

NZFUNDS

CIO Report: Q1 2015

April 2015



First quarter review

Returns for the first quarter of 2015 were strong. As each client's portfolio is customised to their risk and savings (or spending) profile, we use five indicative "portfolios" to track progress. So far this year these Portfolios have appreciated between 3.48% and 8.36% depending on age and risk. This takes client returns over the last twelve months to between 10.01% and 22.86%¹.

While these are encouraging, the only figure that matters at the end of the day is the extent to which we have been able to grow our clients' (and our own) savings over time. While each client's inception date will vary, it is worth setting out the Portfolio gains since 2008 when the Portfolios were restructured. The numbers are after management fees, and tax (assuming the highest PIR rate (currently 28%)). We realise the table omits a number of strategies, both good and bad, that we have managed over the preceding 20 years.

Performance overview *after fees and investor tax*

MANAGED PORTFOLIO SERVICE	1 YEAR	2 YEAR	5 YEAR	SINCE INCEPTION	INCEPTION DATE
Core Cash Portfolio	2.45%	4.36%	10.08%	17.95%	28 February 2008
Core Income Portfolio	4.41%	6.86%	21.45%	29.13%	23 July 2008
Global Income Portfolio	2.80%	4.12%	16.21%	22.75%	31 October 2008
Core Inflation Portfolio	11.28%	13.88%	37.32%	47.75%	31 October 2008
Property Inflation Portfolio	14.37%	15.90%	33.78%	39.63%	31 October 2008
Equity Inflation Portfolio	15.47%	23.39%	56.06%	103.67%	31 October 2008
Core Growth Portfolio	15.99%	34.01%	33.39%	39.46%	31 October 2008
Global Multi-Asset Growth Portfolio	-18.26%	-20.11%	-	-24.37%	7 November 2011
Global Equity Growth Portfolio	23.55%	37.84%	34.02%	40.54%	31 October 2008
Dividend & Growth Portfolio	16.90%	21.02%	36.99%	43.59%	31 October 2008
Capital Opportunities Portfolio	10.59%	23.22%	79.78%	91.26%	23 July 2008

NZ FUNDS KIWISAVER SCHEME	1 YEAR	2 YEAR	3 YEAR	SINCE INCEPTION	INCEPTION DATE
KiwiSaver Income Strategy	3.14%	4.92%	9.81%	14.79%	31 October 2010
KiwiSaver Inflation Strategy	12.41%	16.44%	28.37%	30.52%	31 October 2010
KiwiSaver Growth Strategy	21.66%	39.21%	59.78%	54.29%	31 October 2010
Term deposit index (after tax)	2.70%	5.37%	14.92%	-	-

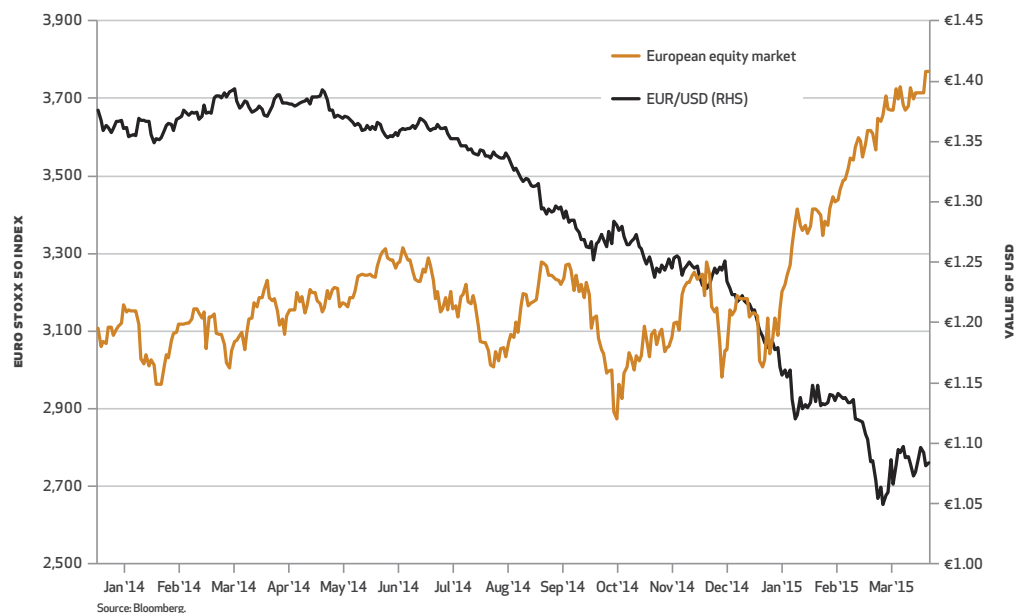
Investment outlook

There is a perception that during good times everyone earns strong returns. It is a half truth. There are as many ways to fail as an investment manager as there are as a client: owning the wrong assets (or managers), buying the wrong shares or bonds, losing one's nerve or changing course, not changing course, and acting without due care, process or integrity. Consequently, we are proud of our progress to date. We are also aware that we are only half way through the current investment cycle. To use a cricket analogy; we have set a good target batting, but still need to bowl and field well when the downturn comes.

