shape files. For the Araneo web site, I have calculated coverage from existing towers at 5.8GHz (assuming P-P links) and have made this information available on the Araneo website here: http://www.araneo.net.nz/index.php/coverage/. Propagation analysis at 162MHz has resulted in the placement of AIS listeners covering the Marlborough Sounds at a number of locations including Colonial Knob, Porirua, on the North Island.

Radio Design Tools and Resources: I have had extensive experience with EDX Wireless, and have used it on a weekly basis continually since 2007. I designed tables for a PostgresSQL database to store geo-referenced information on radio transmitters, power levels, and antennas. I used SpectrumOnline until its replacement SMART came online, and have used SMART since

then. I frequently use Andrew Stewart's SMARTER tool. I am familiar with many Radio Spectrum Management documents, including PIB22 and PIB38. I have further utilized AS/NZS 5070 and J-STD-607- A in my planning of sites.

[i] http://berec.europa.eu/doc/berec/bor/bor11_54_FMS.pdf

[ii] http://ideas.repec.org/p/rza/wpaper/271.html

[iii] http://ec.europa.eu/information_society/policy/ecomm/doc/implementation_enforcement/annualreports/15threport/at.pdf

[iv] http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=1542

[v] http://www.telecomitalia.com/tit/en/archivio/media/comunicati-stampa/telecom-italia/mercato/consumer/2012/10-16.html

[vi] http://www.oecd-ilibrary.org/science-and-technology/oecd-communications-outlook-2013_comms_outlook-2013-en

[vii] http://www.comcom.govt.nz/dmsdocument/10043

[viii] http://www.stats.govt.nz/~/media/Statistics/Browse%20for%20stats/ISPSurvey/MRJun12/ISPSurveyJun12MR.pdf

[ix] http://www.cisco.com/web/solutions/sp/vni/vni_forecast_highlights/index.html

[x] http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html

[xi] http://www.sandvine.com/downloads/documents/Phenomena_1H_2013/Sandvine_Global_Internet_Phenomena_Report_1H_2013.pdf

[xii] http://dl.acm.org/citation.cfm?id=1159938

[xiii] http://dspace.mit.edu/handle/1721.1/34538

[xiv] http://nztelco.com/?p=464

[xv] http://www.rsm.govt.nz/smart-web/smart/page/-smart/domain/licence/SelectLicencePage.wdk?fromHome=Yes

[xvi] http://www.motorolasolutions.com/web/Business/_Documents/static%20files/Realistic_LTE_Experience_White_Paper_FINAL.pdf

[xvii] http://www.fiercewireless.com/europe/story/analysys-mason-lte-can-boost-revenues-alone-cant-make-tough-market-conditio/2013-08-21