NEW ZEALAND TECHNOLOGY
INDUSTRY ASSOCIATION

DIGITAL NATION NEW ZEALAND

From Tech Sector to Digital Nation

An Analysis of the Impact of the Tech Sector
and Technology on the New Zealand Economy

digitalnation.nz

References and Definitions

All the graphs in this book and the data used to create them can be freely accessed from Figure.NZ, a social enterprise making it easier for everyone to find and use data about New Zealand.

This printed report is also available in a digital format, to access the eBOOK please head to the NZTech website, **www.nztech.org.nz.**

2nd Print Run - August 2016

NEW ZEALAND TECHNOLOGY
INDUSTRY ASSOCIATION

About NZTech

NZTech is the voice of the New Zealand technology sector.

The New Zealand Technology Industry Association (NZTech) represents over 300 organisations from across the New Zealand technology landscape from start-ups and local tech firms to multinationals, and from ICT to high tech manufacturing. Organisations that are redefining the world we live in.

Our goal is to stimulate an environment where technology provides important productivity and economic benefits for New Zealand.

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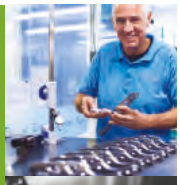

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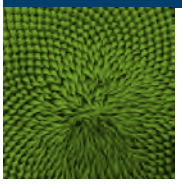

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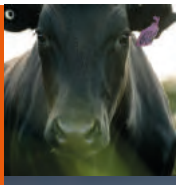

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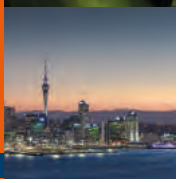

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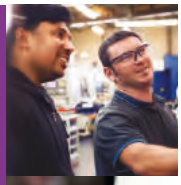

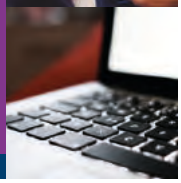

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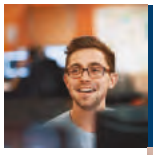
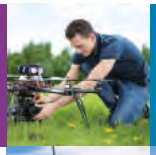
Towards a Digital Nation











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THANK YOU TO ALL

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nzsa


medical technology
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Precision Agriculture
Association New Zealand


NZmea

Graeme Muller
Chief Executive, NZTech

Introduction

With the rapidly changing pace of technology, most people are unaware of the exponential impact many technologies are having throughout society.

NEW ZEALAND TECHNOLOGY INDUSTRY ASSOCIATION

While there is general agreement that technology is important to the New Zealand economy, until now there has been little research to confirm this.

As the voice of the technology sector, NZTech set about finding out just how important it is. Without an answer there is serious risk that as a country we will miss opportunities for both economic and social growth.

While growth in tech exports will continue to be significant for New Zealand's economy, the social and economic gains that technology can enable are so vast that we believe more focus should be placed on it. This is why our report is titled "Digital Nation New Zealand, from tech sector to digital nation". The aim of this report is to deepen understanding and discussions about the benefits technology brings and the role that it could play in redefining the New Zealand we live in.

NZTech is a not for profit organisation whose purpose is to create a prosperous New Zealand led by a vibrant technology sector. NZTech engaged independent economic consultancy, the New Zealand Institute of Economic Research (NZIER) to analyse the sector and provide input into this report. Given the complexity of the task, another independent economic consultancy, Sapere was engaged to provide a peer review.

This study has been designed to define and size the broader technology sector, the jobs it creates, the export earnings it contributes AND the positive role that technology plays in other parts of the economy and society as a whole.

With a project of this size and scale, it would not have been possible without support from a large number of organisations. In particular, NZTech would like to thank its key supporters, The Ministry of Business, Innovation & Employment and Microsoft New Zealand. NZTech would also like to recognise and thank the many tech firms and industry organisations that supported and enabled this project.

FOREWORD

Chair of the Board, NZTech

New Zealand's tech sector is soaring as innovation and global connectedness obviate our small size and relative isolation.

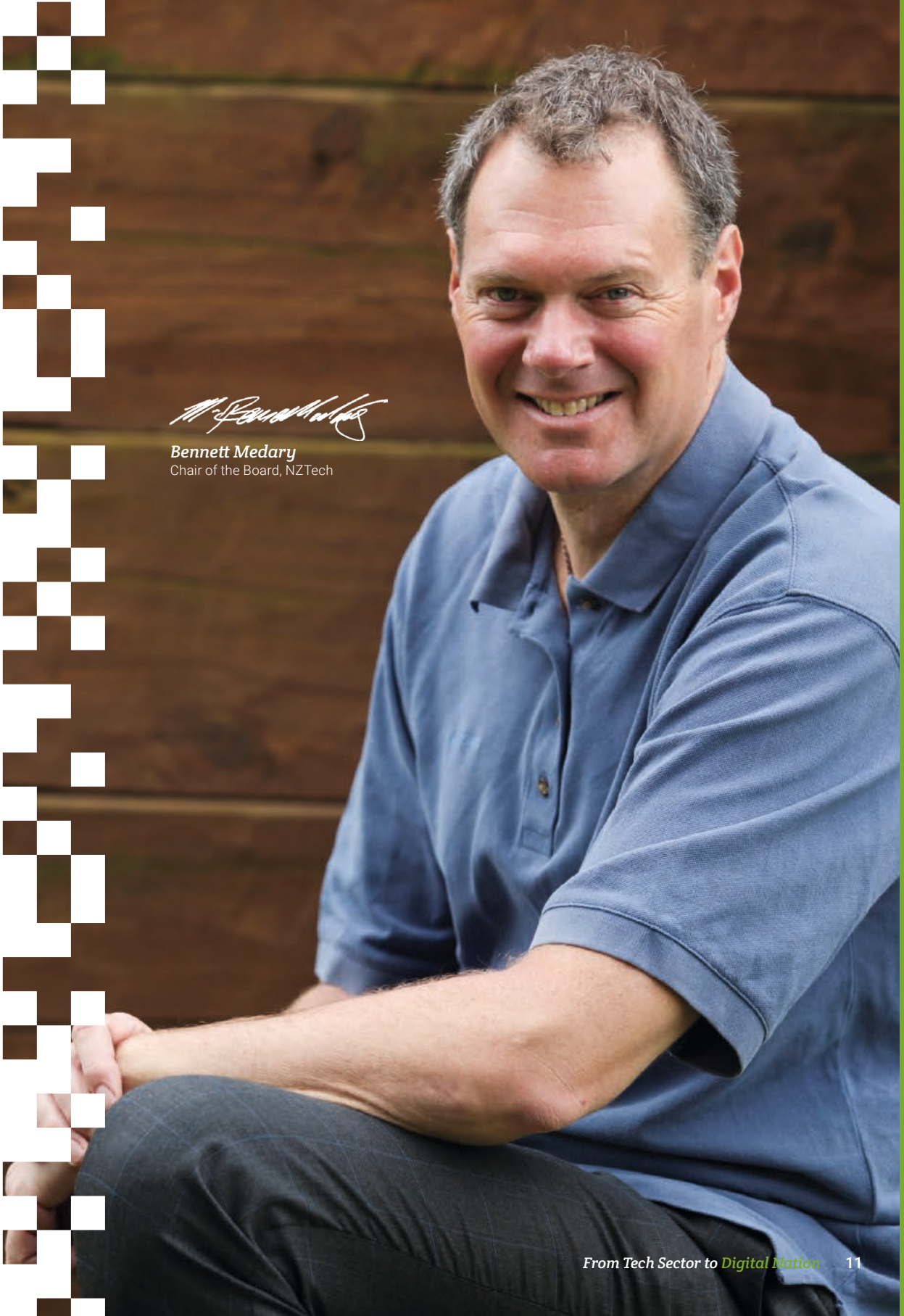
NEW ZEALAND TECHNOLOGY
INDUSTRY ASSOCIATION

New Zealand has 29,000 tech firms with nearly 100,000 employees contributing $16.2 billion to gross domestic product (GDP) and producing $6.3 billion in exports. It's this country's third biggest revenue earner. The world doesn't care about our size or location on the map, instead they recognise our innovation, quality and ease of doing business. Isolation now is more about connectivity and bandwidth as opposed to freight distances. In fact, our relative insignificance and neutrality in geopolitical terms makes us an attractive host nation. If we are cohesive as well as small, we can then also be both agile and decisive. That would be a huge competitive advantage.

The potential economic and social benefit of New Zealand as a truly digital nation is almost surreal. Already, in just over a decade, our contributions to GDP growth has been higher than any other OECD country. If we were to fully commit to being a digital nation as a core national strategy, and engage with global partners and investors, we could achieve an astonishing amount in five to 10 years. Ultimately, we will know we have made it as a digital nation when we are recognised for being the world's most tech savvy country, as well as being a beautiful place to visit with and the best source of food and beverage.

While the tech sector is our fastest growing industry, I would like to see tech, tourism, agriculture and many other sectors all growing concurrently and grabbing global market share. The biggest opportunity for NZ growth is the digital enablement of the rest of the economy, including the public sector.

The government needs to be bold and proud about our strategic direction as a digital nation. Our vision of Digital Nation New Zealand is a unifying platform. We need to include it in our national culture and psyche and this requires leadership. This research highlights and quantifies the importance of technology to our economy and the incredible potential we have to harness that. Now's the time!



Bennett Medary
Chair of the Board, NZTech

FOREWORD

Ministry of Business, Innovation & Employment

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

The purpose of the Ministry of Business, Innovation and Employment is to grow New Zealand for all. The growth of the digital sector, and the transformational impact that this sector can have on the wider economy, will play a critical role in creating a prosperous nation.

Digital technologies are transforming virtually all aspects of New Zealanders' lives. They are changing how we interact with one another and how we express ourselves, the way we learn, work and play, and how we access goods and services – including those delivered by government. Businesses and governments are going digital too. And it's changing the way goods and services are designed and delivered, and how providers engage and build relationships with their customers.

We are beginning to see some of the significant opportunities that digital technologies are creating in areas such as precision health care, e-education, and autonomous vehicles, and as government we need to consider what these changes mean for the work that we do. Over the coming decades, government – along with the rest of New Zealand – will be transformed irrevocably by digital technologies.

As a nation, we need to position ourselves to make the most of the opportunities that digital technologies are creating. Our small size gives us a unique advantage over larger countries. It means that we can move quickly and purposefully to seize the opportunities and manage the challenges of our changing digital world.

Our stable political and regulatory environments, along with our extensive investment in digital infrastructure, make us one of the best places in the world to do business and develop new technologies. We are a highly skilled nation, we have an international reputation as innovators, and our small but rapidly growing digital technologies sector shows that we can disrupt and compete in the global digital market.

The 2015 'Business Growth Agenda: Towards 2025 – Building Innovation Chapter' includes the Digital Economy Work Programme as a key focus. Through the Programme, government is driving an integrated set of cross-agency initiatives to enable New Zealand to become a leading digital nation.

This report, produced by NZTech, provides valuable information to help us better understand the technology sector and the opportunities this sector presents for New Zealand. The report also helps to extend discussion beyond the technology sector to the broader social and economic impacts that digital technologies are having on our lives. We look forward to working with the sector to shape government's Digital Economy Work Programme to enable a successful digital future for our nation.

David Smol
Chief Executive,
Ministry of Business, Innovation
and Employment

Barrie Sheers
Chief Executive,
Microsoft New Zealand

FOREWORD

Microsoft New Zealand

There is no doubt that we are all seeing and feeling the ever growing importance and impact of digital technologies in the lives of New Zealanders.

They are transforming our society and the economy in fundamental ways, and are integral to all our futures – especially our children's. But what does that really mean, what should we do about it and where does our technology sector feature in the answers?

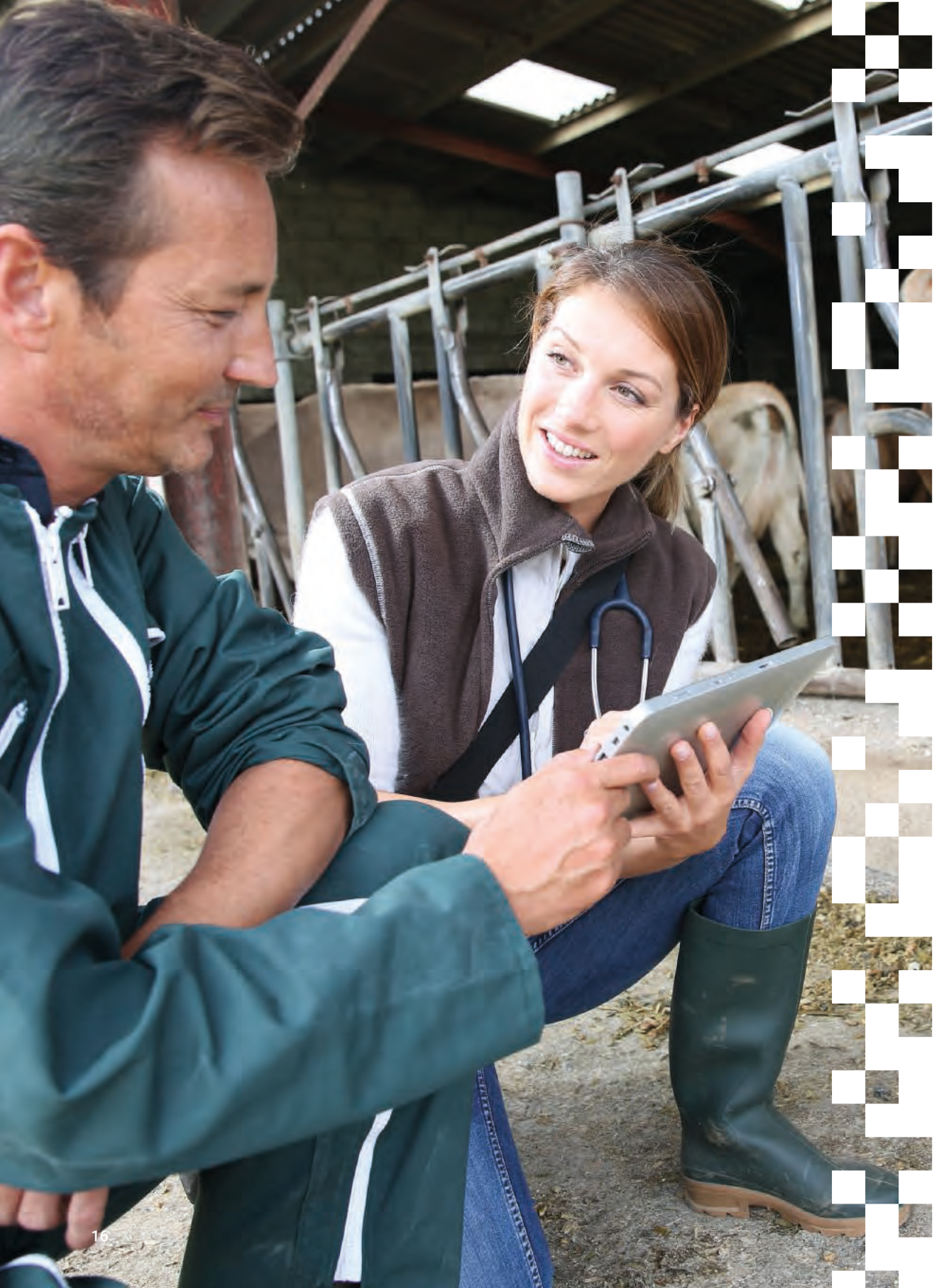
As this report shows, digital technologies are now a vital part of our economy. Looking simply at their impact on our national income, the technology sector's export earnings have doubled over the past few years, making it one of the country's largest export contributors.

However, looking at export earnings is insufficient for a full understanding of the role that the technology sector plays in New Zealand. This report highlights the fact that digital technology is now part of the very fabric of the economy and society. It is reshaping the nature of the opportunities our businesses face both locally and globally. It is changing the pattern of where we choose to live, the nature of the work we do and how we do it, and the choices we make about education and lifestyles. These and many other changes are dynamic, and their pace is accelerating.

Our collective future will be shaped by how well we understand and respond to such change. Businesses need to recognize new opportunities and make the right investments to realise them. Individuals and communities need to make informed choices about how they will react to the changes enveloping them. Government also needs to ensure that the actions it is taking – from making laws and developing strategies and policies, through to making long-term public investments, not just in digital infrastructures, but in things such as the education system and supporting innovation – serve to set the underlying conditions for our future success. All these things relate to the questions of what our technology sector is, and where it is headed.

This is where this report is so valuable and why we are so pleased to have been able to support it. It sheds new light and enables new and better understandings of both what our "tech sector" is, and where it fits in our economy. It provides insight into the many ways that New Zealand is already realising its digital opportunities that will inspire creative thinking about what comes next. I am confident that it will be invaluable to the many New Zealanders who are thinking about where digital technology can take us in future – both individually and collectively.

At Microsoft, our vision is to enable and empower every person and every organisation on the planet to achieve more. The title of this report – Digital Nation New Zealand: from tech sector to digital nation – perfectly articulates the context that surrounds how we set about achieving this mission, and the outcomes to which we want to contribute. But it is far beyond Microsoft and the rest of New Zealand's technology sector to do this on our own, and indeed not right that we should. Government, businesses and the people of New Zealand are all stakeholders in this journey, whether they realise it or not. Success demands that we all understand where we stand today, and where we might go tomorrow. This report will help us chart that journey forward.



Technology
- what is it and why is it important?

Technology, in its broadest sense, is machinery and devices developed from scientific knowledge and applied for practical purposes. In this research, when we discuss technology we are referring to "high-technology", which by definition is any technology requiring the most sophisticated scientific equipment and advanced engineering techniques, such as computers, data processing, telecommunications, the Internet, microelectronics and "high-tech" manufacturing.

Technology creates growth

Economic growth is driven by changes in technology. Economists[1] have found that long-run growth is driven by technological change rather than by greater inputs of capital or labour. New technologies such as steam power, electricity, vehicles, ICT and biotechnology have spawned clusters of innovations and cycles of growth.

Technology produces direct and indirect impacts

Technology is also important due to its ability to create both 'direct' (production) impacts and 'indirect' (use) impacts on economic growth. The first, is economic growth coming from the tech sector itself and is easily measured in GDP. The second, is the economic growth from the use of technology by other sectors. The evidence is that 'use' effects are much bigger than 'production' effects. It is what firms outside the tech sector do with technology that matters the most, but these are harder to see in the GDP numbers.

Technology enables information sharing

Technology enables information sharing and economic research shows this also helps drive economic growth. For example, in a recent World Bank study[2] it was estimated that each 10% increase in broadband penetration adds 1.3% to a country's GDP.

Technology allows data driven innovation

Improvements in computer technology have led to the ability to better capture, store, analyse and share data. This offers enormous potential for improving our understanding about customers and production processes allowing data-driven innovation and decision-making across products and processes. Recent research[3] found that New Zealand consumers enjoyed benefits of $1.3b in the form of lower prices, and businesses benefited by $1.1b of higher revenue, lower costs and more efficient operations thanks to data driven innovation.

Better use of technology creates better growth

McKinsey & Co.[4] recently identified a growing technology gap between the 'haves' and 'have mores' in the US economy, rather than a gap between the 'haves' and 'have nots'. Their report indicates tremendous potential growth for those adopting and using technology to its full potential, and a sizeable gap down to those who have the technology at their disposal but haven't yet been able to exploit it to its full potential.