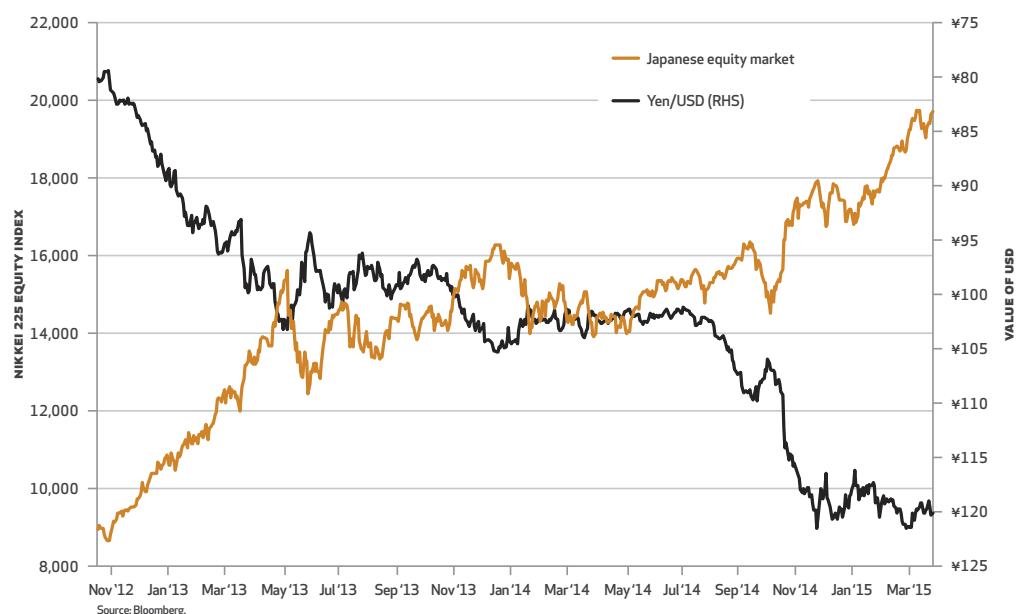
Current approach

Globally, shares continue to rise, driven by artificially low interest rates, weak but positive economic growth and continued quantitative easing. Regional economies are becoming more aligned thanks to central bankers. In quick succession we have now seen expansionary monetary policy boost United States, European and Japanese shares. Outside the United States, this trend has seen a decline in their currency followed by a rise in their sharemarkets. We are seeing the pattern repeat itself in China and are currently looking to take advantage of this. Clients currently own meaningful shareholdings in each market: United States \$168 million, Europe \$62 million, Japan \$31 million and China \$15 million, respectively.

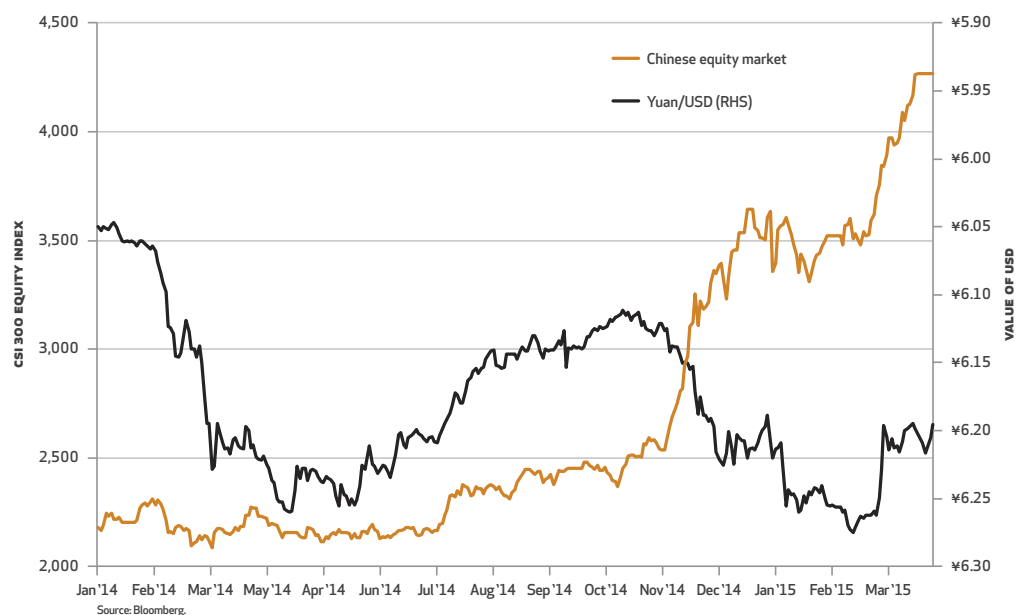
European equity market



Japanese equity market



Chinese equity market



Ultimately, this is an unsustainable state of affairs. Either central banks will have to begin raising interest rates, or inflation will be rekindled. Over the past year we have reviewed each scenario to see how we can fortify clients' savings against these possibilities.

First, as shares have risen we have increased our investment in defensive managers such as New York based **Tweedy, Browne**, Chicago based **LSV**, London based **TT Funds**, and added a local boutique, **Devon Funds**. We believe these managers will hold up well during a downturn.

Second, we continue to increase clients' investment in downside orientated hedge funds, such as Florida based **Universa** and London based **ISAM**. During the Global Financial Crisis, Universa's portfolio rose over 100% in value, while ISAM delivered a 77% return.

Third, we have also increased clients' exposure to hedge funds where the managers have the ability to be both long and/or short individual companies. Long-short manager returns are predominately determined by their ability to identify good quality companies rather than by the direction of the market. We include London based **Odey** and New York based **Suverture** in this category.

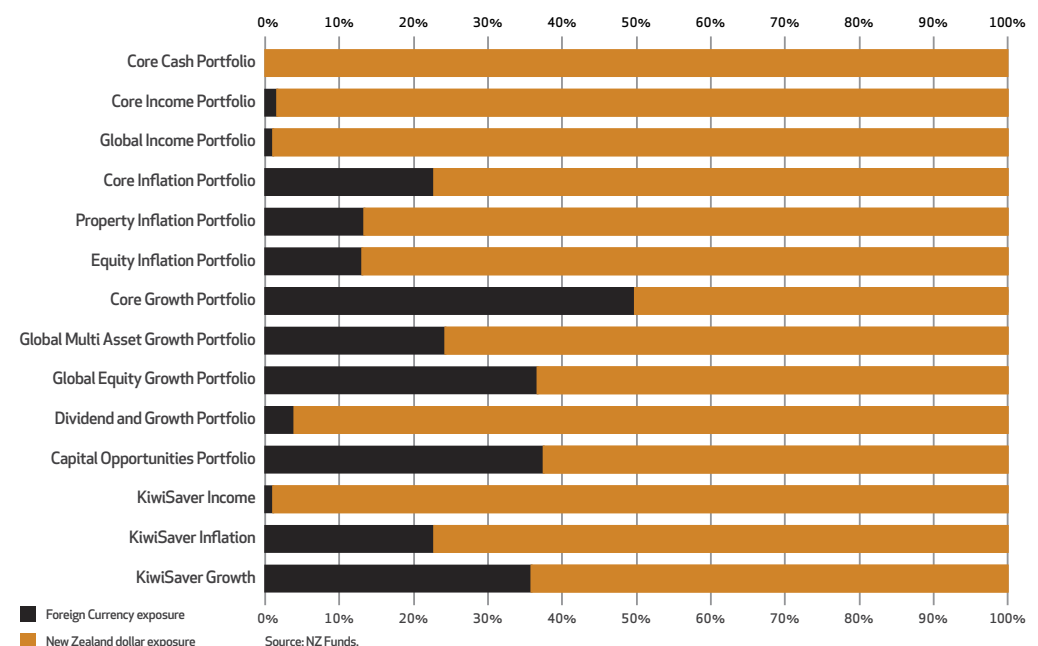
And while the threat of inflation would appear less imminent, our portfolio construction methodology ensures all clients own an actively managed exposure to inflation-orientated assets such as property, inflation linked-bonds and commodities. Commodities in particular have underperformed for a number of years and in many cases now trade well below long-term sustainable prices. As has been the case with shares, the time is approaching where our job will be to capture the upside from commodities, rather than mitigate the downside. We look forward to the challenge.