Technology delivers benefits beyond GDP

Many ICT services in widespread use are provided for free to consumers, and their benefits are not counted in market transactions. For example, Facebook and other apps used for communication, recreation or convenience deliver definite consumer benefits, but are funded entirely by advertisers. There are significant benefits from ICT services that are not fully recognised in the GDP numbers. Additionally, GDP doesn't take into account the social, cultural or environmental impacts of technology.

Executive Summary

The convergence of ultra-fast connectivity, mobility and data analytics provides the platform for an ever increasing pace of technological change.

This change is global and as technology begins to remove traditional barriers, New Zealand is well positioned to take advantage.

Historically, New Zealand has not had a strong focus on high-tech, we are a primary production stronghold. Yet, the characteristics of our culture that led to the strength in primary production appear to also be useful in a connected, high-tech world. Now that geographic distance is no longer a barrier, our resourcefulness is being applied to problems all over the world via our fast growing tech sector. While the tech sector is a critical component of New Zealand's future economic success, the biggest impact will come from what we do with the technology that the sector produces.

The Tech Sector

The tech sector is made up of both ICT and high-tech manufacturing firms. Akin to the tourism sector, it consists of an array of different types of firms, yet there are common features that support viewing them as a sector. Organisations within the tech sector tend to have high levels of connectedness, innovation, R&D intensity and demand for similar skills.

Using an OECD definition for ICT and high-tech manufacturing, we established that in 2015 the tech sector consisted of 28,749 firms employing 5% of the national workforce, or 98,911 people. A further 20,154 tech workers are employed in other sectors. On average, those employed by the tech sector are the highest paid and highest qualified of all sectors.

The sector is a significant part of the economy producing $32.2 billion in total output, of which $16.2 billion contributes to the country's GDP.

The tech sector also generated $6.3 billion, or 9% of the country's exports in 2015. Unlike traditional exporters such as dairy ($12b), meat ($6.3b), forestry ($4.6b), horticulture ($3.7b) and wine ($1.4b), tech exports are often services via offshore subsidiaries. Consequently, the numbers do not capture the total value of the sector's offshore activities. This is because export numbers do not capture the sales made by offshore subsidiaries that are repatriated as profits. While it is currently impossible to capture total offshore revenues for the tech sector, we did establish through the balance of payments that the sector repatriated $66 million worth of profit in 2015.

Auckland, Wellington and Christchurch all have large tech sector's contributing to their regional growth. However, the tech sector is not solely confined to major urban centres. Regional New Zealand is also benefitting from the growth of the tech sector. Through the connectivity of the tech sector there are real opportunities for all of New Zealand to benefit.

The Impact

The research established that, due to the pervasive nature of technology, a 4% productivity improvement in the tech sector has a large positive impact across the economy and is estimated to produce $2.7 billion in GDP growth. The tech sector's productivity has grown at an average of 1.7% per annum for the past 15 years, versus 0.7% for the national economy over the same period. A 4% productivity growth is equivalent to actual tech sector productivity growth in 2011.

This observation means that every dollar spent to stimulate the tech sector should generate about $3 of growth across the national economy.

The research also found that New Zealand adopts technology well, with 97% of firms having computers and 96% using the Internet. In addition, New Zealand has the second highest ratio of computers to students in schools in the world. Yet, it is not having the technology that makes the biggest difference, it's what you do with it. In New Zealand, firms that make smarter use of Internet services are 6% more productive than average firms in their industry. If all firms made better use of Internet services it could lift GDP by $34 billion. Additionally, better use of data for decision making could provide a further $4.5 billion of benefit to the economy over the next five years alone.

Tech sector innovations should also be a central focus of all other sectors as the means to improve productivity and lift our overall quality of life. There are enormous benefits to be had for all New Zealander's through the use of advanced technology across rural New Zealand, healthcare and in the support of delivering a 21st century education. Education is critical to economic growth, and the OECD estimates that if New Zealand was to raise its education outcomes over a period of 20 years to a level comparable with Finland it would generate an additional US$258 billion of GDP. Better use of technology is absolutely critical in achieving this.

Creating a Digital Nation

The tech sector is a large part of the economy, generating considerable value, jobs and exports. The sector is also the foundation for New Zealand's successful transition to a digital nation. From the critical infrastructures that provide the underlying connectivity, to the innovations of our local and international tech firms, and our high growth tech exporters. Additionally, due to the way that technology reaches across all parts of the economy, as the tech sector grows and becomes more productive, everyone benefits.

The number one catalyst for the success of the tech sector is a sustainable supply of skilled resources. There is a global shortage of tech skills, so immigration of this talent will only get us so far. New Zealand must enhance its own education system to develop a local talent base. To do this, we must increase investment to support our school leaders and teachers as they transition to 21st century teaching models. We must prepare students from an early age for a very tech centric future through the introduction of computational thinking and digital technologies into their learning. Finally, we must bridge the gap between the tech sector and the education system to support the development of work ready graduates.

The government, as the tech sector's largest customer, will inevitably play a big role in the creation of a digital nation. By incentivising agencies to be innovative and take risks as they transform the delivery of their services, the government can stimulate tech innovation and productivity. To help New Zealand tech firms successfully sell this innovation globally, we must enhance the New Zealand story to showcase New Zealand as a world class digital nation with leading technology companies.

In conclusion, the real economic opportunity will come from better use of technology across the economy. Work must be undertaken to educate all business owners on ways to use technology and connectivity to increase productivity. Incentives should be considered to accelerate the uptake and exploitation of technology as every New Zealander will benefit from the transition to a digital nation.

Key Highlights

THE TECH SECTOR IN 2015

28,749
TECH SECTOR FIRMS

CONTRIBUTED
$16.2b
GDP (8% OF GDP)

EXPORTED
$6.3b
GOODS & SERVICES
(9% OF EXPORTS)

3rd
LARGEST EXPORT SECTOR

EMPLOYED
98,911
PEOPLE
(5% of the workforce)

An additional
20,154
TECH WORKERS
work in other sectors

THE TECH SECTOR HAS *higher paid* AND *higher qualified* EMPLOYEES THAN ALL OTHER SECTORS, **ON AVERAGE**

ICT'S CONTRIBUTION TO **GDP GROWTH** IN NEW ZEALAND HAS BEEN
higher
THAN ANY OTHER **OECD COUNTRY** FROM 2001 TO 2013

EACH **NEW TECH SECTOR JOB** CREATES UP TO
5 new
SERVICES JOBS AROUND IT

EACH **4% PRODUCTIVITY IMPROVEMENT** IN THE TECH SECTOR IS ESTIMATED TO DELIVER AN ADDITIONAL *$2.7b GDP*

97%
OF FIRMS WITH MORE THAN 5 EMPLOYEES **USE COMPUTERS**

96% OF FIRMS WITH MORE THAN 5 EMPLOYEES **USE THE INTERNET**

EVEN THE LEAST CONNECTED SECTORS USE COMPUTERS & THE INTERNET

91% OF PRIMARY SECTOR FIRMS **USE THE INTERNET**

TELECOMMUNICATIONS **INVESTMENT** REACHED
$1.7b
IN 2014 (INCL. UFB & RBI)

INCREASED USE OF UFB WILL DELIVER AN ESTIMATED
$5.5b
TO GDP OVER THE NEXT 10 YEARS

FIRMS THAT MAKE SMARTER USE OF **INTERNET SERVICES ARE**
6%
MORE PRODUCTIVE THAN AVERAGE FIRMS IN THEIR INDUSTRY

IF ALL FIRMS MADE **SMARTER USE OF INTERNET SERVICES** IT COULD **LIFT GDP** BY
$34b

MAKING DECISIONS **USING DATA** IN 2014 PROVIDED
$2.3b
IN BENEFITS TO THE ECONOMY

IT IS ESTIMATED THAT **BETTER USE OF DATA** BY BUSINESS & GOVERNMENT COULD DELIVER
$4.5b
OVER THE NEXT 5 YEARS

SMES THAT ARE HIGHLY **DIGITALLY ENGAGED** HAVE **20%**
HIGHER REVENUES, FASTER GROWTH & STRONGER JOB GROWTH
THAN FIRMS THAT ARE LESS DIGITALLY ENGAGED

PART ONE

The Tech Sector

23

The Tech Sector

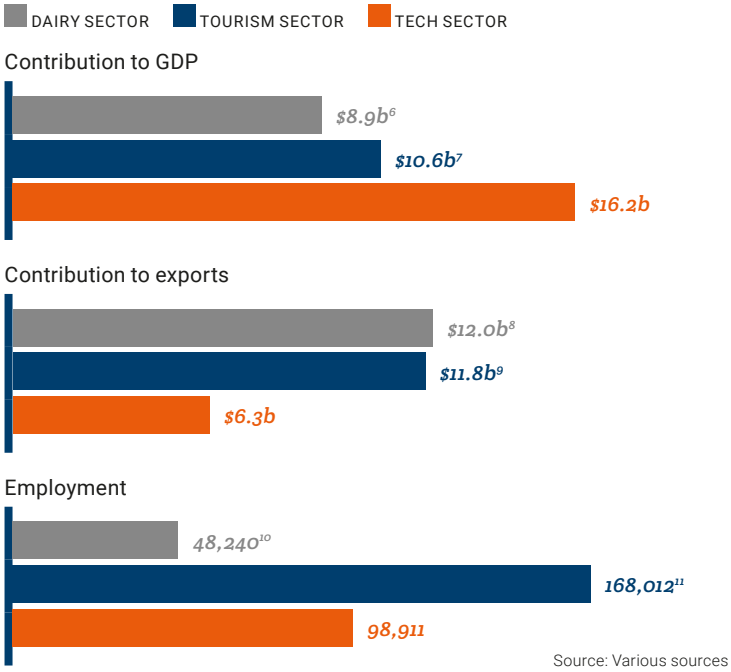
The Tech Sector is large and growing

The tech sector, defined as a combination of ICT and high-tech manufacturing[5], is a dynamic and growing part of the New Zealand economy, featuring high levels of innovation, connectedness and expenditure on R&D.

The combined tech sector accounted for an estimated 8% of GDP in 2015, contributed 9% to exports and employed about 5% of the total workforce. The tech sector's economic contribution of $16.2 billion to GDP and almost 100,000 jobs means that it accounts for a considerable portion of economic activity and employment. The growth of both the tech and tourism sectors in terms of economic contribution and exports is supporting critical diversification of the New Zealand economy.

FIGURE 1: MAJOR EXPORT SECTORS OF NEW ZEALAND

2014/2015

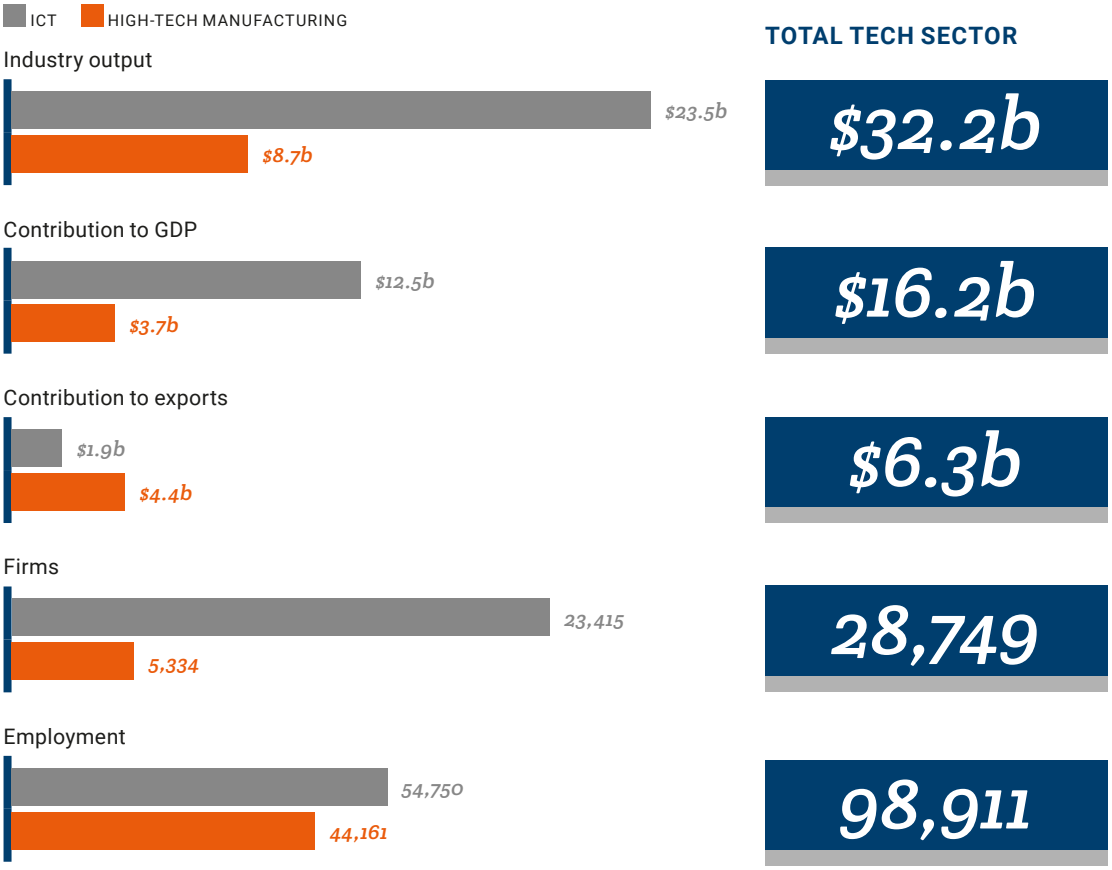


Source: Various sources

The tech sector's two main sub-sectors of ICT and high-tech manufacturing both contribute strongly to the economy in their own right. Businesses in some parts of the ICT sector also belong to the high-tech manufacturing sector.

FIGURE 2: THE NEW ZEALAND TECH SECTOR

2015



Source: NZIER from Stats NZ data

The ICT Sector

ICT occupies a unique position in the tech sector owing to its cross-cutting impact. This sub-sector of the tech sector directly generated over $23 billion in output and contributed $12.5 billion or 6.2% of GDP in 2015. The 23,415 ICT firms employed 54,570 people. The ICT sector also contributed $1.9 billion or 2.5% of New Zealand's exports. The benefits of the use of ICT throughout the economy mean that the economic impacts of ICT are likely to be much larger than these numbers suggest, but the indirect impacts are not easily seen in the GDP statistics.

Statistics New Zealand's biennial survey of the ICT sector[12] states that sales of ICT goods and services in 2014 were up 3% from 2012[13] and exports of ICT services increased by 23%. There was $21.7 billion worth of ICT sales in New Zealand in 2014. However, while sales have been increasing, prices have been falling[14], resulting in an ever increasing volume of investment in technology permeating the economy.

TOTAL DOMESTIC ICT SALES

$21.7b

TOTAL ICT EXPORTS

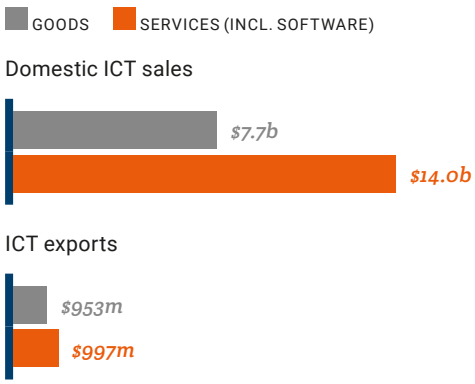
$1.9b

TOTAL ICT SALES

$23.4b

FIGURE 3: NEW ZEALAND'S ICT SECTOR SALES

2014/2015



Source: Statistics New Zealand

Sales of ICT services have been growing faster than goods, and have been growing as a proportion of the ICT sector since 2008. Together with software sales, ICT services now contribute almost two thirds of total ICT sector sales. ICT services are provided by services firms such as Datacom, Fronde, IBM, Fujitsu and Optimation, as well as ICT applications or product firms such as Xero, Orion Health and Vista Group.

As well as the 54,750 people employed in the ICT sector in 2015, there were an additional 20,154 ICT workers employed in other sectors.

The High-Tech Manufacturing Sector

High-tech manufacturing has shown vibrant growth in recent years despite total manufacturing having slipped from 26% of GDP in 1972 to about 15%. High-tech manufacturing is a relatively small subset of the manufacturing sector accounting for less than 22% of economically significant manufacturing firms[15].

The high-tech manufacturing sector, excluding the ICT manufacturers, is made up of 5,334 firms that employ 44,161 people, contributing $3.7 billion to GDP and $4.4 billion of exports.

The sector has developed since the early 1990s, becoming a significant export earner. While the sector struggled with both the rising exchange rate and the Global Financial Crisis through the last decade, exports recovered strongly in 2011. High-tech manufacturing firms generally export most of their output, making the sector very export intensive.

The high-tech manufacturing sector is primarily made up of a relatively small number of large firms such as F&P Healthcare, Glidepath, Gallagher Group, Compac Sorting and Scott Technologies. The 44,161 people employed in this sector are predominantly located in Auckland (54%), followed by Christchurch (25%) and Hamilton (3%).

CALL TO ACTION

The tech sector is a significant part of the New Zealand economy, yet government statistics do not capture the sector as easily or as well as they do for traditional goods exporting sectors. This is also a challenge for the tourism sector, and the government has responded by producing specific statistics on tourism.

- **NZTech recommends** that the key economic measures for the sector (sales, GDP contribution, jobs, exports, offshore revenues) are regularly reported on, as we have done, using the OECD definition.

We know that direct economic measurement alone misses a lot of the value added by the use of technology, and that many people working in tech are outside the measured tech sector.

- **NZTech recommends** that the government and the tech sector continue to work together to establish more dynamic and complete ways of identifying and measuring the contribution of the many vibrant tech firms that are contributing to the digital growth of New Zealand.

The Tech Sector touches all of New Zealand

Regional economic growth throughout New Zealand is crucial to the overall economic growth of the country. Auckland, Wellington, Christchurch and their surrounding regions account for almost two thirds of national GDP and are the connectors to the rest of the world. However, New Zealand's rural areas drive our largest industry, primary production.

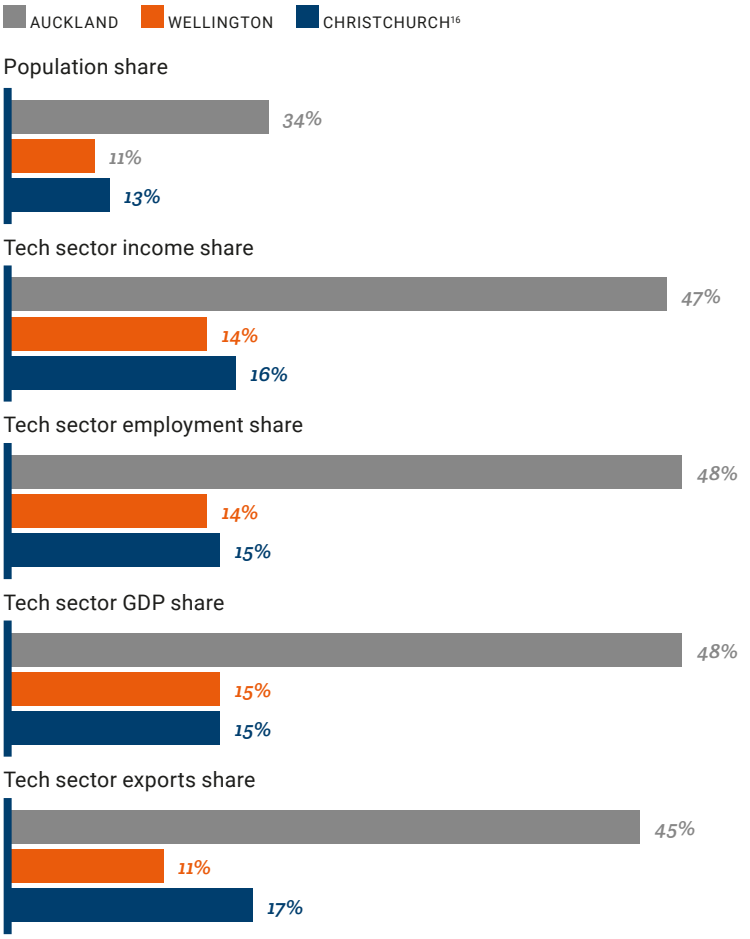
Adopting technology is essential for both the survival and economic growth of rural New Zealand. New communication technology, especially the Internet, can connect businesses with their customers and employees regardless of the physical distance between them. It can provide opportunities for people to enjoy country lifestyles but work in city jobs. It can enable businesses to find, attract and sell to customers from across the world.

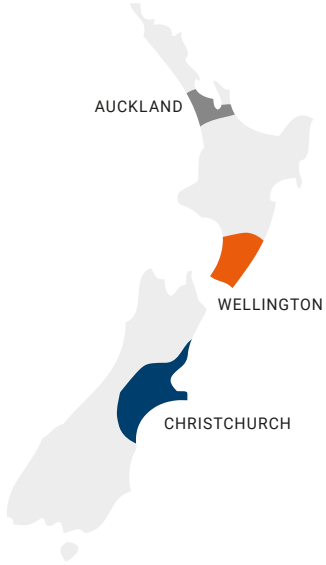
The economic case for New Zealand's ongoing investment in fast broadband networks is strong. It presents a big opportunity for regional New Zealand. While there are economic benefits from clustering in larger cities, technology and the fast internet infrastructure can enable information sharing virtually so even our regional towns should be able to grow vibrant tech sectors.

Wharf42 in Tauranga is a great example of a firm in regional New Zealand that is supporting the clustering of local tech firms directly with Silicon Valley. In April this year they organised a delegation of 30 New Zealand agritech companies to attend the Silicon Valley AgTech Conference in the US.

FIGURE 4: TECH SECTOR REGIONAL SNAPSHOT

Percentage, 2015





Source: NZIER estimates from Stats NZ data

The Auckland Tech Sector

The mix of Auckland's industry is moving towards knowledge-intensive sectors, including ICT, media, financial and insurance services, all of which are big users of tech services.

Figure 4 shows that while Auckland has a third of New Zealand's population, it accounts for almost half of the tech sector's income, employment, GDP and exports. The tech sector is contributing $7.8 billion in GDP to the local Auckland economy and providing 47,682 jobs.

The Auckland ICT sector is a significant contributor to local GDP, generating $6.2 billion in 2015, while the Auckland high tech manufacturing sector leads the way in exports.

Producing world leaders

The Auckland tech sector is large and diverse with a broad range of ICT and high tech manufacturers that are world leaders in their markets:

Compac Sorting Equipment – a world leader in automated produce sorting equipment. With revenues of almost $100 million and more than 700 people globally, Compac provides packhouse solutions for customers in more than 40 countries.

Glidepath – a world leader in airport baggage handling systems. Glidepath is a 40 year old Kiwi company that has deployed more than 700 baggage handling systems in 65 countries.

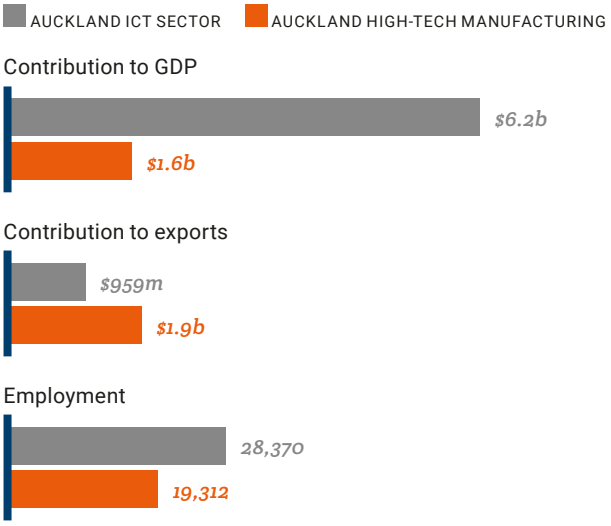
Vista Group – a world leader in cinema management and box office analysis software. With revenues of over $65 million and around 300 staff, they have over 38% of the global large cinema market and process more than a billion cinema tickets a year.

Orion Health – a world leader in healthcare integration and precision medicine. With revenues of $164 million and over 1,200 staff Orion support the decision making of hundreds of thousands of clinicians in over 17 countries and manage the patient care for the more than 90 million patients on their systems.

TranscribeMe – developed a simple, fast and accurate way of converting speech to text using technology and crowd-sourced transcribers. Born out of winning the StartUp weekend competition in Auckland in 2011, the company has gone on to employ over 40,000 "microworkers" around the world serving a global customer base.

FIGURE 5: THE AUCKLAND TECH SECTOR

2015



Source: NZIER

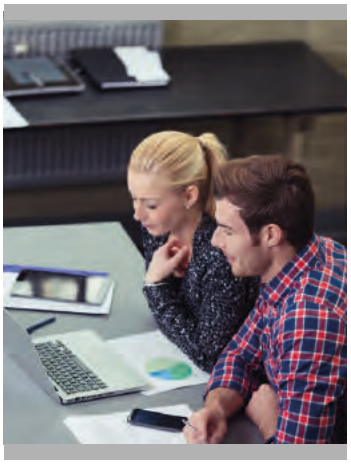
TOTAL AUCKLAND TECH SECTOR

$7.8b

$2.8b

47,682

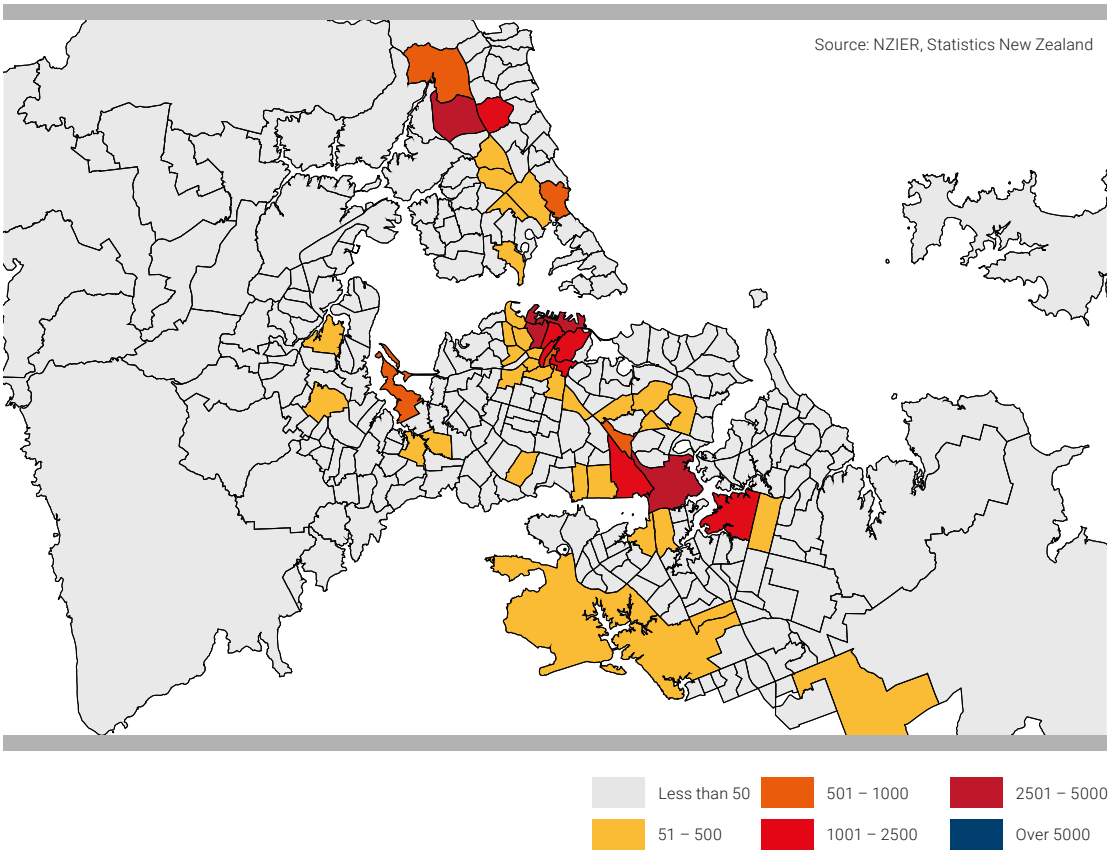
The tech sector in Auckland benefits from other thriving sectors within the region. Auckland is home to more than 60% of the fast-growing export education industry. This adds to the information-sharing benefits generated by Auckland's many public and private research organisations, including its world-class universities. Basic and applied research is thriving in the areas of life sciences and biotechnology and Auckland leads the country in the number of patent applications.



Analysis of spatial employment data for the Auckland tech sector reveals clear patterns of clustering by ICT firms, as can be seen in Figure 6. Central Auckland, particularly the Wynyard Quarter is showing an increasing density of ICT firms. There also appears to be clustering around university locations. This clustering is important as it helps accelerate information sharing and sector growth.

There are very different spatial patterns in the results for the high-tech manufacturing sector. To some extent, the spatial patterns reflect what has happened to the wider category of all manufacturing in New Zealand, that is, less concentration around urban areas. As land costs have risen and transport costs have fallen, it is no longer ideal for manufacturers to be in city centres. Additionally, there is not the same incentive related to information sharing that drives urban clustering in the ICT sector.

FIGURE 6: EMPLOYMENT DENSITY - AUCKLAND ICT FIRMS



The creation of an innovation precinct

The first in New Zealand when launched, the innovation precinct in the Wynyard Quarter has been designed to foster clustering and knowledge sharing between ICT and digital media companies. The precinct is being developed as the centrepiece of an innovation corridor which is taking shape from north to south across the Auckland region.

Rising from an understanding that proximity facilitates both connection and collaboration, a shared working space, GridAKL, has been created as the hub of the precinct to bring established innovative businesses and start-ups together into a shared environment. Running activities such as Lightning Lab out of the space has bought support from tech corporates like Spark, Microsoft and Huawei into GridAKL to mentor and support the growth of the next generation of tech startups.

Already some of the successful tenants of GridAKL, such as 90 Seconds, have grown so fast they may need to find new homes soon to let the next wave of startups roll through.

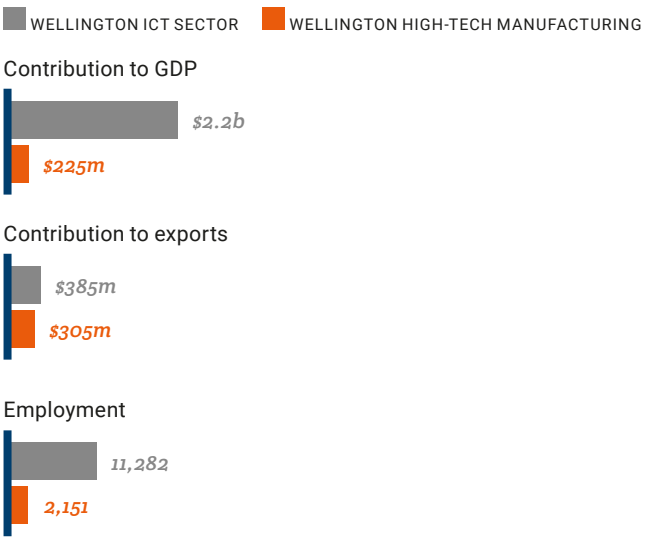
The Wellington Tech Sector

Earning New Zealand's highest household incomes, three-quarters of Wellingtonians are employed in high-skilled occupations. The region has a tech sector with high levels of innovation, R&D and business collaboration.

Whilst Wellington accounts for 11% of the national population, the Wellington tech sector produces 14% of the national tech sector employment and 15% of its GDP. Tech sector firms generate $2.4b worth of GDP for the local economy, bring in $690 million in exports and employ almost 13,500 people.

FIGURE 7: THE WELLINGTON TECH SECTOR

2015



Source: NZIER

TOTAL WELLINGTON TECH SECTOR

$2.4b

$690m

13,433

Wellington is also home to a thriving software development industry. Wellington headquartered, cloud-based accounting software company Xero is rated the most innovative company in the world by Forbes[17]. The region has a high proportion of employees in other knowledge-intensive industries, from ICT to financial and insurance services. The film industry has also clustered in Wellington and is a large user of tech sector products via post production and visual technology businesses.

Many tech sector products play an important role in the provision and delivery of public services, such as health, education and government administration. Those services are concentrated in

major urban areas, and play a particularly important role in the expansion of the Wellington economy.

With a tag-line of New Zealand's high tech capital, Wellington has developed a vibrant local tech community that has generated a number of successful global businesses.

Wellington tech is going global

Wellington has had many tech firms achieve success internationally, from the well-known Xero to a multitude of less well known, but highly successful firms including:

Wipster – a cloud based intuitive video review and approval offering that grew from the original Lightening Lab accelerator in Wellington. Now used in over 190 countries and by high profile companies like Evernote and Shopify. They recently announced a partnership with Vimeo, who has more than 35 million registered members.

GreenButton – an on-demand super-computing cloud platform that spun out of Weta Digital to provide customers with access to large scale computing resources as needed. Grew to service clients such as Pixar, NASA and Boeing before being acquired by Microsoft in 2014.

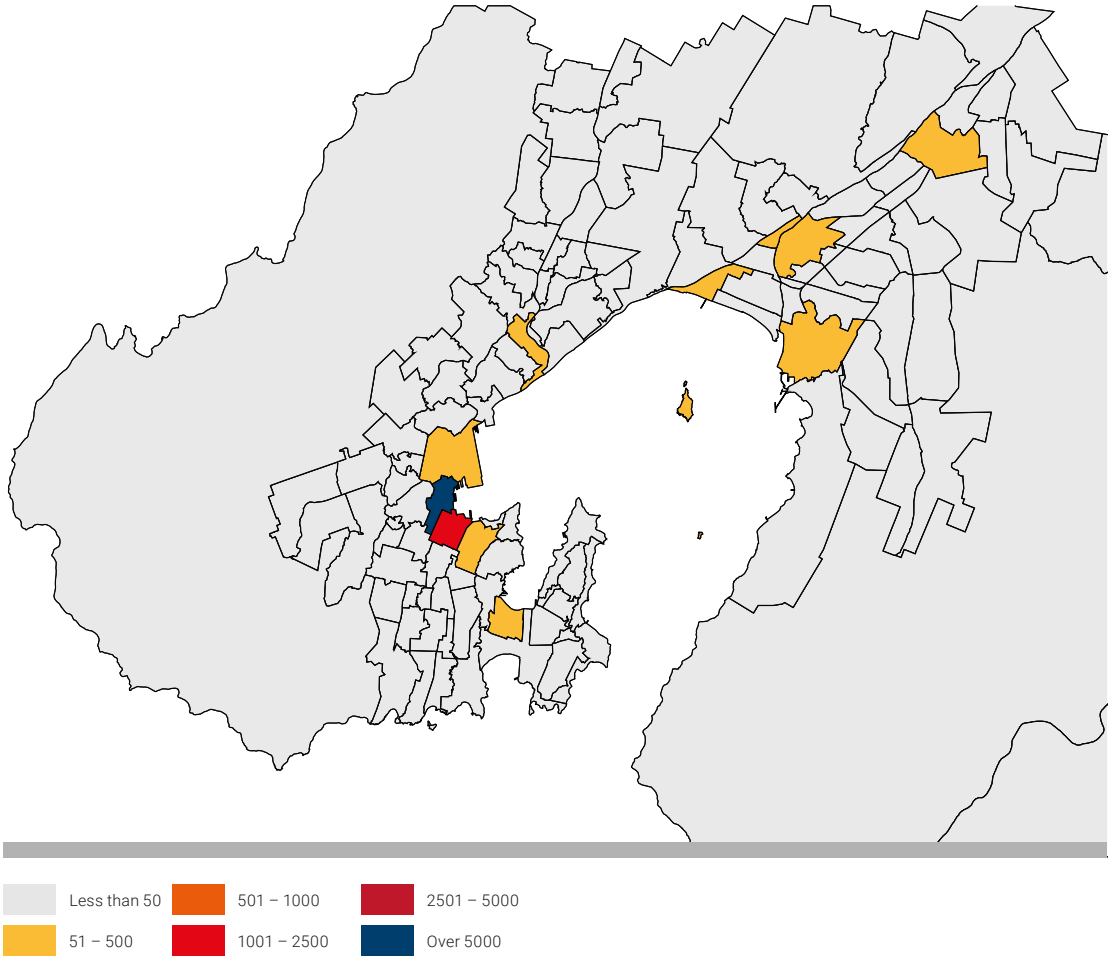
Area360 – with an interactive mobile app, STQRY, that helps organisations such as museums, art galleries and zoos engage visitors and tell their stories. Having recently raised US$5.5 million in funding they have developed a high-profile client base that includes the Seattle Art Museum and the Walt Disney Family Museum.

Optimation – an IT service provider with a large government and finance client base has developed an online life insurance platform for the US market that enables fully automated underwriting and real-time policy purchase and issue.

PartsTrader – an online marketplace for sourcing car parts for collision repairs. Having grown rapidly in New Zealand they launched in the US in 2013 and supply parts to over 10,000 car repairers using over 20,000 suppliers.

FIGURE 8: EMPLOYMENT DENSITY - WELLINGTON ICT FIRMS

Source: NZIER, Statistics New Zealand



The small size of the Wellington CBD maximises the benefits of clustering. There are clear patterns of concentration exhibited for ICT firms with clustering patterns emerging in the central business district, as shown in Figure 8.

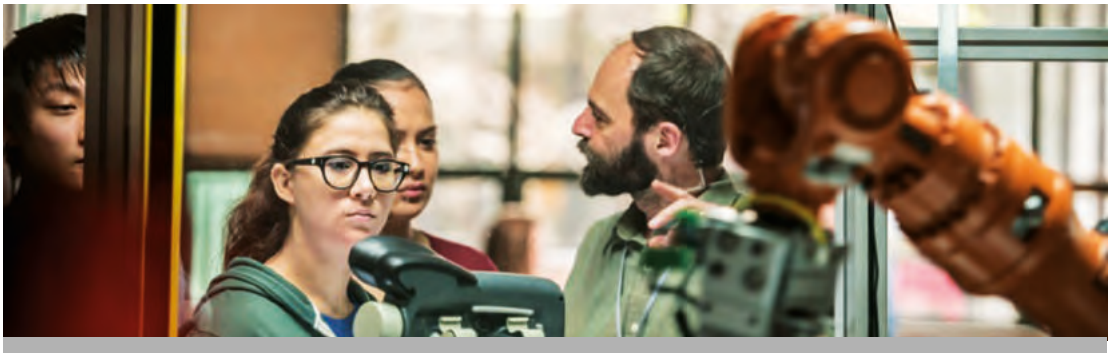
The clustering in the Wellington tech sector is enhanced by a vibrant startup and social enterprise community. The interaction between these social entrepreneurs, large ICT firms and the staff from the many Wellington headquartered multi-national technology leaders all adds to the success of the local startups and the growth of the tech sector.