In what currencies should clients hold their wealth?

Globally we are seeing a marked increase in the speed at which global currency prices change, including our own New Zealand dollar. It is as important to address the risk New Zealanders take by holding all their wealth in New Zealand dollars, as it is to consider the risks associated with New Zealanders holding a portion of their wealth in foreign currencies without the specialist tools needed to manage volatility.

By way of example, on 10 March the New Zealand Stock Exchange announced a trading halt on listed dairy producing companies. The New Zealand dollar fell over half a cent against the United States dollar within minutes. In this case the announcement was about the possible 1080 contamination of baby milk powder and was subsequently considered a low possibility by the markets so the currency quickly recovered. But if, for example, it had been an announcement about an outbreak of foot and mouth, the currency may well have lost a third of its value or more. It therefore makes sense to ensure clients hold a portion of their wealth in the currency of a larger, more diversified economy.

Clients' foreign currency exposure



On the other hand, we are surprised by the number of New Zealanders we meet who have diversified their investments internationally but who have little or no ability to protect themselves from a change in value of the currency. For example, over the last three years the New Zealand dollar has increased in value by 25% against the Australian dollar. This has reduced the value of Australian investments owned by New Zealanders by a corresponding amount.

Investing through PIE tax efficient portfolios, as we advocate, enables clients to be diversified internationally and to have their foreign currency exposure professionally managed.

NZ Funds' investment team includes Dave Wilson, former Reserve Bank of New Zealand economist with 30 years experience, Mark Brooks, an interest rate and currency specialist with more than 20 years industry experience and Grant Cotty, who before joining NZ Funds worked on the currency desk of a major Australasian bank. Had an outbreak of foot and mouth occurred we stood by ready to move a significant portion of our clients' growth-orientated assets into United States dollars.

United States dollar



Devon Funds Management

As clients know, we seek to ensure their assets are managed by a range of global investment specialists that complement our experienced in-house investment team. During the quarter we confirmed the inclusion of New Zealand based Devon Funds Management (Devon) as a manager.

Managers either provide a superior way to access an asset class, for example they might offer higher returns (after fees and tax) than an index approach, or they may manage risk more actively than an index-orientated approach. Clearly, if an asset class no longer makes sense for clients, we are likely to redeem from a manager chosen for this reason as well.

Alternatively, we may also choose to invest with a manager, irrespective of our view of the asset class they invest in, where we believe the manager is so good that they can add value to clients' portfolios, irrespective of an asset class's underlying rate of return.

Devon falls into the latter category. Their approach to Australasian shares complements NZ Funds' dividend harvesting long-term buy and hold approach. Their inclusion enables clients to be invested in both styles. We have known a number of their team for over 20 years. They are exceptional guardians of client capital.

Global manager selection

During the quarter we also reviewed the performance of the managers we have chosen to invest with since 2009. Of the 33 different managers we worked with, 19 (58%) both grew clients' capital and out-performed their benchmark. Two managers lost money (reflecting the asset class they invested in), but were able to mitigate the loss that would have occurred had we invested in a passive index. The remaining 12 (37%) underperformed their benchmark but in four of these cases this was due to the manager taking a more conservative (less risky) approach, a quality we looked for when investing with them. We redeemed from six managers due to their poor performance and the remaining two that have underperformed are currently on our watch list.

This analysis shows we have experienced a 75% success ratio when selecting managers. The results speak volumes about the proprietary approach the team has to manager selection which deliberately eschews the approach taken by investment consultants.

People and companies

Once a week the Investment Research & Management team spends half a day peer reviewing research undertaken during the week. The meeting is attended by our Legal & Compliance team. With more than 90 years of collective investment experience in attendance the meetings can be an intimidating forum to present to. Last month Adrian Hansen presented an exceptional piece of research on Chorus, a summary of which is attached.

Chorus is building a fibre optic network which will reach over 50% of New Zealand households. We estimate it will take 11 years and cost \$1.6 billion to build. Taking a very conservative view which assumes continued loss in market share to wireless operators, we estimate that when this network is built, Chorus' annual earnings before depreciation, interest and tax will be at least \$550 million. Using a multiple of earnings typically associated with a regulated utility, under this scenario Chorus's shares would be worth at least \$5.50. Today the shares are trading at around \$2.90. We also expect them to pay a dividend higher than bank deposits while they build the network. NZ Funds currently holds an \$11 million shareholding in Chorus on clients' behalf.

Top 10 Companies - Managed Portfolio Service (MPS)

COMPANY	INDUSTRY	COUNTRY	NZFM CLIENT HOLDING	% OF TOTAL MPS	DIVIDEND YIELD*	COMPANY SIZE (MILLION)
Chorus	Telecommunication Services	New Zealand	\$9,516,917	1.21%	4.1%	NZD1,130
Metlifecare	Health Care	New Zealand	\$9,159,572	1.17%	1.2%	NZD1,000
Meridian Energy	Utilities	New Zealand	\$8,784,442	1.12%	8.7%	NZD6,340
Servcorp	Financials	Australia	\$8,327,119	1.06%	5.2%	AUD644
Mighty River Power	Utilities	New Zealand	\$5,666,647	0.72%	7.0%	NZD4,268
DNZ Property Fund	Financials	New Zealand	\$5,103,380	0.65%	6.3%	NZD580
Spark New Zealand	Telecommunication Services	New Zealand	\$4,036,011	0.51%	8.5%	NZD5,468
Fletcher Building	Materials	New Zealand	\$3,222,756	0.41%	5.6%	NZD5,792
Z Energy	Energy	New Zealand	\$3,158,952	0.40%	7.6%	NZD2,052
American Homes 4 Rent	Financials	United States	\$3,103,007	0.40%	6.5%	USD3,499

Top 10 Companies - NZ Funds KiwiSaver Scheme

COMPANY	INDUSTRY	COUNTRY	NZFM CLIENT HOLDING	% OF TOTAL KS	DIVIDEND YIELD*	COMPANY SIZE (MILLION)
Metlifecare	Health Care	New Zealand	\$2,522,004	2.40%	1.2%	NZD1,000
Meridian Energy	Utilities	New Zealand	\$2,287,192	2.18%	8.7%	NZD6,340
Spark New Zealand	Telecommunication Services	New Zealand	\$887,695	0.84%	8.5%	NZD5,468
Mighty River Power	Utilities	New Zealand	\$830,669	0.79%	7.0%	NZD4,268
Restaurant Brands	Consumer Discretionary	New Zealand	\$783,724	0.75%	7.2%	NZD395
Fletcher Building	Materials	New Zealand	\$677,194	0.64%	5.6%	NZD5,792
Johnson & Johnson	Health Care	United States	\$631,790	0.60%	6.5%	USD279,617
SAP	Information Technology	Germany	\$618,625	0.59%	5.6%	EUR80,626
Royal Dutch Shell	Energy	Netherlands	\$609,149	0.58%	9.4%	EUR129,871
Port of Tauranga	Industrials	New Zealand	\$594,046	0.57%	4.7%	NZD2,307

* Dividend yield hedged to New Zealand dollars.