Social entrepreneurs using tech to create change

At the core of Wellington's social enterprise community is Enspiral – a collaborative network of companies and social change focused professionals working together to create a thriving and valued society.

Established in 2010, Enspiral now encompasses fourteen startups and over two hundred professionals reinventing processes, systems and ways of thinking to form a common community.

Enspiral has been behind the creation and success of ventures such as Loomio, an online tool for everyday democracy and decision making, Lifehack, which aims to improve the mental health and wellbeing of young people and Chalkle, a vibrant learning community to enable people to teach and learn practical, real-life and creative skills outside of formal education.



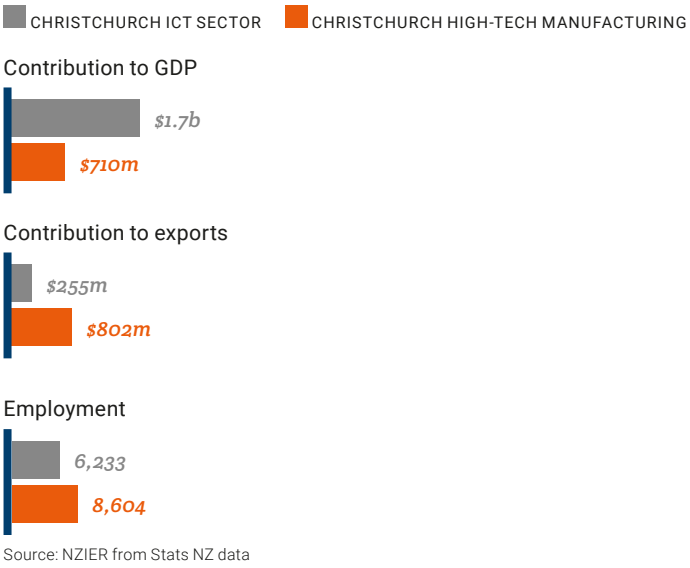
The Christchurch Tech Sector

Physically New Zealand's biggest region, the Christchurch region has a large agricultural sector. Continued growth in the dairy sector depends on the innovative use of farm management techniques, including water and nutrient management. Christchurch is the manufacturing centre of the region and post-earthquakes reconstruction is still an important part of economic activity.

In the decade before the earthquakes, Christchurch's ICT sector grew at more than 1½ times the national rate, but since the earthquakes, Christchurch ICT sector employment has fallen by 7% (2012-14) while New Zealand ICT sector employment overall increased by 6.2%. The local economic development agency, Canterbury Development Corporation, has identified that the Christchurch tech sector is vital for creating a wealthy city for everyone. In recognition of this, they have published a long-term tech sector strategy that focuses on attracting talent, developing centres of excellence, connecting and supporting the local tech community, and increasing global exposure.

FIGURE 9: THE CHRISTCHURCH TECH SECTOR

2015



Source: NZIER from Stats NZ data

TOTAL CHRISTCHURCH TECH SECTOR

$2.4b

$1.1b

14,837

The Christchurch tech sector contributes $2.4 billion worth of GDP and 14,837 jobs to the local economy. Christchurch has a high proportion of high-tech manufacturing firms and is New Zealand's second largest manufacturing centre. It is headquarters to iconic New Zealand companies such as Hamilton Jet, Tait Communications, Skope, Dynamic Controls and Skellerup.

Christchurch also hosts operations for a number of multi-national manufacturing companies.

Christchurch the HQ for multinationals

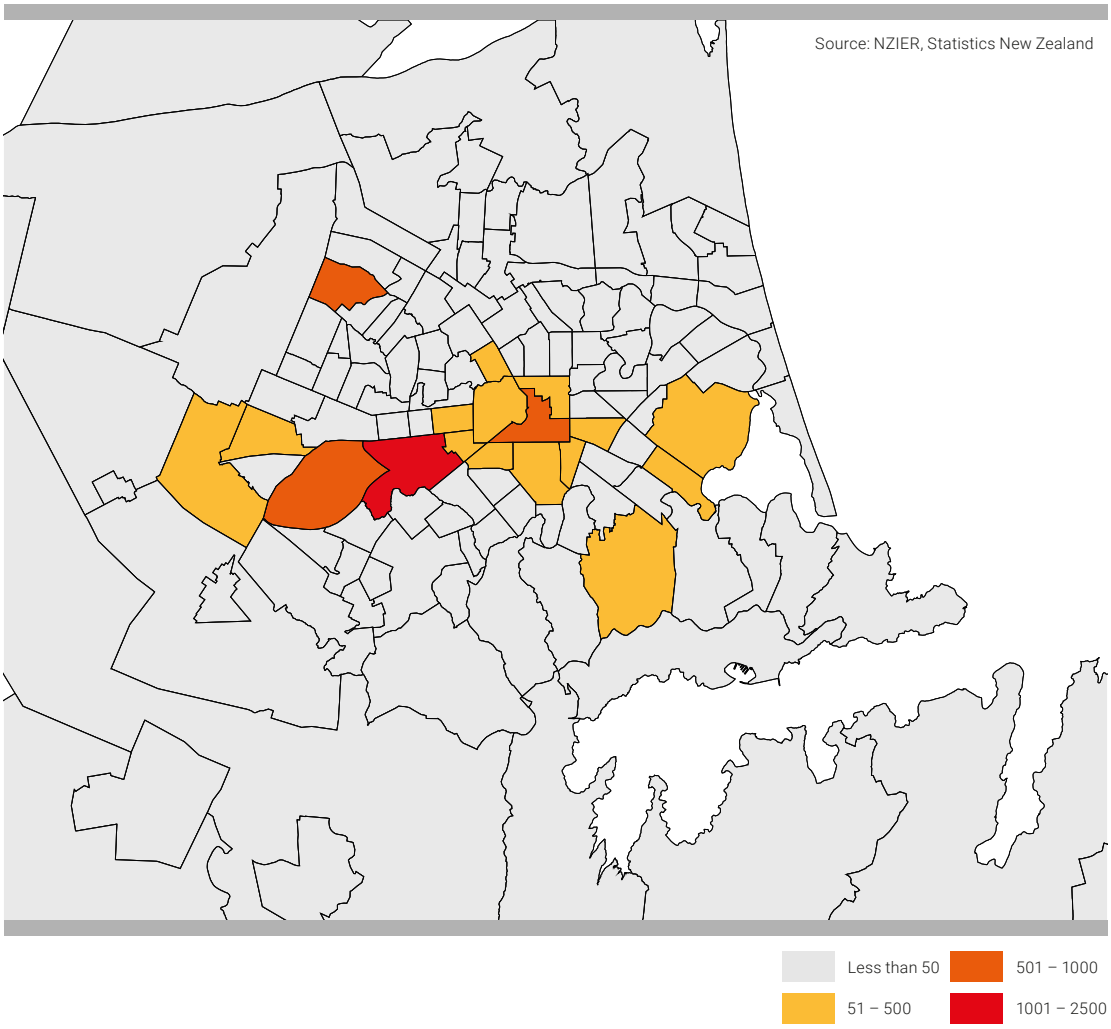
Christchurch, due to its strong manufacturing history, has attracted the New Zealand headquarters for a number of significant multi-national high-tech manufacturers including:

Trimble New Zealand – a subsidiary of Trimble Navigation, a US$2.3 billion manufacturer of advanced location based solutions, employs over 250 people in Christchurch and generates $48 million in local revenues.

Dynamic Controls – a subsidiary of Invacare Corporation a $6 billion manufacturer of medical products, employs over 300 people in Christchurch and manufactures and exports electronic control systems for power wheelchairs and scooters.

Allied Telesis Labs – a subsidiary of Allied Telesis Group, a 28 billion Yen manufacturer of IP/ethernet and telecommunications products, employs 130 people in Christchurch and generates an estimated $135 million in local revenues.

FIGURE 10: EMPLOYMENT DENSITY - CHRISTCHURCH ICT FIRMS



There has been limited clustering of the tech sector within Christchurch. However, following the earthquake rebuild, there has been the establishment of an innovation precinct in the central city and the development of a new tech campus at Tait Communications. It is hoped that these initiatives will support tech sector clustering as this will help reinvigorate innovation and growth. With three major tertiary institutions, a vibrant startup and commercialisation ecosystem and a local government with a clear digital strategy the Christchurch tech sector is poised for further growth.

Building success from the ground up

Following the earthquake, the success of the EPIC shared working space encouraged the rebuild project to establish an Innovation Precinct within Christchurch's central city. The Precinct is designed to create a cluster of knowledge intensive and technology based innovative firms; from SMEs to global organisations, from agri-tech to gaming software. By creating a critical mass of knowledge intensive and technology based firms, incremental idea generation and improved commercialisation rates will occur. The Precinct has already attracted a combination of shared working spaces for start-ups, local high growth software exporters and multinational tech firms, with anchor tenants such as Vodafone Xone and Wynyard having moved in.

GreenHouse, one of the early buildings in the new innovation precinct, was supported by the Christchurch Development Corporation and the Ministry of Business, Innovation & Employment. It recently housed the first Lightning Lab accelerator in Christchurch and is now home to a number of tech based start-ups that graduated out of that programme including PropertyPlot, Debtor Daddy, Pensolve and MTech Games. As a national sponsor of the Lightning Lab accelerators, Microsoft New Zealand has moved into GreenHouse with their Christchurch based employees to ensure greater collaboration with the tech start-up sector.

Driving the success of these initiatives is the vibrant tech community, centred on the local Canterbury Tech cluster. With an active membership of over 100 local tech firms Canterbury Tech provides the regular networking that makes Christchurch a human scale tech city.

The Tech Sector is not limited to main cities

Whilst not a large part of regional New Zealand's economy, large tech firms are found outside of the main centres. Dunedin's tech sector generates approximately $330 million in local GDP and provides almost 2,000 jobs. With companies like Scott Technology, AD Instruments and Animation Research, the Dunedin tech sector generated $154 million in exports in 2015.

DUNEDIN TECH SECTOR

$330m GDP

1,904 JOBS

TAURANGA TECH SECTOR

$545m GDP

3,923 JOBS

HAMILTON TECH SECTOR

$1.0b GDP

6,609 JOBS

As technology permeates other sectors we are seeing growth of the tech sector in regions historically known for more traditional industries. In Tauranga, the combination of traditional sectors, technology and entrepreneurialism has seen the development of new businesses such as robotic fruit picking system, RoboticsPlus, and Rapid Advanced Manufacturing, who provide commercial 3D titanium printing. This growing Tauranga tech sector provides almost 4,000 jobs and $545 million to the local economy. Of the $288 million in tech exports generated in Tauranga in 2015 a large proportion (85%) came from high-tech manufacturing exports.

Hamilton is the innovation centre of the Waikato region, with strength in utilities, manufacturing, ICT and agritech. It is the technology centre for value-added dairy product processing and the dairy herd improvement industry and has the fourth largest tech sector employee base delivering 6,609 jobs and $1 billion of GDP to the region.

TABLE 1: TECH SECTOR IN REGIONAL NEW ZEALAND

2015

	Regional Population (%)	Regional GDP (%)	Tech Sector GDP ($m)	Tech Sector % of region GDP	Tech Sector Employment	Tech Sector Exports ($m)
Northland	3.7	2.5	191	3.3	1,285	96
Auckland	**33.9**	**35.3**	**7,791**	**11.6**	**47,682**	**2,838**
Waikato	9.6	9.0	1050	5.9	6,609	484
Bay of Plenty	6.3	5.2	545	4.7	3,923	288
Gisborne	1.0	0.7	43	2.3	356	23
Hawke's Bay	3.5	2.8	248	3.5	1,566	133
Taranaki	2.5	4.0	284	4.5	1,897	148
Manawatu-Wanganui	5.2	4.0	409	4.4	2,291	204
Wellington	**10.9**	**13.2**	**2,413**	**9.8**	**13,433**	**690**
Tasman/Nelson	2.2	1.8	167	3.8	1,035	76
Marlborough	1.0	1.0	84	3.2	826	39
West Coast	0.7	0.7	44	3.0	230	24
Canterbury	**12.7**	**13.1**	**2,428**	**9.1**	**14,837**	**1,058**
Otago	4.7	4.3	330	3.5	1,904	154
Southland	2.1	2.4	134	2.6	1,043	73
New Zealand	**100**	**100**	**16,159**	**8.0**	**98,911**	**6,326**

Source: NZIER

CALL TO ACTION

Many regions are too small to make an impact on their own. But as a country, if we did a better job of connecting and working together there would be less fragmentation of resources and better results. Professor Shaun Hendy talks about "a city of four million people" in "Get Off the Grass", a book he co-authored with the late Sir Paul Callaghan.

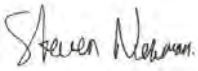
- **NZTech recommends** that the industry, government and regional development agencies come together to develop a national/regional digital strategy. This would tie together the various regional digital strategies, share resources, speak with a coordinated voice, create specialisation and avoid unnecessary competition.

Fast broadband networks are essential to regional prosperity and participation in the tech economy. The extension of the UFB and RBI networks need to be carefully considered to maximise opportunities.

- **NZTech recommends** that the government consider regional tech focused economic development opportunities as part of its thinking around where and when to extend the UFB and RBI networks.

"Jobs are critical for both the economic and social well-being of New Zealanders and the tech sector is currently creating more jobs than there are trained people in New Zealand to fill them. As the tech sector continues to grow at a rapid pace, job creation will continue to grow. Ideally, these jobs will be for Kiwi's as the education system catches up and begins to produce greater numbers of tech capable employees. The growth in tech jobs will also create opportunities to host new and exciting talent from around the world, adding to New Zealand's vibrant culture.

ERoad is contributing to this growth and success. ERoad have added over 40 new people to the company in the last year alone and as we grow internationally, we plan to maintain the bulk of our staff here in New Zealand, contributing to local economic growth."



Steven Newman
Chief Executive, ERoad

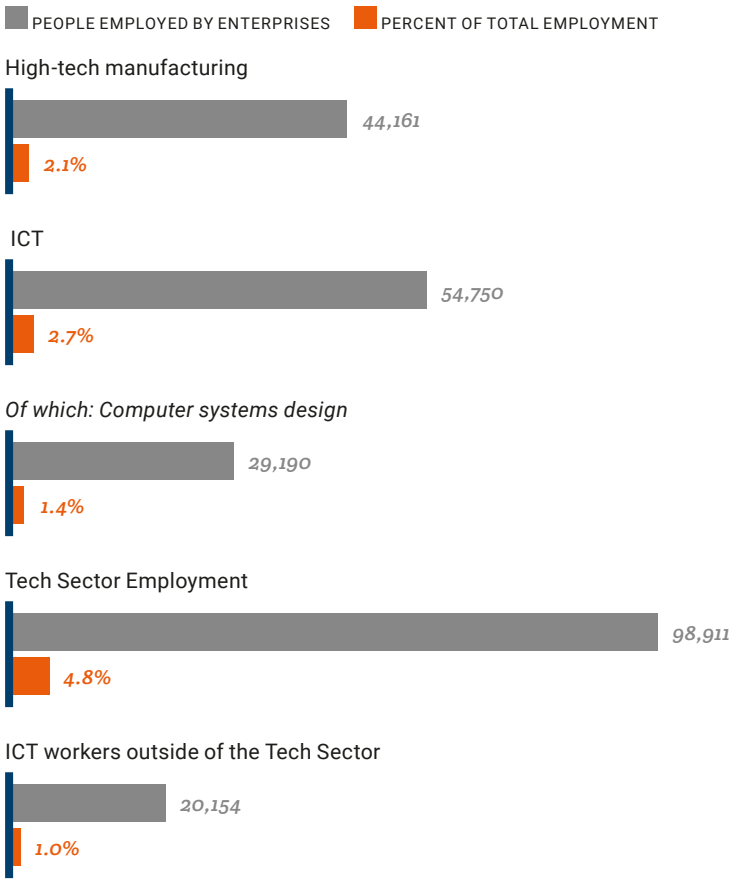
The Tech Sector is creating jobs

Tech Sector Jobs

Over the last few years, employment in the New Zealand tech sector has been steadily increasing, enabling growth in output and exports. NZIER calculate total employment in the tech sector is now 98,911, with 44,161 in high-tech manufacturing and 54,750 in ICT.

FIGURE 11: TECH SECTOR EMPLOYMENT

2015



Source: NZIER estimates from Statistics NZ data

It is worth noting that not all ICT workers work in the ICT sector itself. Employment in ICT roles across all sectors is also rising. There were 20,154 people working in ICT roles outside of the tech sector in 2015.

The Tech Sector creates jobs

The traditional link between innovation and growth (and therefore employment) is now threatened by the rise of disruptive technologies, such as robotics and artificial intelligence. Uber is disrupting the taxi booking industry, Airbnb is changing the hotel industry, and companies like Xero are challenging the accountancy profession. Meanwhile, manufacturing is being revolutionised by new technologies such as 3D printing and easy-to-use robots.

NZIER recently released a report arguing that 885,000 or 46% of New Zealand jobs are likely to be automated within the next two decades. However, NZIER also showed that numerous jobs will be created in the implementation and delivery of new services and products. As shown throughout history, in the longer-term technological change is enormously beneficial. In short, predicting half of today's jobs being automated in 20 years does not mean half the workforce will be unemployed. New technologies create new demands for occupations as well as new occupations.

The rise of technology doesn't mean that all jobs will be in the tech sector. Economist Enrico Moretti[18] found that for each new high-tech job in a city, five additional jobs are created outside high-tech in that city. Jobs in professional services, health services and education tend

EACH **NEW TECH SECTOR JOB** CREATES UP TO

5 new

SERVICES JOBS AROUND IT

The impact of new technologies on jobs

The bank ATM is sometimes taken as an example of a technology substituting for workers; the ATM took over cash handling tasks. Yet the number of fulltime equivalent bank tellers has grown since ATMs were widely deployed during the late 1990s and early 2000s. Indeed, since 2000, the number of fulltime equivalent bank tellers has increased 2% per annum, substantially faster than the entire labour force. Why didn't employment fall? Because the ATM allowed banks to operate branch offices at lower cost; this prompted them to open more branches, offsetting the loss in teller jobs. At the same time, teller skills changed. Non-routine marketing and interpersonal skills became more valuable, while routine cash handling became less important. That is, although bank tellers performed relatively fewer routine tasks, their employment increased.

New technology can increase demand for an occupation, offsetting job losses. The ATM story is not exceptional, for example:

- Barcode scanners reduced cashiers' checkout times by 18-19%, but the number of cashiers has grown since scanners were widely deployed during the 1980s.
- E-commerce has also grown rapidly since the late 1990s, now accounting for over 7% of retail sales, but the total number of people working in sales occupations has grown since 2000.

to build up around tech clusters. Moretti also found that wages in lower skilled jobs are higher in places where more people have high-skilled jobs. That is, it makes sense even for those employed outside the tech sector to cluster together with those in the tech sector.

Tech Sector employees are highly qualified and high earners

According to Statistics New Zealand, the median annual income before tax, from wages and salaries across all jobs in New Zealand, was $45,864 in 2015. The AbsoluteIT Remuneration Report[19] released in January 2016 found the national median base salary for tech sector employees to be $82,000, up 1.86% on the previous year. The survey also found that with 15 years of experience the median salary exceeds $100,000.

NZ MEDIAN SALARY

$45,864

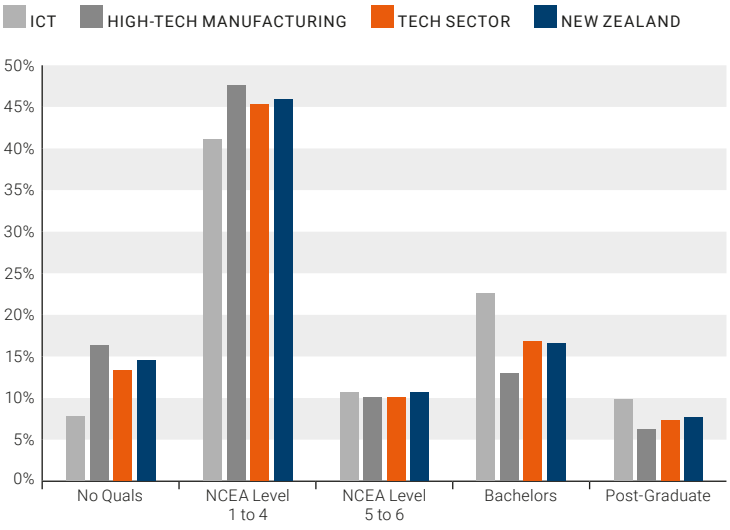
MEDIAN TECH SALARY

$82,000

NZIER examined data on qualifications and earnings of employees throughout the economy and found that employees in the tech sector have higher qualifications, on average, than other industries and that the ICT sector in particular has a very high proportion of tertiary qualified employees.

FIGURE 12: HIGHEST QUALIFICATIONS

Highest qualification, percent of employees

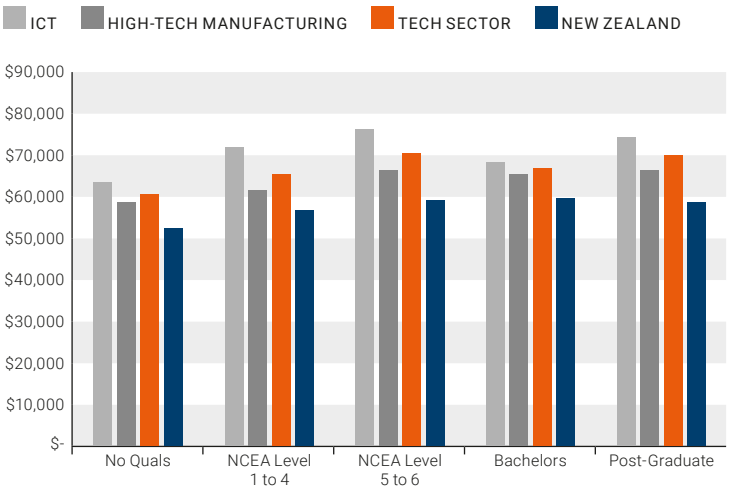


Source: Statistics New Zealand, Census 2013

Given employees in the tech sector are more highly qualified than average, it is no surprise that tech sector incomes are higher than the national average. As can be seen in Figure 13, ICT employees in particular are paid well above the national average regardless of their qualification levels.

FIGURE 13: HIGHEST INCOMES

Mean personal income by sector



Source: Statistics New Zealand, Census 2013

CALL TO ACTION

The tech sector creates many good jobs and stimulates the economy, but the sector is constantly challenged by skills shortages. The New Zealand education system is not evolving fast enough to generate local talent to support the growth of the tech sector. There are interesting new efforts to train workers for the tech economy such as High Tech Youth in Auckland and Dev Academy in Wellington.

- **NZTech recommends** ongoing efforts to lift the responsiveness of the education system to the needs of tech sector employers.

Technology is generating rapid changes to work practices. It is critical for all children to develop skills to prepare them for the jobs of the future.

- **NZTech recommends** faster implementation of computational thinking, computer programming, and digital and collaborative learning into the curricula, and teaching throughout New Zealand schools from year 1.

There is a need to teach teachers how to bring technology into the classroom, not as a specialist subject, but as a method of teaching all subjects. The MindLab by Unitec is a fast-growing example of what is possible.

- **NZTech recommends** that increased investment is immediately made in teachers' skill development to enable the effective delivery of teaching using technology.
- **NZTech recommends** ongoing attention to determining what tech-enabled pedagogical changes are working best in New Zealand schools so that successes can be passed more rapidly through the system.

The Tech Sector is generating exports

The small size of our domestic market constrains the potential for New Zealand businesses to grow without trading. New Zealand is not going to get rich by selling to itself. The ability for businesses to sell their goods and services to customers in overseas markets is critical.

For a geographically isolated country like New Zealand, global connections are critical. Falling travel costs and greater connectedness due to technology have reduced the negative impacts of being far from global markets and created new opportunities for trade in many diverse sectors.

Recognising the importance of trade, the New Zealand government has set a goal of increasing the ratio of exports to GDP to 40% by 2025. This will increase per capita GDP, levels of employment and prosperity.

New Zealand's exports are predominantly primary products with more than half of all exports in the year to June 2015 from primary products ($35.7 billion). While natural resources will remain the basis of our competitive advantage for years to come, there are natural limits to the growth of the primary sector and a need to ensure sustainability by working within environmental constraints. Ultimately, for New Zealand to diversify its export base, technology will play a critical role in creating new exports and higher value niche products that complement our existing national specialisation in agriculture. There is also scope to use technology to improve value-add in agricultural exports.

Tech exporter contributing to traditional export sector's growth

New Zealand high-tech manufacturer, Scott Technology, is a world leader in automated meat processing. They have developed a fully automated boning room with x-ray scanning technology, which removes meat processing staff from hazardous machinery, addresses labour shortages within the industry and improves cut accuracy to be more precise on high value animals, creating higher value export products and delivering better returns.

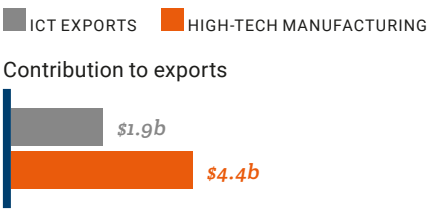
Not only is Dunedin's Scott Technology enabling the New Zealand meat sector to improve its productivity, they have also generated a significant global export business as world leaders in the design and manufacture of automated boning systems.

Tech Sector Exports

Since 1990, exports from New Zealand's high tech manufacturing sector have grown from under $100 million to $4.4 billion in 2015. Exports of high-tech goods and services from the ICT sector have grown to $1.9 billion in 2015. In total, the tech sector generated $6.3 billion of exports, making it one of the largest export sectors for New Zealand.

FIGURE 14: TECH SECTOR EXPORTS

2015



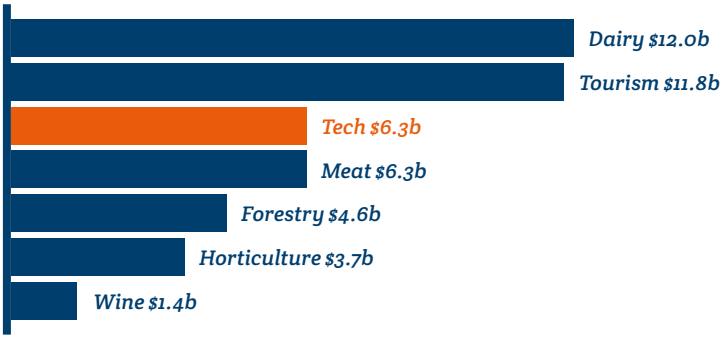
Source: NZIER from Stats NZ data

TOTAL TECH SECTOR

$6.3b

FIGURE 15: EXPORTS BY SECTOR[20]

$ billion, 2015



Source: Statistics New Zealand, as at June 2015

A combination of factors may be contributing to the growth of New Zealand tech exports. As well as the growing scale of a number of tech exporters there is also growing breadth. For example, exports from New Zealand video game developers exceeded $100 million in 2015, up from $80 million in 2014.

Tech export successes are also being built off global technologies as local ICT firms find ways to add value to international products and leverage off their channels to market.

Building export success off global technologies

Inspired by teachers at Point England school in Auckland, New Zealand startup Hapara developed a piece of cloud based software that lets teachers see what students have on their screens when using Google Apps in the classroom. Now only five years old, Hapara tools are used by schools in every U.S. state and in more than 30 countries opening them up to a global edtech market worth US$100 billion.

Tech Sector offshore revenues versus exports

There is often confusion between offshore revenues and exports, yet both are important metrics when it comes to sectors that deal in services.

The trouble with exports

Not all international revenues are exports so the trouble with exports for measuring the economic impact of the tech sector is that export numbers understate the scale of the international impact of the tech sector.

Like most services exporters, tech firms typically need an offshore entity to be close to their customers. Generally, the sales by these entities are not captured as exports as the money stays offshore. For example, while Datacom Group reported $937 million in revenues in 2015 almost 50% of this was revenue generated by Datacom Australia. Only the direct transactions between Datacom NZ and Datacom Australia, and between Datacom NZ and any other offshore entity are actually exports. Most of the funds generated in Australia were used to pay local costs and generate no benefit for the New Zealand economy.

The scale of offshore activity from the tech sector is as important as the value of their exports. As the sector grows internationally it not only creates exports, but also offshore investments that return dividends, profits and intellectual property back to New Zealand.

Successful enterprise software exports from New Zealand

ASX and NZX listed Gentrack as a world leader in the provision of specialist enterprise application software to electricity, gas and water utilities, and to airports. With over 50 utilities and 61 airports using their software, Gentrack has a strong ANZ operation and a rapidly growing business in the UK. Three quarters of Gentrack's $42.1 million revenues in 2015 came from offshore business, yet 62% of their 216 staff are based in New Zealand. Gentrack operates offshore entities in Australia and the UK to deploy and support its software and often staffs these offices with Kiwis. While most license fees are paid directly to Gentrack's New Zealand business, project deployment and support services are usually transacted locally, with some remote services delivered from Auckland.

Currently, there is no formal measurement of the offshore revenues for the entire tech sector. The annual TIN100 survey[21] reported that in 2015 the top 200 ICT and high-tech manufacturers exported $6.5 billion. This measurement is self reported exports and may capture some level of offshore revenue rather than exports as would be captured by the balance of payments. Nevertheless it does reinforce the scale and impact of the New Zealand tech sector's offshore activities.

According to Statistics New Zealand, the balance of payments captured that while there were only $997 million worth of ICT Services exports in 2015, there were actually $1.2 billion in offshore sales. From these sales $66 million was returned to New Zealand as repatriated profits and $997 million as exports. The remaining $137 million was used offshore to run subsidiaries or make investments.

$66.6m

OF REPATRIATED PROFITS

CALL TO ACTION

New Zealand has a large and dynamic tech export sector but this is not evident in the positioning of New Zealand globally. Go to Silicon Valley and talk about agri-tech and everyone says Israel, yet we have a globally respected agri sector. Go to the UK and mention ed-tech and they say USA, yet we have a globally respected education sector.

Ask anyone overseas what they know about New Zealand, and if they know anything at all, it is usually sheep, hobbits and nice scenery. None of this is particularly helpful if you are trying to export high tech products.

- **NZTech recommends** that the tech sector and the government combine forces to start creating an international position and tell the story of New Zealand as a successful high tech country, an incubation nation, a world class digital nation with world class technology companies.

"Increasing access to high-speed broadband is changing the world. Ultra-Fast Broadband (UFB) has the potential to transform New Zealand's economy, our communities, and the way we connect to the rest of the world. As broadband becomes fundamental to social and economic participation, it will be seen as an essential service and a human rights issue, rather than a luxury. As cities increasingly compete for talented individuals and innovative businesses, having strong connectivity will be an attractive point of difference. Technology will be used to overcome challenges, such as limited budgets and ageing infrastructure, revitalising urban areas and improving economic growth.

Chorus is at the forefront of this work, investing billions of dollars and creating thousands of jobs rolling out fibre to 24 towns and cities throughout New Zealand."

Mark Ratcliffe
Chief Executive, Chorus

The Tech Sector provides the foundation for all sectors

The economic impact of the networks

New Zealand is well placed among developed countries in the rollout of fibre, wireless and international cable networks. The Government's Ultra-Fast Broadband (UFB) programme and Rural Broadband Initiative (RBI) are advanced and these networks are critical drivers of economic activity, productivity growth and employment across the economy.

By December 2015, the UFB network was available to 875,000 households and businesses[22] or 60% of the total target of connecting 1.459 million households and businesses with fibre to the premises by the end of 2019. These 1.459 million households and businesses correspond to network coverage of 75% of New Zealanders.

UFB network deployment is now well advanced, but there are still substantial backlogs in the two tech centres of Auckland (43% deployed) and Wellington (41% deployed). This indicates not only the greater workload to get through but also the potential for users to benefit from the rollout and subsequent take-up and use of fibre connections.

There is also substantial scope to grow take-up by customers and therefore gains for households and businesses. The current uptake of UFB is only 18.6%.

As for the RBI, Government has partnered with Chorus and Vodafone to build and upgrade wireless towers, upgrade or install rural telecommunications cabinets and extend Chorus's existing fibre network by about 3,350 kilometres. Effectively, all priority users (schools and rural hospitals) have now been connected through the UFB or RBI.

In 2015, the Government further extended the UFB programme and the RBI. An investment of $210 million from the Future Investment Fund will raise the targeted number of New Zealanders with access to UFB from 75% to 80%, so about 50 more small towns will have access to UFB. Government will also invest another $100 million to extend the reach of the RBI, with the cost funded by an industry levy. The government is also talking to businesses and communities about improving mobile coverage along main highways and at major tourist sites.

The critical network infrastructure for delivering fast internet connection is not limited to fibre deployment or fixed networks. With the growing trend of mobility and the use of mobile data the mobile networks are also an essential part of the underlying connection fabric.

Mobile data traffic in New Zealand[23] is forecast to grow at a compound annual growth rate of 43% and is now measured in exabytes – that's a billion gigabytes. In 2015, New Zealand mobile data exceeded 0.1 exabytes, equivalent to 10% of all global traffic only 15 years ago. Most of the demand has been coming from the growth in smartphone connections, but as the internet-of-things grows, machine to machine connections are also growing rapidly.

With the demand for data comes the demand for speed, so a continuous evolution of mobile networks is needed. The transition to 4G, fourth generation mobile network infrastructure, is still underway and already the telecommunications companies have started planning for 5G which will only be a few years away from deployment.

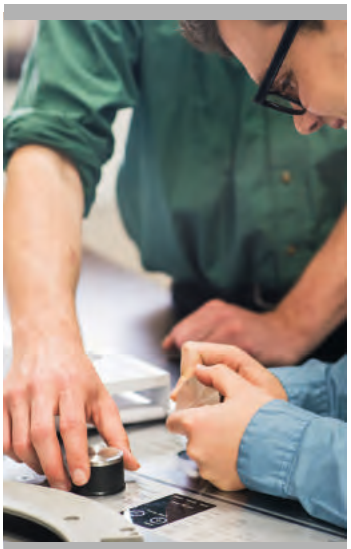
Investment in telecommunications is high in New Zealand. A recent report on the telecommunications sector by Sapere[24] noted that New Zealand was near the top of the OECD rankings in 2013 for the proportion of telecommunications revenue that was invested by operators. Total telecommunications investment reached $1.7 billion in 2014 (including the UFB and RBI investments).

Rollout of infrastructure is just the first step. The second step is actual connection or uptake by households and businesses. This follows a learning process during which users gradually begin to realise and exploit the potential of the new infrastructure. For example, many small businesses may start by replacing costly 'resilience assets' such as servers, by transferring data storage to the cloud.

Research by Statistics New Zealand[25] shows that investment in ICT capital that increases ICT capital intensity was the most important driver of productivity growth in New Zealand in the period from 1978-2011. The contribution of ICT capital to labour productivity was also far greater than the contribution made by all other types of capital. Statistics New Zealand found that when communications are included in the IT capital-services index that ICT's contribution accounts for about half of labour productivity growth.

The OECD found the ICT sector's contribution to New Zealand's GDP growth was higher than that of any other OECD country, including our 10 main OECD export competitors from 2001 to 2013.

This result reinforces the importance of the tech sector to productivity and economic growth. It also emphasises the value of the underlying networks and the positive network effects that are generated by rollouts of network infrastructure.



$1.7b

INVESTED IN 2014 BY TELECOMMUNICATIONS COMPANIES INTO NETWORKS

International connectivity

Until recently, New Zealand's main international connectivity to the internet was via the Southern Cross cable which has a figure 8 design with dual route redundancy and provides excellent low latency connectivity to Australia, the US and to the rest of the world.

There had been concerns for some time about having a single provider with growing internet traffic and a small risk of being cut off from the rest of the world. Yet in recent months two new cables have been announced - a new link to Australia (the Tasman Global Access) and a new link to the US (the Hawaiki).

The investments in these two cables will further strengthen New Zealand's digital access globally by improving redundancy and by creating competition.

HIGHER USAGE OF INTERNET SERVICES BY ALL FIRMS WOULD RAISE GDP BY

$34 billion

The economic impact of the internet

A recent report by economic consultancy Sapere[26] examined the economic impact of use of the Internet for businesses outside the ICT sector. Firms that make extensive use of Internet services were found to be 6% more productive than average firms in their industry. The 6% result is equivalent to the firms using Internet services more extensively being four years ahead of the average in their industry in terms of business competitiveness. The report also estimated that if all firms were more extensive users of Internet services, the productivity impact on national GDP would be as much as $34 billion a year.

CALL TO ACTION

The economic impact of the Internet and the importance of the underlying networks are beyond question. We must ensure that network builders and the operators using them continue to have incentives to invest to maintain our global competitiveness.

The regulatory frameworks for telecommunications after 2020 are a current item of discussion.

- **NZTech recommends** that the government carefully consider the importance of certainty in the telecommunications regulatory framework when looking at how best to regulate UFB services from 2020.