As with many of the largest positions we have acquired, we expect Chorus to remain a regulated asset. We see this as a positive factor and not a negative. The Commerce Commission have, over many decades, proven themselves excellent at balancing New Zealanders' right to a fair price, with investors'

need for a competitive return. In time we expect Chorus to join the long list of regulated, high quality, New Zealand assets which have returned multiples of the original investment for clients².

Our ability to systematically identify investment opportunities of such calibre depends on the quality and stability of the people at our firm. Adrian has a background in electrical engineering and holds a Bachelor of Engineering Degree from Auckland University with first class honours. He joined NZ Funds' Research & Management team five years ago, after spending six years as a senior member of the IT team. The barriers to joining the investment team are significant, and the internal and external competition intense. Applicants are required to study in their own time to become a Chartered Financial Analyst (CFA) charterholder. The CFA programme requires candidates to sit three six hour exams. The ten year average pass rate per exam is only 42%.

After completing his studies, Adrian has proven himself to be an exceptional addition to the team. Many Authorised Financial Advisers who partner with NZ Funds will be familiar with the rigorous risk management and compliance software system which he developed. We believe it to be superior, for Australasian securities, to some of the top global trading systems available including UBS Delta Software, Bloomberg's Asset and Investment Manager and MSCI Barra One's Risk Management System.

I believe client outcomes will ultimately be determined by the culture, skill and integrity of the organisation they partner with. We are grateful that individuals of Adrian's calibre have chosen to share their career with NZ Funds and our clients.

Thank you for investing with us, and for your continued confidence.



Michael Lang
Chief Investment Officer.

1 Pre tax returns are stated after Portfolio fees and expenses, but before any advisory fees or investor tax. Post tax returns are stated after Portfolio fees and expenses and investor tax at the highest Personal Income Rate (PIR). From 1 October 2008 to 30 September 2010 the highest PIR was 30%. Since 1 October 2010 the highest PIR has been 28%. Past performance is not necessarily an indication of future returns.





2 Companies which NZ Funds has purchased on clients' behalf which have more than doubled include Auckland International Airport, Trustpower, Port of Tauranga, SkyCity Casino, Sky TV, Natural Gas (now Vector) and most recently MetlifeCare, ServCorp and Meridian Energy.

Investment Statement(s): For further information or to request a copy of the NZ Funds Managed Portfolio Service Investment Statement or the NZ Funds KiwiSaver Scheme Investment Statement, please contact NZ Funds or see our website www.nzfunds.co.nz

Appendices

Managed Portfolio Service: Performance (Part 1)





Cumulative returns to 31 March 2015

Managed Portfolio Service		Actual Portfolio Returns							Historic Investment Profile Returns	
Category	Portfolio		1 month	3 months	6 months	1 year	2 years	5 years	10 years	Since inception
 Cash	Core Cash Portfolio ²	Pre tax	0.30%	0.87%	1.76%	3.42%	6.11%	14.31%	-	26.20%
		Post tax	0.22%	0.62%	1.26%	2.45%	4.36%	10.08%	-	17.95%
 Income	Core Income Portfolio ³	Pre tax	0.21%	1.49%	2.98%	6.17%	9.62%	31.04%	-	42.99%
		Post tax	0.15%	1.07%	2.14%	4.41%	6.86%	21.45%	-	29.13%
	Global Income Portfolio ¹	Pre tax	0.10%	0.58%	1.39%	3.89%	5.73%	23.33%	-	33.38%
		Post tax	-0.03%	0.26%	0.91%	2.80%	4.12%	16.21%	-	22.75%
 Inflation	Core Inflation Portfolio ⁴	Pre tax	-0.57%	3.37%	3.86%	11.61%	14.20%	30.26%	-	36.99%
		Post tax	-0.70%	3.05%	3.96%	11.28%	13.88%	37.32%	-	47.75%
	Property Inflation Portfolio ¹	Pre tax	0.83%	3.52%	8.31%	15.06%	17.85%	39.97%	-	46.69%
		Post tax	0.58%	3.08%	7.27%	14.37%	15.90%	33.78%	-	39.63%
	Equity Inflation Portfolio ⁴	Pre tax	-0.94%	3.75%	6.67%	14.88%	21.35%	34.43%	-	40.91%
		Post tax	-0.98%	3.88%	7.12%	15.47%	23.39%	56.06%	-	103.67%
 Growth	Core Growth Composite Strategy ⁶	Pre tax	0.33%	7.81%	10.95%	19.15%	38.63%	40.64%	92.66%	163.85% ⁸
		Post tax	-0.11%	6.71%	8.42%	15.99%	34.01%	33.39%	-	n/a
	Global Multi-Asset Growth Portfolio ⁹	Pre tax	-2.81%	-1.87%	-10.09%	-16.27%	-18.20%	-	-	-22.58%
		Post tax	-3.07%	-3.00%	-11.78%	-18.26%	-20.11%	-	-	-24.37%
	Global Equity Growth Composite Strategy ⁵	Pre tax	1.19%	8.83%	16.62%	27.32%	42.59%	39.46%	91.86%	216.97% ⁸
		Post tax	0.82%	7.81%	14.38%	23.55%	37.84%	34.02%	-	n/a
	Dividend and Growth Composite Strategy ⁷	Pre tax	-0.21%	6.36%	13.57%	18.08%	24.43%	41.24%	60.23%	518.52% ⁸
		Post tax	-0.78%	5.92%	12.77%	16.90%	21.02%	36.99%	-	n/a
	Capital Opportunities Portfolio ³	Pre tax	0.28%	3.24%	3.33%	10.86%	28.16%	112.74%	-	108.16%
		Post tax	-0.07%	2.69%	2.90%	10.59%	23.22%	79.78%	-	91.26%

IMPORTANT: Please refer to page 10 of this summary for the footnotes relating to this page.
Past performance is not necessarily an indication of future returns.

Managed Portfolio Service: Performance (Part 2)

Annualised returns to 31 March 2015

Managed Portfolio Service		Actual Portfolio Returns							Historic Investment Profile Returns	
Category	Portfolio		1 month	3 months	6 months	1 year	2 years	5 years	10 years	Since inception
 Cash	Core Cash Portfolio ²	Pre tax	0.30%	0.87%	1.76%	3.42%	3.01%	2.71%	-	3.34%
		Post tax	0.22%	0.62%	1.26%	2.45%	2.16%	1.94%	-	2.36%
 Income	Core Income Portfolio ³	Pre tax	0.21%	1.49%	2.98%	6.17%	4.70%	5.56%	-	5.49%
		Post tax	0.15%	1.07%	2.14%	4.41%	3.37%	3.96%	-	3.90%
	Global Income Portfolio ¹	Pre tax	0.10%	0.58%	1.39%	3.89%	2.83%	4.28%	-	4.59%
		Post tax	-0.03%	0.26%	0.91%	2.80%	2.04%	3.05%	-	3.25%
 Inflation	Core Inflation Portfolio ⁴	Pre tax	-0.57%	3.37%	3.86%	11.61%	6.86%	5.43%	-	5.03%
		Post tax	-0.70%	3.05%	3.96%	11.28%	6.71%	6.55%	-	6.27%
	Property Inflation Portfolio ¹	Pre tax	0.83%	3.52%	8.31%	15.06%	8.56%	6.96%	-	6.15%
		Post tax	0.58%	3.08%	7.27%	14.37%	7.66%	5.99%	-	5.34%
	Equity Inflation Portfolio ⁴	Pre tax	-0.94%	3.75%	6.67%	14.88%	10.16%	6.10%	-	5.49%
		Post tax	-0.98%	3.88%	7.12%	15.47%	11.08%	9.31%	-	11.72%
 Growth	Core Growth Composite Strategy ⁶	Pre tax	0.33%	7.81%	10.95%	19.15%	17.74%	7.06%	6.78%	8.48% ⁸
		Post tax	-0.11%	6.71%	8.42%	15.99%	15.76%	5.93%	-	n/a
	Global Multi-Asset Growth Portfolio ⁹	Pre tax	-2.81%	-1.87%	-10.09%	-16.27%	-9.56%	-	-	-7.26%
		Post tax	-3.07%	-3.00%	-11.78%	-18.26%	-10.62%	-	-	-7.89%
	Global Equity Growth Composite Strategy ⁵	Pre tax	1.19%	8.83%	16.62%	27.32%	19.41%	6.88%	6.73%	6.23% ⁸
		Post tax	0.82%	7.81%	14.38%	23.55%	17.41%	6.03%	-	n/a
	Dividend and Growth Composite Strategy ⁷	Pre tax	-0.21%	6.36%	13.57%	18.08%	11.55%	7.15%	4.83%	8.50% ⁸
		Post tax	-0.78%	5.92%	12.77%	16.90%	10.01%	6.50%	-	n/a
	Capital Opportunities Portfolio ³	Pre tax	0.28%	3.24%	3.33%	10.86%	13.21%	16.30%	-	11.58%
		Post tax	-0.07%	2.69%	2.90%	10.59%	11.00%	12.45%	-	10.18%

IMPORTANT: Please refer to page 10 for the footnotes relating to this page.
Past performance is not necessarily an indication of future returns.

Managed Portfolio Service: Notes

Returns

Pre tax returns are stated after Portfolio fees and expenses, but before any advisory fees or investor tax. Post tax returns are stated after Portfolio fees and expenses and investor tax at the highest Prescribed Investor Rate (PIR). From 1 October 2008 to 30 September 2010 the highest PIR was 30%. Since 1 October 2010 the highest PIR has been 28%. Past performance is not necessarily an indication of future returns.

Composite Strategies

The Composite Strategies have been developed to illustrate the long-term performance of the investment categories represented by the relevant Portfolios.

The Composite Strategies are not the historic returns of the Portfolios.

They illustrate the historical performance of the NZ Funds approach of managing assets of the type held within the respective NZ Funds Managed Portfolio Service Portfolio to which each Composite Strategy relates.

The Composite Strategies are tax-adjusted to remove, as much as possible, the impact of the different tax regimes that applied during the calculation period. The pre tax returns are also stated after Portfolio fees and expenses, but before any advisory fees or investor tax. The post tax returns are stated after Portfolio fees and expenses and investor tax at the highest Prescribed Investor Rate (PIR).

For more detail on the calculation of each of the Composite Strategies please contact NZ Funds.




The performance of the Composite Strategies is not an indication of future Portfolio returns.

Footnotes for pages 8 & 9

- 1 Inception date was 31 October 2008.
- 2 Inception date was 28 February 2008.
- 3 Inception date was 23 July 2008.
- 4 Performance is measured since the launch of the APS platform (now known as NZ Funds Managed Portfolio Service) on 31 October 2008. The post tax since inception returns for the Core Inflation Portfolio and the Equity Inflation Portfolio include the benefit of formation tax losses under the PIE rules. For more detail, please contact NZ Funds.
- 5 Composite strategy inception was 6 March 1996.
- 6 Composite strategy inception was 1 May 2003.
- 7 Composite strategy inception was 2 December 1992.
- 8 Pre tax equivalent gross return (for more detail, refer to the performance page for each Portfolio/Composite Strategy).
- 9 Inception date was 7 November 2011.