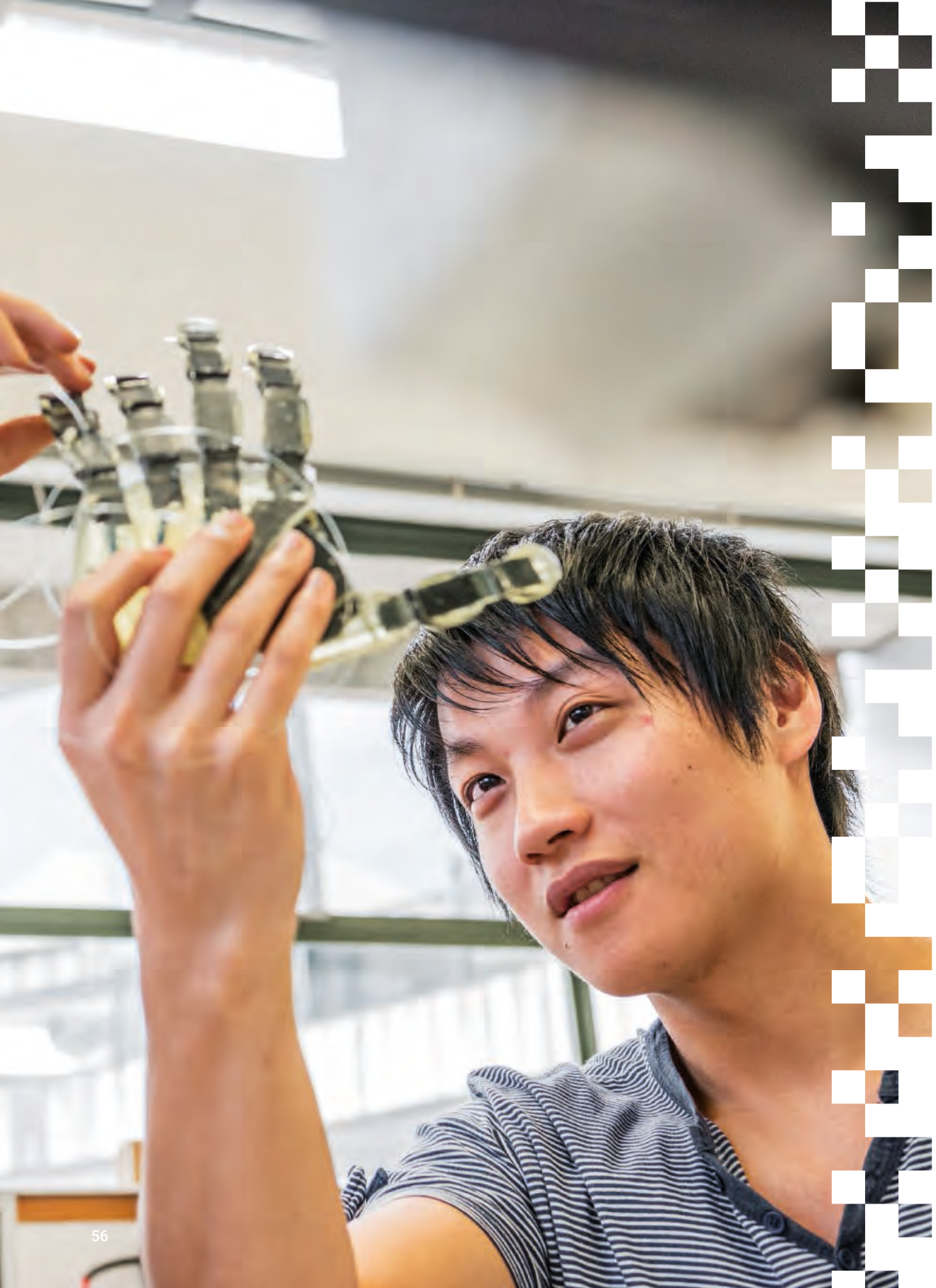
The largest economic growth opportunities from the Internet will come from businesses and government organisations throughout New Zealand effectively using Internet services better to improve their productivity.

- **NZTech recommends** that the government continues the efforts foreshadowed in MBIE's Digital Economy programme to help New Zealand businesses secure the benefits of increasing use of internet services.

PART TWO

The Impact

55



TECH SECTOR PRODUCTIVITY UP

1.2% pa

VS **NATIONAL PRODUCTIVITY** UP

0.7% pa

The Impact of Tech Sector Growth on the Economy

Due to the pervasive nature of technology, the outputs of the tech sector are closely linked to the inputs of other industries. This means an improvement in technology or productivity in the tech sector itself could lead to increased growth across all industries and regions of the economy. This section studies the potential impact across the economy of productivity growth in the tech sector.

The impact of innovation on the economy can be modelled and estimated using computable general equilibrium (CGE) methods as described in the appendix to this report. NZIER used a CGE model to simulate the impact of a 4% productivity improvement in the tech sector[27] to see what effect it would have on the rest of the economy. Please note, we are only talking about the economic impacts of a change in the New Zealand tech sector, although obviously improvements in tech products or services imported from other countries would also have positive economic impacts.

The model assumes there has been an innovation that enables the tech sector to produce 4% more output than before. This innovation can be thought of as an improvement to current sector practice, such as new software code which makes products cheaper or faster to make. It can also be thought of as the tech sector producing new products and services, such as cloud-based computing services or a new device, which opens up new possibilities for others and make the sector's products more valuable to other businesses and consumers.

The NZIER simulation is well within the bounds of the kinds of productivity gains that have been seen in the tech sector over recent decades. NZIER estimate that overall productivity growth in the New Zealand tech sector has averaged 1.2% per annum in the past 15 years[28], compared with 0.7% for the entire economy over the same period. The 4% improvement being measured here is, for example, equivalent to the actual productivity growth in the sector in 2011.

FOR EVERY **4% GROWTH IN THE PRODUCTIVITY** OF THE TECH SECTOR, THE **ENTIRE ECONOMY** LIFTS BY

1% or $2.7b

Labour productivity growth has been particularly strong in the New Zealand tech sector, with growth of 3.1% – twice that of the national average[29].

The NZIER model indicates that a 4% tech sector productivity improvement would cause New Zealand GDP to expand by 1%[30]. This amounts to a $2.7 billion expansion of the economy, while labour income and capital income would grow by approximately $1.6 billion and $798 million respectively[31, 32].

The expansion is spread across all regions. Auckland would grow most ($1.0 billion) followed by Canterbury ($391 million).

With the tech sector comprising 8% of total production in the economy, a 4% stimulus within that sector is like stimulating the entire economy by only 0. 32%[33]. Thus, growth of 1% is three times the value of the initial stimulus. This magnification of growth comes about because tech sector productivity growth increases household income, nationwide investment and export income.

Businesses that buy products from the tech sector also benefit, whether from lower cost tech sector products or higher quality products. Those businesses then also attract higher investment, produce more, export more and generate higher incomes. The effect is cumulative so the economy as a whole benefits by more than the assumed increase in productivity.

Such effects are not unique to the tech sector. Productivity growth applied to any sector would have a compounding effect on economic growth. But the characteristics of the tech sector, particularly its outward focus, mean that the impacts are high. Furthermore, the tech sector is a hub for innovation therefore it achieves stronger productivity growth than other sectors.

There are good reasons to expect that growth in the tech sector would drive greater innovation and economic growth in ways not captured by the analysis. This would be the case if expansion of the tech sector increased the diffusion of technology from overseas. It may also cause an increase in local innovation in new goods or services. Or it might spur an inflow of skilled migrants. None of these things are captured in the NZIER analysis, but any or all of them would further expand the tech sector and have further and larger economic impacts on the wider New Zealand economy.

In short, the NZIER analysis understates the benefits of the tech sector to the wider economy. But it does show many of the dynamics of an expansion of the tech sector and the benefits all New Zealanders would experience regardless of whether or not they work in the sector.

EVERY DOLLAR INVESTED IN RAISING **TECH SECTOR** PRODUCTIVITY DELIVERS

$3.00

OF **ECONOMIC GROWTH**

Tech sector growth drives increased investment

One of the more important effects of tech sector growth is increased investment. The greater productivity of the tech sector not only raises output but profits too, and a portion of these profits would be re-invested in the economy. The NZIER analysis identified that a 4% productivity gain in the tech sector would raise returns or profits in

the sector and that in turn would increase the level of investment in the economy by around $400 milion in today's prices.

Investment would also come from overseas as external investors observe the rising levels of productivity and profitability in New Zealand and react by investing in the economy in the hope that they too will earn better returns on their investments here. Foreign investment will grow the New Zealand economy without the need for New Zealanders having to defer current consumption (which is part of growth) to fund the expansion themselves.

Some, but not the majority, of investment would come from local sources. Expansion of the tech sector means that incomes of New Zealanders rise and they have more to invest. Inevitably, some of that will go back into the tech sector, as well as other sectors of the economy.

Export growth will improve because the tech sector is outward facing

Another result of increased productivity of the tech sector is that exports would increase by $630 million. This is almost entirely an increase in tech sector exports and exports of sectors closely related to the tech sector.

Overall, export growth is spurred by the fact that the tech sector is export-intensive. The tech sector has a higher than average propensity to export because its output is readily traded internationally.

4%

LIFT IN **TECH SECTOR PRODUCTIVITY** WOULD INCREASE **NATIONAL WAGES BY 1.4%**

Households benefit from cheaper goods and higher wages

A 4% increase in tech sector productivity is also associated with a $1.3 billion increase in household consumption spending. This increase in living standards comes from a combination of higher wages and lower prices for a higher quality of goods and services.

The analysis shows that wage increases are one of the largest effects of the tech sector expansion with real wages up 1.4%.

At the same time, an increase in the exchange rate, while not positive for exporters, helps most households by reducing the price of imports.

Positive impacts nationwide, but benefits are concentrated in urban centres

As tech sector productivity grows, regions gain across the board at different rates. This is a reflection of pre-existing strengths in the tech sector in the major urban areas and also the high use of tech sector products in industries in urban centres.

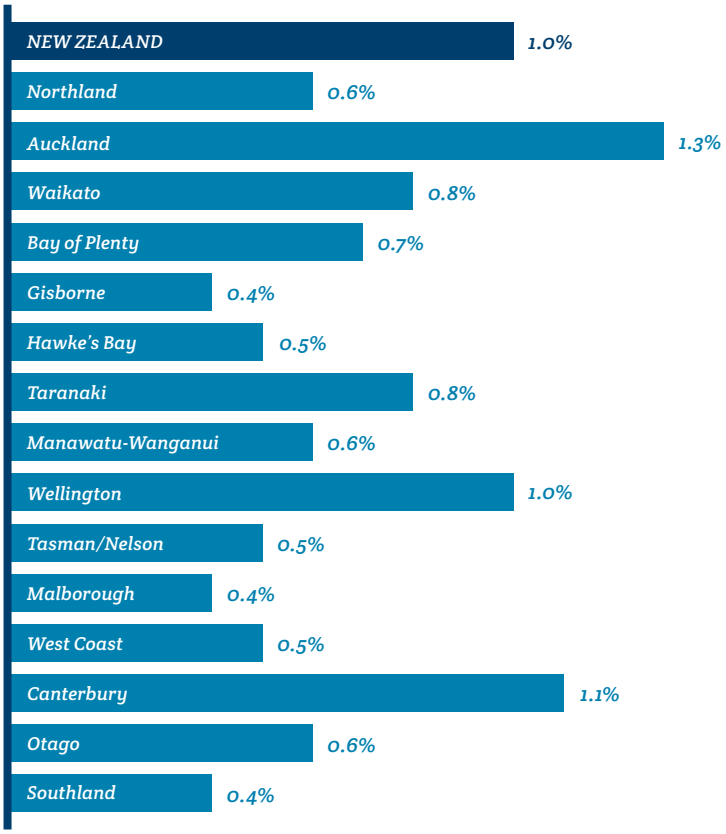
A feature of some tech sector products is that they play an important role in public services such as health, education and government administration. Those services are concentrated in major urban areas and play a particularly important role in the expansion of the Wellington economy.

All three major urban centres have relatively high shares of their economy in the tech sector and thus they exhibit the largest growth impacts. Auckland has the largest growth impact with a 1.3% improvement in local GDP, followed by Canterbury (1.1%) and Wellington (1.0%).

Changes in wages are more evenly spread across the regions than GDP impacts. Most regions see wage increases of similar amounts, between 1.3% to 1.5%.

FIGURE 16: REGIONAL ECONOMIC IMPACTS OF TECH SECTOR GROWTH

Percent increase in economic activity (GDP) from a 4% rise in tech sector productivity



Source: NZIER analysis

CALL TO ACTION

The impacts of increased productivity in the tech sector are significant and diverse. The NZIER analysis shows that any investment to grow the tech sector in effect gets you a three times return due to the impact tech sector growth has on investment growth, export growth, lower cost imports and higher wages.

- **NZTech recommends** that the government maintains and strengthens its focus on supporting the growth of the tech sector.

Critical to sector growth is a flow of well trained staff and graduates, support with start-ups, good access to capital, support with R&D, and a government procurement process for ICT that supports innovation.

- **NZTech recommends** that the government and the tech sector accelerate the work underway to measure and combat skills shortages.
- **NZTech recommends** the establishment of a national Tech Start-up body, as an NZTech community, to create a nationally connected tech start-up ecosystem to support information and experience sharing.
- **NZTech recommends** that the government rethinks the procurement process for software in a way that enables government agencies to fearlessly contract for product design assistance, rather than feeling that they have to have already fully designed their product before procuring assistance in building it.

The Impact of Technology on other Sectors

When the tech sector innovates it invariably supports growth in other industries. The Internet and cloud services are enabling firms to scale up faster and to reach global markets. New computing platforms are reducing the costs of doing business and tech sector innovations are changing the way businesses operate and improving their productivity.

The NZIER analysis of the wider economic impacts of tech sector productivity gains can begin to capture some of these effects, but not all of them. In particular, it cannot capture the breadth of ways in which tech sector innovation enables innovation in other industries, nor does it capture the impacts of innovation in technology offshore on domestic production.

There are so many ways that technology can be used by other sectors that we could not hope to discuss them all. But in the final sections we discuss a selection of ways in which the technology is driving innovation and growth in other industries.

Manufacturing and Retail

Numerous technological developments are transforming the manufacturing and retail sectors. For example, in manufacturing there are developments in materials science, 3D printing, sensors and robotics. Retail is being revolutionised by the growth of online sales and mobility. Both manufacturing and retail are being shaped by the Internet of Things, where parts and machines are connected to the Internet. Improved internet connectivity is benefiting both the retail and manufacturing sectors by enabling the connection of goods, machines, suppliers and consumers to each other.

Technology and Manufacturing

New Zealand's manufacturing industries make an important contribution to the national economy. In the year ended September 2014, manufacturing sector output accounted for 11% of real GDP. Around 12% of the labour force was employed in manufacturing[34].

Digital technologies are starting to disrupt the manufacturing sector as they have the media, finance and other sectors. New computing capabilities and increasing data, along with advances in automation, robotics, additive technology, artificial intelligence and human-machine interfaces are unleashing innovations that are disrupting manufacturing.

As innovations in the tech sector begin to flow into the manufacturing sector, an initial trend is for manufacturers to retrofit or upgrade existing plant to improve processes rather than completely replace machinery and equipment. The addition of improved connectivity, new software, sensors and analytics are allowing manufacturers to boost the performance of existing machinery.

The main impact of these tech sector improvements on manufacturing is cost reduction, although new manufacturing technologies also allow manufacturers to increase quality and introduce new product varieties.

NZIER calculated that a 4% improvement in tech sector productivity would flow through the manufacturing sector and increase GDP by as much as $700 million. Most of this expansion would be seen in the high-tech manufacturing sector, but almost $200 million would stem from expansion of more traditional manufacturers use of technology.

FUJITSU

"Manufacturing and retail make up the backbone of our economy and are critical components of an economically successful New Zealand. We are seeing the growth in use of technology such as internet shopping, sensors and the Internet of Things driving increases in productivity and profitability in firms across both of these sectors.

Fujitsu New Zealand has 850 staff throughout New Zealand supporting New Zealand businesses and the New Zealand government to gain productivity benefits through technology."

Stuart Stitt
Managing Director, Fujitsu

A 4% LIFT IN **TECH SECTOR PRODUCTIVITY** WOULD INCREASE MANUFACTURING GDP BY

$700m

While some manufacturers are recognising the opportunities - and threats – of digitisation, few are responding in a comprehensive, coordinated way. For example, manufacturing generates more data than any other sector of the economy yet few companies are harnessing it. Manufacturing companies that invest in technology to capture and understand the data they generate will uncover valuable insights to drive profits and growth.

New advancements in additive or 3D printing, robotics and virtual reality are enabling manufacturers to design and manufacture faster, safer, more customised and cost effectively.

Globally, the digital manufacturing revolution is still in its infancy. For example, global additive manufacturing is expected to reach US$20.4 billion by 2019[35] which is nothing compared with the global manufacturing market worth approximately US$11 trillion.

This disruption presents New Zealand with an enormous opportunity. Over the past decades manufacturing in New Zealand has decreased as bigger plants in lower cost countries had a competitive advantage. Now as we enter an era of digital manufacturing, design and production near to demand will be a competitive advantage. New Zealand manufacturers that evolve fast to new technologies, leveraging sensors, data analytics, additive manufacturing and virtual reality will be able to compete well on the world stage. The export success of the tech sector's high-tech manufacturers is testament to the ability of New Zealand manufacturers to leverage advanced technology to take on the world.

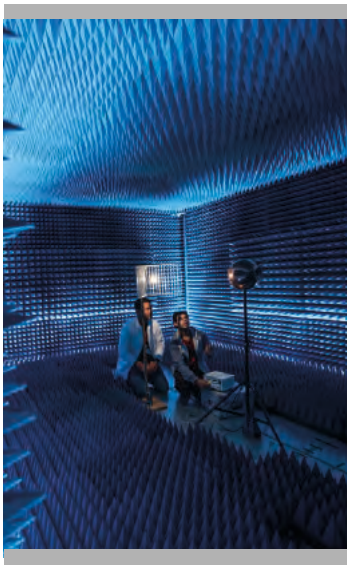
3D printing titanium

During the build up to the 2013 America's Cup Regatta, Emirates Team New Zealand identified the need to kit each crew member with an emergency knife. John Bamford of Victory Knives set about designing a state of the art, light-weight, small knife, yet strong enough to cut through marine ropes. It was decided that they needed to be manufactured in titanium to meet strength and weight requirements, yet with such a small run it would make the knives unfeasibly expensive.

Tauranga commercial 3D titanium printers, Rapid Advanced Manufacturing, worked with Victory Knives to 3D print the state of the art knife and sheath in Ti64 alloy powder, then super coated it to produce individual knives that can cut through strong marine ropes in one blade stroke compared to their existing knife which took 10 strokes.

The entire project was urgent and was turned around in six weeks. Emirates Team New Zealand entered the America's Cup with their sailors wearing the new knife in their wetsuit thigh pockets as a safety requirement. The XTB Sailor's Blade was such a success that the 3D printed titanium knife is now available to consumers.

Technology and Retail



The retail sector would respond quite strongly to a tech productivity rise, through the benefits of the latest sensor technology, improved inventory management, better connectivity to retail services and more effective connections between retailers and customers.

Sensor technology and associated information systems for retail are becoming more advanced. Sensors are being embedded into products, which are then connected to each other via information networks, creating new business models, improving processes and reducing costs and risks.

In-store experiences and store profitability can be improved through sensors that monitor and deliver new services to shoppers – the emergence of so-called 'smart stores'. Sensors can be used to monitor shelf stock levels and analyse shopper traffic patterns. Technology exists for special sensors to detect where shoppers' eyes linger, and even to react to a shopper's attention by providing a special offer on that product in real time.

NZIER calculated that a productivity increase in the tech sector, perhaps driven by sensors, could boost the retail sector's GDP by as much as $200 million. Particularly impacted would be the retail centres of Auckland, Wellington and Christchurch. Consumers benefit a great deal too, with efficiency gains passed through to customers to the point where prices would fall.

Online sales have grown tremendously yet most retail sales are still concluded in physical stores. Previous research[36] has shown that retailers are slightly lower users of Internet services than businesses as a whole. Despite the obvious promise of online sales, they are less likely to have a website and less likely to have most of their staff online. Bigger firms are generally more engaged online than smaller firms.

Use of the Internet can give retailers greater reach but it also brings greater competition, particularly for some goods like clothes or books that are exposed to stiff international competition. Internet services can also sharply improve operations including through inventory mangement, point of sale and better business information.

Rising productivity of internet infrastructure and continued innovation in shopping applications can be expected to lift output and employment in the retail sector, perhaps partly by boosting online sales and partly by facilitating the connectedness of sensors to goods, services and consumers.

Google research[37] found 84% of smartphone shoppers use their phones while in a physical store. The tendency for consumers to rely on their mobile devices to help them shop has led retailers to start using sensors to trigger messages delivering highly relevant content to shoppers' devices while they browse the store.

These innovations are increasing the efficiency of retail marketing and promotion activities and boosting prospects for growth of retail sector sales and profitability.

Integrating software in the cloud

Crane Brothers is a high-end contemporary tailoring business with retail outlets in Auckland, Wellington and Sydney. As the business grew, keeping track of everything manually became overwhelming, so it moved to a computerised system, initially opting in 2004 for a server and some expensive software to help run its business.

Then along came fast internet and the Crane Brothers began moving everything online. Using Xero for the accounting system and Vend for point of sale the Crane Brothers traded off a less than 100% fit from the software, for time and cost savings. A traditional point of sale system looked like costing $30,000 whereas Vend does what they need for $140 a month.

On top of that, productivity improvements equivalent to 40-80 hours a week were gained through better inventory management and reduced technology management. Savings equivalent to two full time people. Freeing up the staff has led to better customer experiences, better products and more sales.

Rural New Zealand

Rural New Zealand is predominantly devoted to agricultural activities. Despite being outside the tech sector, agriculture is a big user and creator of technology. Sapere's 2013 research showed that agricultural producers are generally low users of Internet services relative to other industries, but they are still highly connected. The rollout of networks and the increasing availability of internet connectivity, especially driven by the Rural Broadband Initiative, are enabling transformation in the way the agricultural sector operates and how suppliers integrate into the supply chain from pasture to plate.

There are significant positive impacts available from connecting farms to broadband and from relatively simple data sharing applications. Internet connectivity and broadband brings the prospect of increased digital customer interactions for businesses such as Alliance, Farmlands and Fonterra. For example, online transactions and data transfers between dairy farmers, Fonterra and the Livestock Improvement Corporation reduce transactions costs

and improve logistical co-ordination and farm management. There are also opportunities for the application of big data and analytics, particularly as speedy online transfers of data between farmers and suppliers become the norm.

The Precision Agriculture Association for New Zealand was launched in 2013 following a growing awareness of the benefits of precision agriculture. The organisation focuses on increasing uptake of precision agricultural technologies across land-based primary production systems. Technologies such as drones, sensors, geospatial mapping, variable rate irrigation, mobile devices, wireless networks and data analytics are changing the face of New Zealand farming.

The Primary Growth Partnership (PGP), administered by the Ministry for Primary Industries, was set up to enable innovation in the primary sector and to facilitate collaboration across the value chain. Business expenditure on R&D in the primary sector increased sharply between 2010 and 2012, thanks in large part to PGP co-funding.

A recent report by NZIER shows that the PGP could add up to $6.4 billion to New Zealand's GDP from 2025, with the possibility of a further $4.7 billion if the aspirational goals of the programmes are realised, the innovations are taken up widely, and all the research and development is successful.

Tech sector innovations are being adopted in many of the PGP programmes with examples such as the application of precision agriculture on-farm and industry-wide information capture and utilisation through the development of the Dairy Data Network.

Technology and agriculture productivity

According to the World Bank[38], while New Zealand's agricultural productivity growth is still ahead of the world average of 1.7% a year, it has markedly slowed in recent years from 3.2% annually in 1991-2000 to 2.3% in the decade of 2002 to 2011.

In a recent article in the NBR[39] the trend of reducing agricultural productivity was discussed and it was noted that reigniting productivity in the rural sector was critical for both farmer profitability and New Zealand's global competitiveness.

This trend of reducing agricultural productivity is typical across most other high-income nations, with one exception being the Netherlands. Despite being a third of the size of the North Island and having 26% of the country below sea level, it is now the second

Spark New Zealand

"Innovation in the rural sector has been a key driver of New Zealand's economic prosperity for the past 150 years. Looking ahead, innovation enabled by technology will become even more vital to unleash the potential of rural New Zealand – enhancing productivity, improving the use of precious natural resources, and underpinning research and development. New Zealand's reputation as a world-leading provider of agricultural technology solutions continues to grow and connectivity is the heart of this technological progress. Spark has continued to invest heavily in rural New Zealand and our experience working alongside communities and regions to deliver better technological solutions means we understand its importance and the difference it can make."

Simon Moutter
Managing Director, Spark

largest exporter of agricultural products in the world by focusing on innovation and value-add.

Production costs have put pressure on the competitive position of New Zealand agriculture in world markets. Reversing a slowdown in productivity growth is critical given the challenges the sector faces with strengthening environmental regulation.

Previously, productivity growth was driven by open market reforms in the 1980s and then changing land use, particularly conversions from sheep and beef farming into dairy production. Significant expansion of irrigated land, which has doubled every 12 years since 1970, has also contributed to land use change and increased productivity. Future expansion, particularly in dairy, is now challenged by the impact of land use on water quality.

Digital agriculture, in the form of precision farming, big data, sensor technology and drones, delivers a new potential for productivity gains across rural New Zealand.

The Connected Cow

Fujitsu has developed a 'connected cow' product that detects oestrus signs in dairy cattle from changes in step count data. Cows are fitted with pedometers, connected to on-farm receivers. Step count data is transmitted to a Microsoft Azure cloud-based service that detects oestrus signs and sends an alert email to the dairy farmer.

A sharp increase in the step count is a reliable indicator of oestrus. Dairy farmers can arrange for insemination at exactly the right time, a huge time saver that improves farm management and reduces the lost opportunities from missing the signs of oestrus.

Technology and Irrigation

Irrigation is essential for consistent, quality food production on the dry, east coast regions of New Zealand. The Government's Irrigation Acceleration Fund supports investment in irrigation to increase land productivity. Irrigated farmland typically generates three times the production of an equivalent area farmed under dry-land systems. Studies of the socio-economic effect of irrigated agriculture show for every $1 of wealth created on an irrigated farm at least another $3 is created in the wider rural and urban communities.

Tech sector innovations are being applied to derive cost savings and efficiencies from investments in irrigation. In particular, tech sector productivity advances in high performance irrigation systems and smart 'just in time' irrigation practices are being adopted. But there are concerns about the environmental impacts of increasing agricultural output. For example, the potential environmental impacts of land intensification associated with large irrigation schemes include elevated levels of nitrogen leaching, sediment runoff, microbial contamination and an over-allocation of water resources.

Therefore, irrigators must now manage water quality and quantity to limits. Increasingly, regional councils require independently audited farm environmental management plans that include nutrient, riparian and irrigation management plans.

Internet connectivity, broadband access, the use of sensors and cloud software services will increasingly be required to help farmers and irrigators use water and nutrients more efficiently and precisely.

Technology investment drives secure growth

Zespri is the world's largest marketer of kiwifruit and one of the most successful horticultural marketing companies in the world with annual sales of US$1.5 billion. In 2012-13, Zespri sold more than 100 million trays (3.3 billion pieces) of premium-quality kiwifruit in more than 53 countries, supplying 30 percent of global kiwifruit sales.

In January 2011, Zespri was on track to double sales and triple revenues by 2025 when disaster struck. First, a deadly virus swept through New Zealand kiwifruit fields, devastating many growers' crops and wiping out entire orchards. Then a month later, a major earthquake shook New Zealand. Zespri revenues plummeted and the company had to quickly reduce operating costs.

Due to the crisis Zespri realised that their reliance on antiquated technologies was both risky and unproductive. Zespri decided to move their business critical enterprise software onto a Microsoft Azure cloud platform to give them disaster recovery and the ability to easily scale up and down as needed. The move reduced IT costs by almost $1 million and allows them to focus on growing and selling kiwifruit.

The Internet of Things can minimise the application of nutrients in precision farming. Equipment with wireless links to data collected from remote (airborne and satellite) and proximal (ground) sensors can monitor crop conditions and adjust the way each individual part of a field is farmed — for example, by spreading more fertiliser on areas that need more nutrients, or by spatially varying the amount and timing of irrigation.

Technology promises to cut costs and enable faster repayment of both irrigation scheme and farm infrastructure capital, whilst allowing farmers to demonstrate their compliance with environmental and other regulatory requirements.

Precision agriculture technologies lift production

The McCarthy Farm in North Otago is a farming enterprise of 1,400 hectares of cropping land owned and run by the Mitchell & Webster Group. Due to the area's rolling, clay rich soils they use four pivot irrigators with precision variable rate irrigation (VRI) technology and electro-magnetic maps.

Through the implementation of precision agriculture technology on the McCarthy block the Mitchell & Webster Group has been able to reduce their water usage from 34 litres per second to 26 litres per second. These savings have been the result of avoiding irrigation application over 7 hectares of springs and ditches as well as varying application rates based on soil texture groups identified by electro-magnetic mapping. With high costs for irrigation shares as well as additional water usage charges, reduced flow requirements meant the Group no longer needed $77,000 worth of irrigation shares. In addition, they estimate that through the use of VRI there has been an average increase in production of 5%.

Agritech - a growing opportunity

Research undertaken for NZTE by Coriolis Research found that New Zealand had approximately $1.2 billion[40] worth of agritech exports in 2013 and was growing at a compound annual growth rate of 4%. A comparison between New Zealand's agritech exports and its key competitors (defined as Israel, Ireland and the USA) shows New Zealand is underperforming in the absolute size of agritech exports but is showing good growth. For example, Israel, a tiny desert state the size of the West Coast, exports approximately 10 times as much agritech as New Zealand.

AGRITECH EXPORTS

$1.2b

According to the Coriolis report, in comparison to peers in various export markets, New Zealand could be exporting 5-10 times more agritech. While we export well to Australia both Europe and the US cold take significantly more agritech from New Zealand. Overall, New Zealand has a good mix of agritech products and there is strong growth potential.

Global agritech investment is growing rapidly, with investment in 2014 estimated at over US$2.36 billion making the sector larger than the global fintech market. With our traditional strengths in agriculture and our growing strengths in tech this is an opportunity we should pursue with vigour.

There is an enormous opportunity for New Zealand to use technology as a means to support the economic growth of our agri sector and to also work with the sector to become a world leader in a fast growing agritech market.

Developed in New Zealand sold to the world

New Zealand founded agriculture focused GPS guidance system, Tracmap, is a world leader in supplying precision guidance systems for ground applications in the agriculture, horticulture, viticulture and aviation industries.

Founded originally to help New Zealand farmers place fertiliser more accurately, TracMap has been proven to increase the efficiency of application by 20%. Put simply, you get 20% more coverage from the same amount of product. Over 65% of all fertiliser applied to New Zealand farms is now carried out using TracMap guidance and mapping systems.

Customers all around the globe now rely on Tracmap to plan, place and prove their in-field activities in real-time.

"The nature and location of work is changing rapidly and the Government is a significant employer in its own right. Being able to predict demand and manage the process of having the right people doing the right work at the right places at the right times is already enabling sectors such as Health to deliver significant improvement in both patient outcomes and the ability to cope with increase in demand.

50% of the employees within the public health sector and 25% employees within the public service departments are managed by AMS workforce management software resulting in better back-office efficiencies that enable a greater proportion of public funds to be utilised for front-line outcomes."

Joseph Yip
Managing Director,
Advanced Management
Systems

Government Services

The public sector is the single largest customer of the tech sector, according to IDC, a global market analyst firm. The central government accounts for 29% of ICT sector purchasing and upward of 40% of the tech sector's domestic revenues if you include all public sector spending across central and local agencies.

While a considerable cost for the government, technology is also the key to driving new modes of service delivery that both reduce costs and improve experiences for the Government's 'customers'.

Delivering efficient government services

Treasury's Benchmarking Administrative and Support Services Report shows the 26 measured government agencies spent nearly $1.7 billion on administration and support in 2013/14, two-thirds of which was attributable to ICT. Rising ICT expenditure reflects invest-to-save initiatives and a wide acceptance that technology can transform businesses, improve service delivery, strengthen productivity and support decision making.

There are clearly identifiable improvements in productivity delivered by technology across the government sector. These impacts are primarily in the categories of cost savings and more effective service delivery. The government has also implemented cross-cutting innovations, such as improving the way departments and agencies collaborate to use the connectivity of the Internet and the accessibility of data. Over time this will result in productivity increases.

Higher productivity means better government services can be delivered using fewer resources. The savings from these gains can be redeployed into delivering better quality services.

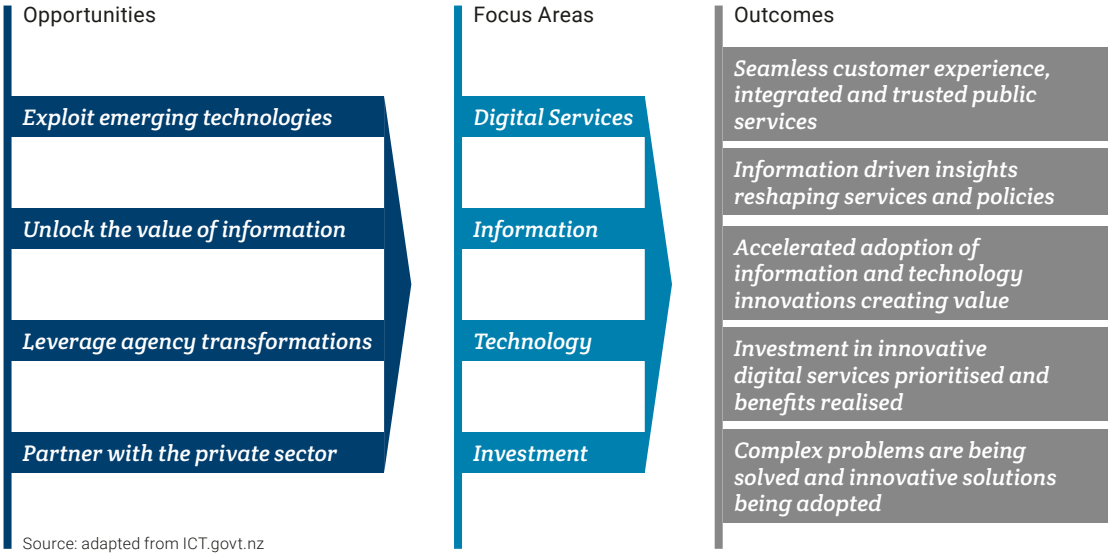
The Government ICT Strategy

The Government ICT Strategy and Action Plan to 2017 was revised in 2015 to ensure that, in a dynamic technology environment, it can achieve the government's aim of an ICT-enabled transformation of public services, so customers can experience seamless, integrated and trusted public services.

The strategy is about enabling the public sector to exploit ICT-enabled opportunities. In effect, to benefit from the innovation, growth and productivity improvements coming from the tech sector.

FIGURE 17: NEW ZEALAND GOVERNMENT ICT STRATEGY 2015

Enabling the public sector to exploit ICT-enabled opportunities



Source: adapted from ICT.govt.nz

The government has identified that to exploit emerging technologies and unlock the value of information it needs to partner with the private sector. Tech sector innovations can be used to completely redefine the way the government conducts its business.

The ICT Strategy is the government's conscious effort to exploit the potential impacts from adopting tech sector innovations. This is an illustration that the same is true as for any sector: benefiting from technology does not happen automatically.

Open Government information and data

The 2014/15 Open Data Barometer Global Report[42] shows that New Zealand is ranked fourth globally and continues to be one of best countries in the world at allowing open access to government data.

As reported by Sapere and Covec in their study on data driven innovation[43], government agencies continue to make substantial efforts to enable their datasets to be more easily available. Just over a third of agencies are now consistently releasing public data fully compliant with the standards the government has set. However, there is still a considerable gap between the government's aspirations for open data and the reality. Many government datasets available online are not in a useable format or published regularly.

Only 45%
OF **DATA RELEASED BY GOVERNMENT** WAS IN OPEN FORMATS IN 2014

The latest government report on progress on its open data efforts says that in 2014 nearly 80% of agencies released datasets, but only 45% were in open formats. Most agencies released just one dataset, a PDF of the Chief Executive's expense declaration. The register at **data.govt.nz** is intended to list all open government datasets, features only a fraction of those that are publicly available on government agency websites.

Open data is a focus for the government, but the attention paid to it by most agencies is very modest, perhaps because they do not think that publishing open data can help them to achieve their

Putting our debt in the cloud

The Debt Management Office (DMO) of New Zealand's Treasury had been using an Access database for the past 20 years to deliver daily valuations, risk analysis and monitoring covering forex trading, bonds, swaps, futures, loans options and notes. The database, Matriarch, was "critical and instrumental" in the management of the office.

However, a review in 2012 found multiple problems, including legacy silos, a lack of documentation, "key man" risk, multiple security issues and that Matriarch was built using inappropriate technologies.

Working closely with their tech sector partners the DMO established that a cloud based solution would improve their productivity and reduce their risk. But there were concerns with having national debt information located on servers offshore. Following a thorough review by the GCSB it was confirmed that the information wasn't confidential and that the proposed solution was actually more secure.

So, in 2014, the DMO began moving modules to a Microsoft Azure cloud.

Clive Trott, Head of Business Information at Treasury at the time, said that the cloud was not a driving force behind the change. The driver was treating information as an asset and finding the most appropriate technology solution. The productivity gains were an unexpected bonus.

organisational goals. There is also a gulf between open data and usable data, which opens up the possibility of use much more widely in order to gain the maximum productivity improvements. Open and useable data enables not just government agencies to gain productivity benefits, it also enables the private sector to create valuable new services.

Results 9 and 10

There is a set of government initiatives referred to as 'Result Areas 1 to 10'[44], of which Results 9 and 10 are efforts to benefit from improvements in tech sector productivity and the internet infrastructure.

The objective of Result 9 is that New Zealand businesses should have a one-stop online shop for all government advice and support they need to run and grow their business. Two powerful examples of

Sharing the State of the Nation

The Salvation Army has published its independent monitoring report, 'State of the Nation', for the past eight years. This aims to encourage public debate around New Zealand's social progress.

The 'State of the Nation' report uses a significant amount of government data, however only the data provided by Statistics New Zealand and NZ Police is open data. The Police and Statistics New Zealand open data can be searched via metadata, be displayed in adjustable table options and downloaded in CSV format for further analysis.