NZ Funds KiwiSaver Scheme: Performance (Part 1)

Cumulative returns to 31 March 2015

NZ Funds KiwiSaver Scheme		Returns						
Strategy		1 month	3 months	6 months	1 year	2 years	3 years	Since Inception
 Income	Pre tax	0.15%	0.69%	1.60%	4.36%	6.82%	13.80%	21.24%
	Post tax	0.01%	0.33%	1.05%	3.14%	4.92%	9.81%	14.79%
 Inflation	Pre tax	-0.48%	3.66%	4.59%	13.19%	17.78%	31.52%	36.07%
	Post tax	-0.64%	3.26%	4.47%	12.41%	16.44%	28.37%	30.52%
 Growth	Pre tax	0.75%	9.39%	16.64%	25.14%	45.07%	68.15%	63.78%
	Post tax	0.40%	8.08%	14.01%	21.66%	39.21%	59.78%	54.29%

NZ Funds KiwiSaver Scheme: Performance (Part 2)

Annualised returns to 31 March 2015

NZ Funds KiwiSaver Scheme		Returns						
Strategy		1 month	3 months	6 months	1 year	2 years	3 years	Since Inception
 Income	Pre tax	0.15%	0.69%	1.60%	4.36%	3.35%	4.40%	4.46%
	Post tax	0.01%	0.33%	1.05%	3.14%	2.43%	3.17%	3.17%
 Inflation	Pre tax	-0.48%	3.66%	4.59%	13.19%	8.53%	9.56%	7.23%
	Post tax	-0.64%	3.26%	4.47%	12.41%	7.91%	8.68%	6.22%
 Growth	Pre tax	0.75%	9.39%	16.64%	25.14%	20.44%	18.91%	11.83%
	Post tax	0.40%	8.08%	14.01%	21.66%	17.99%	16.91%	10.32%

Pre tax returns are stated after Strategy fees and expenses, but before any advisory fees or investor tax. After tax returns are stated after Strategy fees and expenses and investor tax at the highest Prescribed Investor Rate (PIR). From 1 October 2008 to 30 September 2010 the highest PIR was 30%. Since 1 October 2010 the highest PIR has been 28%. Past performance is not necessarily an indication of future returns.

Technological threats to Chorus

Executive summary

This paper investigates potential rivals that could eat into the market share of Chorus' new fibre lines. It tries to determine if within the next 10 years Chorus will have a virtual monopoly or operate in a crowded market.

New cellular technology is the most likely threat to fibre. New generation 4G will be capable of supplying most households with good quality internet even with increases in usage, including internet TV becoming widespread. While this is far from a certainty it is technologically possible. However, to be a viable threat it will need to be of sufficient quality and cheaper. If there is a far greater demand for the internet such as a move to 4k or 8k TV, then it is unlikely that wireless will be able to keep up due to physical constraints of the usable wireless spectrum. Up to a point smarter and cheaper new technology cell towers could be added to many residential streets, but as volumes increase the amount of trenching required, or the need to tap into the Chorus' network, would make this impractical and Chorus a better solution.

Another issue examined is whether Chorus' fibre network will need to be replaced in the foreseeable future. It appears this is unlikely to be the case.

What alternative technologies are available?

i) Wireless cell towers

Wireless cell towers are the incumbent technological alternative to fibre and represent a threat. With the advent of smartphones a great deal of effort has been put into increasing download speeds on mobile networks. This has been achieved in three ways.

First, adjacent cell towers used to have to operate on different frequencies. Towers were arranged in grids of 7 or 9 requiring the usable frequency spectrum at a location to be reduced by 7 to 9 fold. Today new technology has allowed adjacent sites to use the same frequencies allowing the full spectrum to be used.

Second, better encoding means that whereas GSM (2G) could produce 5.2Mbps from a 10MHz bandwidth, 3.5G can now produce about 40Mbps from 10Mhz bandwidth.



Third, systems with multiple antennas create multiple channels of communication increasing the data rate by approximately the number of antennas. Current 4G uses 4 antennas on the base station and the device almost quadruples the theoretical throughput.

Often wireless technology is referred to in terms of peak speed with real world speeds substantially lower. This can lead to overestimates of what is possible. The Data Speed table shows the efficiency increases over time of cell phone technology along with expected real world efficiency (this number is approximate with some studies suggesting only 1/6 of potential efficiency realised in real world implementations - I have tried to use conservative numbers).

Data speeds of various technologies

Technology	Launched	Efficiency (bit/s)/hz	Approximate realised efficiency
2G GSM	1991	00.057	
2.75G	2000	00.450	
WiMax	2004	01.200	
3.5G	2007	04.220	
4G LTE	2009	16.320	
4G LTE Advanced	2013	30.000	10

The question is whether this exponential growth in efficiency can be maintained. Shannon's law states the maximum capacity a communications channel can provide given a certain bandwidth and signal to noise ratio.

$$C = B \log_2 \left(1 + \frac{S}{N} \right)$$

The maximum data throughput a cell site can produce has now exceeded Shannon's law, something few would have thought possible earlier. The way this has happened is by clever technology allowing multiple antennas on a site to use the same frequencies, thereby opening new channels. The law was not broken but the assumptions on how many channels a cell tower can operate on now needs to be revised.

Given this I am not aware of a law that gives a theoretical maximum on what is possible from a single cell site. However, according to CNN "You can try to be more efficient, but we're really nearing the end of that," says Ken Rehbehn, an analyst with Yankee Group. "It's reaching the point of diminishing returns as we push up against the boundaries of physics."

As a consequence existing technology – mobile networks – pose a threat to fibre. The upcoming "true" 4G technology (LTE-Advanced) uses technological innovations, along with structural improvements to the network including using vastly improved small cells. These are small boxes deployable on existing infrastructure such as power poles. These are therefore cheap and do not require resource consent; however, they still require connection to a fixed network. To deploy these down residential streets would require expensive trenching (new fibre in the ground) or connection to Chorus' network.

ii) Satellites

Satellite internet already exists. It is a high cost, low quality solution usually employed in remote locations. It is possible to communicate bi-directionally with the satellites avoiding the use of fixed lines. Using point to point links such as with satellites has the advantage that it can operate over a much larger frequency spectrum (10x the amount of the cell phone spectrum). There are many drawbacks that have made it unpopular with cost being the primary barrier to wider deployment. Further, the high latency of geostationary satellites provides a poor internet experience. There are solutions to some of these issues such as larger satellite dishes and dishes that can track lower, faster moving satellites; however these all come at additional cost.



iii) Ultralight atmospheric aircraft as satellites

Solar powered ultralight aircraft are currently being developed which fly much lower than satellites and maintain a position for communication with a fixed ground antenna. This gets around the latency problem. These drones are still in development and will need to prove themselves able to carry a decent payload of communications gear. Again, they will be limited in spectrum in the same way that satellites are, but do have the potential to reduce the cost of a satellite network.



Will Chorus' fibre need upgrading?

The other threat to fibre is that it might need to be upgraded to meet future demands. Current speeds for fibre are low compared to what it is capable of. With Chorus' current network it is the equipment at each end of the fibre that is the limiting factor, not the fibre itself. The bandwidth of visible light is immense and researchers have already sent 100,000,000 Mbs through fibre optic cables.

The question becomes whether Chorus has sufficiently future-proofed its system by using enough cables and the right quality cables. From reading on the web it appears that individual cables are connected between roadside cabinets and houses and that it is high quality single mode fibres that have been deployed. To substantially upgrade the laid capacity more fibres may need to be threaded between the cabinets and exchanges. These types of upgrades have occurred in the past and are far less drastic than relaying connections to individual houses. It appears that the fibre is therefore well future-proofed.

Forecasting fibre usage

It is hard to predict what the requirements of broadband will be in the future. Most people assume it will be very high. But there have also been precedents for data requirements becoming smaller, such as people choosing the convenience of MP3 rather than the higher quality of CD or its supposed replacement the SACD which few of us ever ended up using. Typically though, with technology, when more capacity is available, it tends to get used.

Currently the big users are streaming television broadcasts (Netflix and Hulu) and internet video (YouTube). To get an idea of current requirements, Netflix suggests 5Mbs for 720p, while full HD (1080p) would require about 10Mbs. 4k Netflix requires 25Mbs. Interestingly, increases in TV size requires exponential increases in data requirements. For example, NHK in Japan is experimenting with Ultra High Definition TV (4320p / 8k) which would require a bitstream of 48,000Mbs that is compressed down to 500Mbs for transmission. If we moved to this standard we would probably require a 1.5Gbs connection for a house if two users wanted to watch different channels, and still have spare capacity for the internet. There could also be a lot of future development in this area, and new currently unthought of technologies that will move into this high bandwidth space.

Forecasting bandwidth requirements

In this section I investigate potential bandwidth requirement and make assumptions about whether the most likely rival technology - cellular networks - can provide it. I make the assumption there are no new speed increases in wireless technology but make generous assumptions about tower use and the availability frequency to use on them. How the future looks will in part depend on how a lounge looks in the future, whether it be users with personal devices such as iPads or centered around home networks and ultra high definition televisions.

If all the future requires is that users want to watch Netflix at 5Mbs, and we assume we have two TVs running per house plus a download going, we will require around 15Mbs. If we used 1000MHz (around one third of UHF) then 670 homes could potentially be serviced per cell site. This is similar to the roughly 600 houses served per cell site in the central North Shore region of Kaipatiki.

However, going to 8k UHD TV we would require 1000Mbs for two TV sets. Under such an assumption ten homes could be serviced. This seems an expensive and inappropriate way to deliver TV or other large bandwidth services.

Moving up a notch into Super High frequency, there is a potential total of 27,000MHz of spectrum, which is suitable for line of sight only, such as satellite communications. This spectrum is currently fully utilised but displacing everyone would allow up to 270 homes to be serviced. This assumes the same efficiency gains could be applied to satellite communications and that satellites could be suitably directional.

Moving up the frequency spectrum again, to the Extra High Frequency, there is another tenfold increase in capacity, but in moving towards the visible light spectrum we begin to experience some of its disadvantages such as being affected by precipitation. This would seriously reduce the reliability of the system.

Possible future scenarios

Scenario 1

The world moves to very high speed internet with the starting point in Gbs. If very high speed internet was ubiquitous, it is likely that fibre will be the transmission mechanism; wireless is unlikely to be competitive in this space. While it could compete on a limited basis the physical constraints imposed would mean few customers could be serviced without massively expanding the network by trenching or tapping into the Chorus network, making Chorus the likely winner.

Scenario 2

Usage of the internet doesn't extend much beyond current usage and some further uptake of Netflix-like services. In this case wireless is a severe threat which would require careful management by providers to maintain quality, but the possibility of utilising more frequency and further gains in efficiency could see large numbers watching internet TV from their home wirelessly. There still would need to be a catalyst for change as often lower cost solutions aren't taken up due to inertia. Chorus is likely to remain relevant and competitive.

Scenario 3

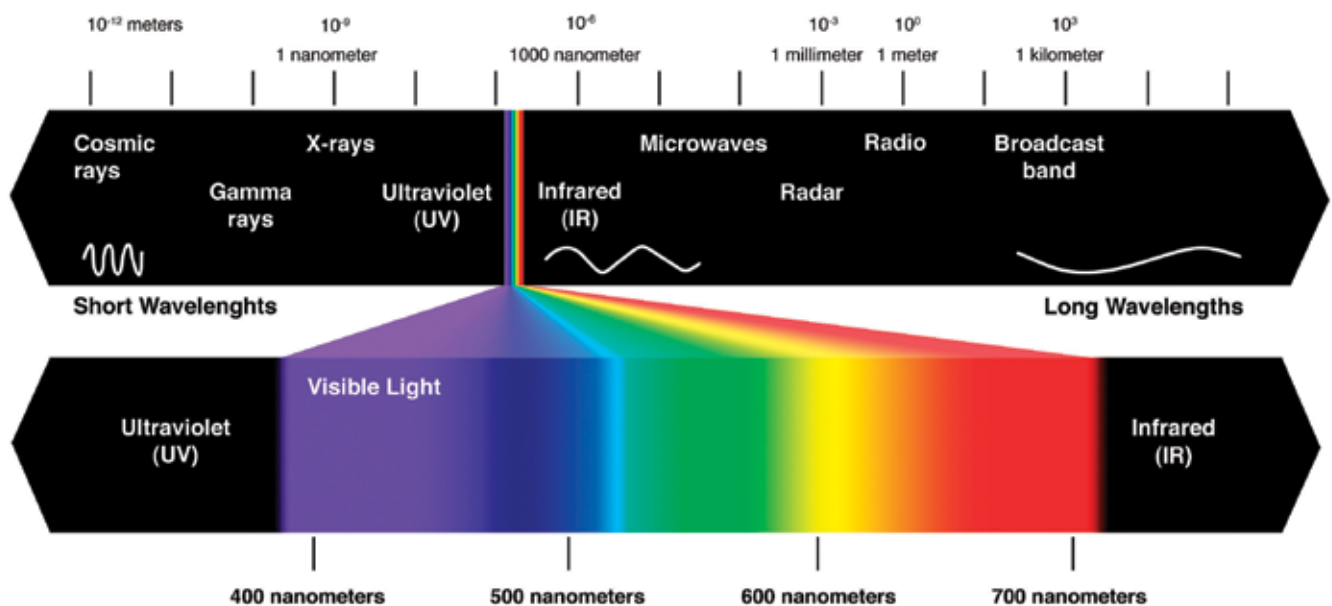
The internet becomes balkanised. There is a split between high data consumers on fibre and cost-conscious consumers opting for wireless. This scenario depends on the future of the lounge, with some users browsing iPads and watching standard definition TV and others having ultra high definition TV coming in via the internet. In this scenario Chorus also plays a role, but its addressable market is a fraction of scenario 1.

Appendices

Electromagnetic Radiation

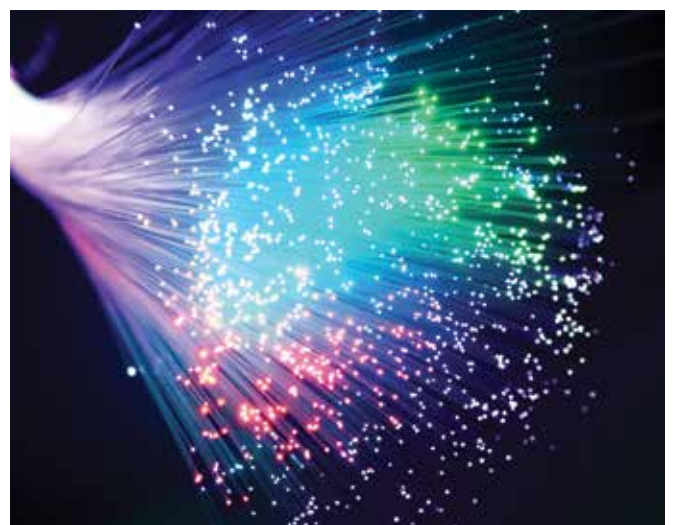
Electromagnetic Radiation(EM) encompasses light, radio waves and x-rays. EM is measured in Hertz(Hz) which equates to cycles/second. The amount of bandwidth available or the range of Hz is a good measure of the amount of information that can be transmitted. Radio waves are at the low end of the EM spectrum, and are used to transmit signals wirelessly. Lower frequencies can be transmitted greater distances and have the ability to bend around obstacles. Higher frequencies such as microwave have

more available bandwidth and are useful for point to point links such as satellite communications. Ultra High Frequency band that encompasses 300MHz to 3000MHz is suitable for cell phone communications due to its ability to bend. Much further up the frequency spectrum is visible light with a bandwidth of 320,000,000Mhz. Radio has physical limitations imposed by the available spectrum, light is constrained by the hardware used to transmit and receive.

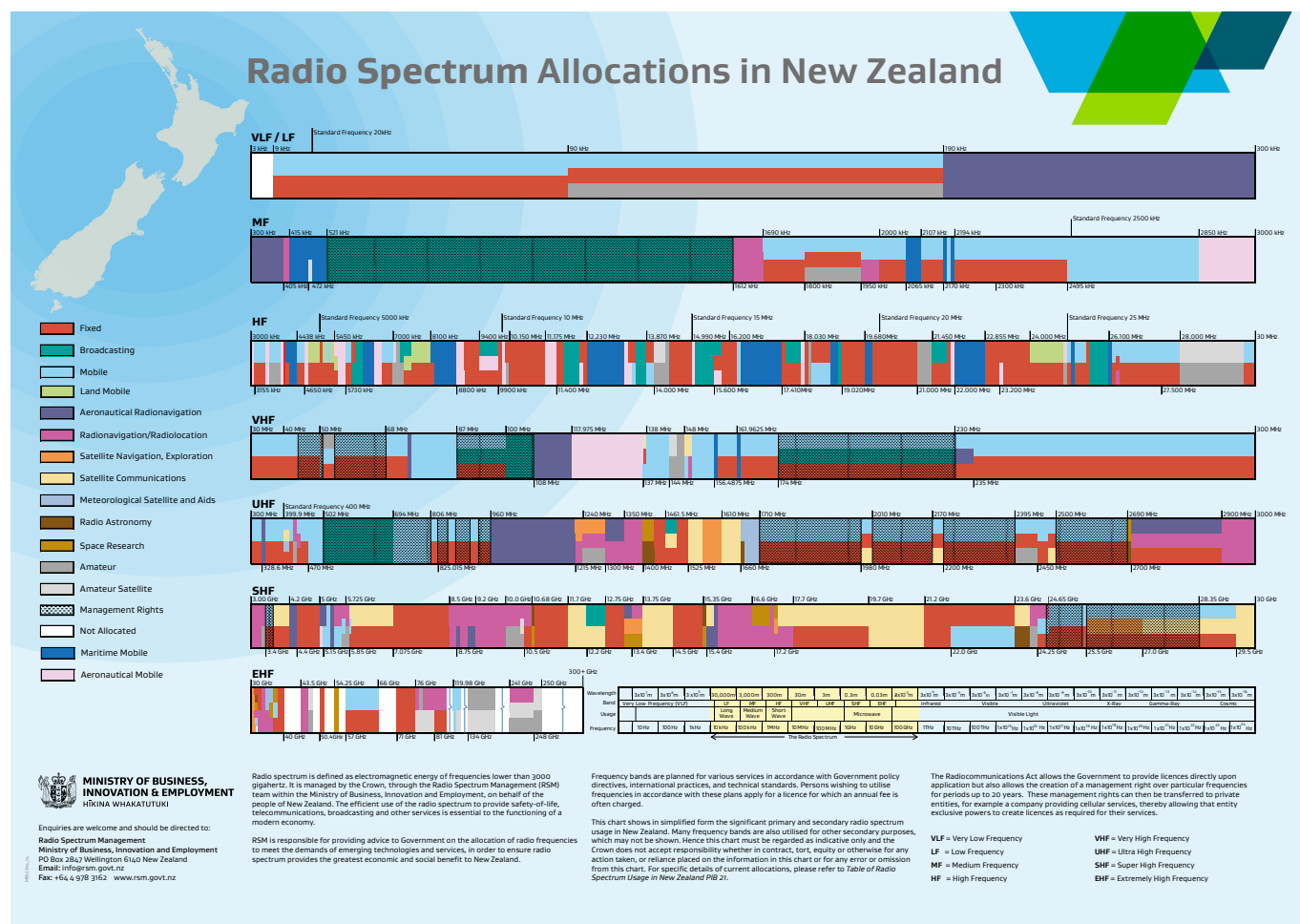


Fibre Optics

A fibre optic is a very thin glass fibre that relies on internal reflection to transmit light over very long distances with minimal loss. The technology is not new: fibre optics were patented for data communication in 1966 by which time lasers were already commercial. Due to the high frequency and bandwidth of light and the low noise characteristics of the fibre, vast amounts of information can be transmitted. The standard plans for fibre in New Zealand is 100Mb/s to a residential address and 1Gb/s to a business. There are 14 fibres connecting New Zealand to the rest of the world through the Southern Cross Link, the current system potential is thought to be >12TBs which per fibre is over 8,000 times faster than 100Mbps currently in use by most households.



Spectrum Allocations



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