The positive impacts of using the NZ.Stat website are deeper analysis and engagement, as well as easier visualisation, as the downloaded data can be combined with other datasets and previous years' results using statistical tools. This provides a quicker, more robust, and less manual process.

progress towards Result 9 are the achievements of Inland Revenue and the Intellectual Property Office (IPONZ), both of which have successfully implemented a large range of online services in the last few years:

- Inland Revenue's myIR service is now used by more than 1.7 million taxpayers to manage their tax affairs online – an example of tech sector productivity improvements being applied by Inland Revenue to deliver time and cost savings to almost all taxpayers.
- IPONZ has streamlined and simplified its business processes and is now 100% online – a world first for an Intellectual Property Office and a real cost reduction for those involved in innovation.

1.7m
TAXPAYERS NOW MANAGE TAX ONLINE

The objective of Result 10 is that New Zealanders should be able to complete their transactions with government easily in a digital environment. The aim is for an average of 70% of New Zealanders' most common transactions with government to be possible in a digital environment by 2017.

These are good examples of government exploiting tech sector productivity improvements to deliver cost savings and more effective service delivery.

Better use of resources

A major impact of government adopting tech sector innovations is the freeing-up of human resources. Cost savings from automation and digitisation are critical for government departments that cannot generate more revenue but need to optimise the use of their existing resources to increase their service levels and output.

For many government departments, the biggest expenditure is people. So, ensuring efficient management of these resources is critical. Additionally, automation of more administrative tasks will also allow better distribution of scarce resources to front line needs.

IMPROVEMENTS IN HR AUTOMATION IN GOVERNMENT COULD SAVE
$37.7 m

Treasury's Administration and Support Services Benchmarking report identifies that good HR management information systems make a difference to productivity. The HR section of the report concludes that the government HR services are not particularly efficient or effective by international standards. Improvements require transforming HR service delivery models and working across agencies to leverage scale, streamlining and automation of processes focused on the needs of customers. The report identifies that annual savings of $37.7 million are possible if agencies below median efficiency reach median efficiency.

Healthcare

The New Zealand government spent $15.6 billion on health in the 2015/2016 year. That accounts for about 80% of all health spending meaning as a country we spend close to $20 billion a year on health. We obviously value healthcare as it improves the length and quality of our lives. It also supports the economy by enabling greater participation in the workforce and higher productivity.

Yet, healthcare costs continue to increase due to new technologies and medicines. Global health spending per head is expected to rise by 4.5 percent a year from 2014 to 2018[45]. In this environment, healthcare providers are challenged to find new ways to manage costs and efficiency without compromising service quality.

Consequently, the health sector is one of the fastest growing users of ICT as it looks to technology to manage costs and improve outcomes. According to IDC Health Insights, a global technology analyst firm, the healthcare sector in New Zealand spent $243 million on IT (excluding telecommunications) in 2015 and this was forecast to grow to almost $300 million by 2019. The healthcare sector currently has the fastest growth in IT spending in New Zealand at a rate of 5.5% per annum.

New Zealand Health Strategy

During most of 2015 the New Zealand Ministry of Health conducted an extensive consultation process in order to review the country's health strategy and develop a new strategy for implementation from 2016 onwards. The health strategy in use at the time was nearly 15 years old and had not kept pace with a number of key emerging factors, technology being one of these. The new strategy has identified a number of areas where better utilisation and uptake of solutions provided by the tech sector will make a significant difference to the development of new models of care and deliver improved efficiencies and health outcomes.

The new health strategy is under-pinned by five key strategic themes where technology will play its part to enable the delivery of enhanced health services.

The themes are:

- **People-powered** - which goes hand in hand with digital technologies, like telehealth systems and mobile health apps, that enable health services to engage with people wherever they are located.

"The health sector is at a critical juncture as it attempts to shift from a clinician-centric to a patient-centric system, from treating disease to promoting wellness. The sector is experiencing unprecedented disruption as it grapples with multiple pressures, including an ageing population, exponential growth in chronic and complex diseases and rising expectations from patients who want personalised, integrated and convenient care. Busy doctors and clinicians are challenged to improve access to treatment and deliver better outcomes, while at the same time reducing the cost of care.

IBM is helping the health sector meet these challenges. Cognitive computing is poised to deliver the game changing transformation the sector needs by helping bridge the gap between data quantity and data insights, enabling enhanced patient care, advanced discoveries and better decision-making".

Rob Lee
Managing Director, IBM New Zealand

$243m
SPENT ON IT
BY **HEALTH SECTOR**

- **Closer to Home** - technology that enables well-designed and integrated pathways for the common journeys people take through the health system (e.g., cancer, maternity, diabetes), starting and finishing in homes.
- **Value and high-performance** - using technology to make information work much harder. Better information about real-time health results, which is more visible, can drive improvements at both the front line and national level.
- **One Team** - enhancing the capability of the people in the health sector and their access to technology infrastructure to allow them to work to their full potential.
- **Smart System** - technologies are revolutionising health systems: robots and other automated systems are carrying out repeatable and predictable processes, advanced analytics are providing new insights into complex health problems and research breakthroughs in human and life sciences are making 'personalised medicine' a reality for more and more people.

Integrating rostering and payroll

One of the country's largest health providers, the Capital and Coast District Health Board (CCDHB) implemented an end-to-end roster to pay system in 2013 as part of an overall workforce management programme.

In 2014, an independent analysis by Cranleigh Corporate Finance and Advisory identified $325,000 worth of annual benefit directly attributable to the use of an integrated roster to payroll system.

The system increased the productivity of CCDHB through automation of HR and payroll processes, thus enabling the DHB to use the savings to deliver better health outcomes.

Technology is already playing a critical role in the health system and this is growing as it enables better health outcomes, reduces errors and helps manage costs.

Connecting with patients

The health sector – like education – was a Government priority for rollout of broadband services, with a policy goal for all health facilities to have access by 2015. By the end of 2015, it was confirmed that all hospitals, all 39 rural health facilities and about 96% of the (numerous) urban health facilities have access to UFB.

UFB will underpin the implementation of the National Health Strategy. It will improve access for primary providers, support common e-prescribing processes and a uniform approach to information sharing. It will also enable remote access and cloud solutions for more effective patient administration.

UFB also enables real advances in telehealth or the delivery of health-related services and information via telecommunications technologies. New Zealand, with its geographic spread has been a rapid adopter of telehealth. More than 2 million calls are made to the National Telehealth service a year and some DHB's are already using video for doctors' appointments to improve patient care.

Telehealth is especially beneficial for New Zealand's rural areas allowing faster and more cost effective access to health professionals. For example, Opotiki GPs and nurses use video conferencing equipment for after-hours care and to connect with other health providers, in other locations, for clinical advice. Their equipment also

Reducing errors and improving results

The New Zealand ePrescription Service (NZePS), designed and developed by New Zealand health software company SimplHealth, provides a secure messaging channel for prescribing and dispensing systems to exchange prescription information electronically. The system enables a prescription to be generated by the prescriber, transmitted to the NZePS health information exchange broker and downloaded electronically at the pharmacy.

Estimates over the last five years show around $40 million of pharmaceuticals have been wasted every year in New Zealand because of inaccurate prescriptions, non-adherence or simply out of date processes.

The NZePS is delivering savings by reducing the risk of dispensing errors, improving communications between the doctor and the pharmacist, assisting with the monitoring of patient's adherence and improving the quality of patient medication history.

links to videoconferencing equipment at the emergency, outpatients and intensive care units at Whakatane and Tauranga Hospitals.

On the rural West Coast of New Zealand a trip to the GP traditionally involves a long drive – and seeing a hospital specialist could require several hours on the road each way. That's changing, thanks to modern high-definition video links – which are deployed in towns up and down the Coast – from Karamea in the north to Haast in the south. New telemedicine equipment is being used to link up with GPs, hospital specialists and others – who may be hundreds of kilometres away.

Monitoring patients

At the level of direct interaction with patients, advanced sensors and data links allow the real-time and low-cost monitoring of patient symptoms, behaviour (e.g., their compliance with treatment regimens) and healing progress.

For example, Silhouette is an easy-to-use, laser-based, 3D wound imaging, measurement and documentation system produced by New Zealand tech firm Aranz Medical that provides accurate wound information at the point of care, and supports the clinical management of wounds.

Patients with chronic illnesses can be fitted with sensors to monitor their condition continuously and remotely, without confining them to hospitals or their homes. The Internet of Things is applied in healthcare as an early warning system and can save lives and expensive unplanned treatments in hospitals.

Putting control in the hands of the patients

Technology is also enabling people to take more control of their own health. For example, leveraging tech sector advances, the health sector is now able to provide patient portals to enable patients to better manage their interactions with their GPs.

Patient portals are secure online sites, provided by GPs, where patients can access their health information and interact with their general practice. As of March 2016, over 100,000 Kiwis were using patient portals. The portals give people convenient and secure electronic access to their health information, increasing their ability to manage their own health care. Through the portals patients can book appointments, request repeat prescriptions, see their lab results, patient notes, diagnosis, medical conditions and communicate securely with their doctor.

Over time the way a GP runs their business and delivers care will change as they start to interact with their patients in more efficient ways. Additionally, the way health consumers manage their own health will change as they begin to take more control over their information.

The future of health

Advances in technology are profoundly changing the way health is managed. While the adoption of technology has been slowly improving health outcomes it is more recent emerging technologies that present the biggest opportunities. With the decreasing cost of sensors, the increasing power of data analytics and advances in both robotics and genomics healthcare is entering a technology revolution.

The rapidly decreasing cost of human gene sequencing has introduced an era of personalised precision medicine. Sequencing a human genome used to cost millions of dollars and take weeks. In 2015 the cost had dropped to $1000 and it only takes hours. The technology keeps advancing and it is projected to cost less than $10 and take minutes by 2020. Genetic information combined with other health data is starting to allow targeted personalised healthcare. In New Zealand, Orion Health and MedTech have recently partnered to combine hospital level clinical data with primary care data and personal health data. The aim is to link this integrated clinical data to genomics and other new health information to enable a truly personalised healthcare system. Globally, personalised health is recognised as a critical evolution of the health system. In 2015 the US President committed US$215 million to launch a Precision

Medicine Initiative in order to reduce health costs in the long run through more targeted and personalised healthcare.

Globally, hospitals have been slow to adopt robotics and artificial intelligence into patient care, although both have been widely used and tested in other industries. Surgeons are already using robots in the operating theatre to assist with surgery. Since 2000, more than two million operations worldwide have been performed by about 3,000 da Vinci surgical robots. A 2013 survey from the FDA found patients operated on by a surgeon using the da Vinci surgical robot experienced less bleeding, fewer complications and recovered faster. The miniaturized surgical instruments on the robotic arms allow for miniscule incisions, leaving less chance for infection and scarring. As the artificial intelligence of these systems increase the ability for the robot to assist surgeons to undertake more complex surgeries, faster, safer and more cost effectively means greater health outcomes at lower costs.

Health analytics used to decrease readmissions

A leading US hospital and healthcare organisation in central Pennsylvania that delivers more than 5,000 babies and performs more than 23,000 surgical procedures, 588 open heart surgeries and 70 kidney transplants each year, was struggling to control spiralling costs.

In an attempt to curb costs they set about trying to reduce readmissions for patients with chronic health conditions. Using a cognitive health system they were able to evaluate the risk of readmission for patients with chronic obstructive pulmonary disease (COPD), enabling effective intervention at the point of care.

By predicting COPD readmissions with greater accuracy, the health provider was able to enhance patient outcomes and lower costs. They are now analysing other chronic conditions with the hope of being able to help their patients to stay healthy and out of hospital.

The increasing computing power of computers is enabling them to analyse enormous amounts of information and to provide advice for medical professionals that is improving health outcomes. For example, Volpara Health Technologies a New Zealand software and health analytics firm has developed software which analyses breast density, which can be a risk factor since it indicates both a higher incidence of breast cancer and can also hide cancer in a mammogram. The Volpara system is used in over 30 countries and provides radiologists with an automated assessment of mammograms. So far, an estimated 9 million women have been scanned using Volpara's software and it is responsible for saving thousands of lives.

Cognitive systems like IBM's Watson are fundamentally changing the way health is delivered. Different from traditional computers, cognitive systems learn from their interactions with data and humans - essentially continuously reprogramming themselves. Systems like Watson can be loaded with billions of pieces of medical literature, texts, imagery. Then, using natural language processing and advanced question-answer systems, the computer learns from responses and continues to perfect its ability to provide useful and accurate information.

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

"Nurturing inquiring minds and growing technology savvy and capable citizens, the education sector is pivotal to the success of New Zealand's technology sector. In a world where technology ubiquity is fast becoming the new normal, education is not immune to its pervasiveness. New models of teaching and research have emerged as the education sector embraces and relies on technology to feed the knowledge economy. At the heart of this transformation is the adoption of technological advancements that redefine pedagogical approaches and open up new worlds for exploration and knowledge creation.

Massey University has been leading the way with technology enabled education for over 50 years, and is committed to producing graduates that fulfill the needs of the technology sector now and into the future."

Hon. Steve Maharey
Vice-Chancellor
Massey University

Education

Digital technologies are rapidly causing changes to work not seen since the industrial revolution. This is a global challenge and, according to the OECD, schools have yet to take advantage of the potential of technology in the classroom in order to give every student the skills they need for today's connected world.

Technology is enabling a transformation of the education system. A shift is occurring from instructional education to a more personalised, self-directed and collaborative learning experience. Increased use of computers in classrooms and increased internet connectivity are impacting on education.

Technology is not only helping teachers become more efficient and saving schools money, but it is also helping to improve the quality of education which often still relies heavily on Victorian-era lecturing methods.

While governments frequently commit to improving the quality of education, it often slips down the policy agenda. Because investing in education only pays off in the future, it is possible to underestimate the value and the importance of improvements. There is often also controversy about what the role of government is, versus the roles of schools and teachers themselves.

In a detailed study[46] comparing the education outcomes and economic performance of a number of countries, the OECD estimated that if New Zealand was to raise its education outcomes over a period of 20 years to a level comparable with Finland it would generate a 204% increase in GDP worth an additional US$258 billion.

There is a very clear message from these calculations - past experiences suggest that there are enormous economic gains to be had by improving the cognitive skills of the population. Moreover, the gains, put in terms of current GDP, far outstrip the perceived costs.

OVER THE NEXT **20 YEARS**, IF NZ COULD RAISE EDUCATION OUTCOMES TO EQUAL FINLAND IT WOULD **GENERATE ECONOMIC GROWTH OF**

US$258b

Recognising the importance of enabling the education system to evolve, the government, through the Ministry of Education and other agencies has prioritised a number of supportive policies. The Ministry's "Towards Digital Fluency" initiative sets out a range of initiatives underway to ensure our schools have:

- State-of-the-art ICT infrastructure
- Equitable access to digital technologies
- 21st century teaching and learning
- Access to quality content and resources

State-of-the-art ICT infrastructure

The Ministry of Education has set out to equip all schools with the infrastructure they need to take full advantage of digital technologies by the end of 2016. The objective is to provide fully funded, uncapped data via high speed broadband connections across integrated IT systems for all schools. The government owned company, Network for Learning, has successfully connected all schools to the new fibre network and is now looking at leveraging opportunities afforded by new technologies to streamline systems and improve access to data and information.

Equitable access to digital technologies

Compared with other countries New Zealand has had quite a fast uptake of computers in the school environment. The OECD reported that only Australia has more computers in its classrooms than New Zealand[47]. According to their study, there are 0.9 Australian school students per computer in each classroom, while the figure is 2.1 students per computer in New Zealand. The percentage of 15-year old students using computers at school is 86.4% in New Zealand and 93.7% in Australia. The OECD surveys indicate there is an intermediate, 'sweet spot' amount of time that students should spend using their computers at school – not too much, and not too little.

THERE ARE

2.1

STUDENTS TO **EVERY COMPUTER** AT SCHOOLS IN NEW ZEALAND

21st century teaching and learning

While access to devices is important, research is showing that it is not just the technology you have but the way you use it to enhance learning that is most important. Throughout the world teachers and educationalists are grappling with 21st century teaching. That is, how to use technology to enable better learning outcomes? Here in New Zealand different schools have been experimenting with technology in different ways with some surprising outcomes.

- Long Bay College is using Microsoft's PowerBI to undertake analytics to identify traits and trends that can impact learning outcomes.
- Opaheke School has been able to use technology to remotely connect with a sick student to keep them engaged in learning.
- Baradene College has been using game development to help year 13 students learn how to create computer code.
- St Kentigern College is using gaming to teach Spanish, with students having to build a Minecraft world in the Spanish version of the game.
- The Manaiakalani programme, a cluster of 12 schools in the Tamaki Auckland region, including Point England School, has deployed a digitally-enabled learning environment connecting students and their communities. Through new teaching practices leveraging technology they are achieving accelerated learning outcomes.

The Ministry of Education's "Towards Digital Fluency" initiative has identified a need to provide in-depth professional development for learning with digital technologies and to prioritise digital fluency in all future professional development provision. The Ministry has also decided to commission national reports from the Education Research Office on how schools are adapting teaching and learning practices to take advantage of digital technologies and flexible learning spaces.

Access to quality content and resources

As schools and students spend more time online not only is access to quality content critical for their learning outcomes, but so is the security of their environment. Network for Learning, having the role of ensuring a safe environment with quality content, launched Pond, an online community and resource sharing hub for New Zealand's educators.

Private Foundation fills the gap

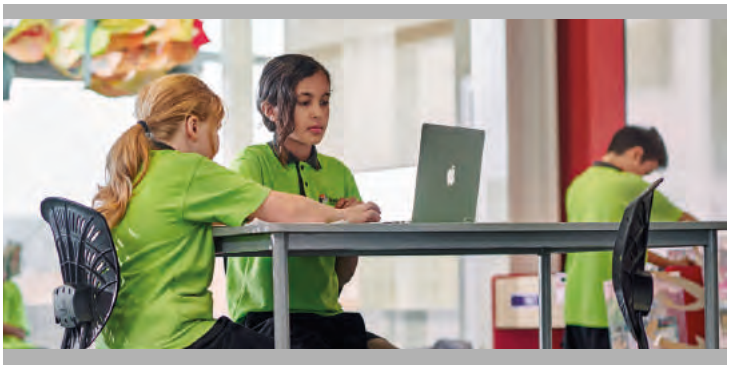
While the New Zealand government has been getting its head around the importance of digital fluency, a private philanthropic foundation has stepped in to fill the gap in an effort to accelerate the evolution of New Zealand's education system. The Next Foundation administers an up to 10 year, $100 million programme of investment to create a legacy of environmental and educational excellence for the benefit of future generations of New Zealanders.

One investment has been to help expand The Mind Lab by Unitec. A programme that is dedicated to enhancing digital and collaborative learning skills for teachers in New Zealand. Frances Valintine, Founder and Chair of The Mind Lab by Unitec has pioneered a postgraduate qualification for educators that is upskilling teachers to implement new digital and collaborative learning practices.

Next Foundation is also supporting the Manaiakalani project to expand its programme of work into other decile 1 clusters throughout New Zealand, reaching and accelerating over 8,500 learners.

The Ministry is also conscious of the need to ensure students develop an understanding of the risks associated with online access and are investing in advice and support on cyber safety for schools and students, including how to deal with cyber-bullying.

The challenge for the Ministry is the pace of change. Technology, its impact on education and on the nature of the work that the students are being prepared for, is evolving at a pace that outstrips the ability of a traditional education system to evolve. As noted at the start of this section, the economic and social opportunities for New Zealand are potentially enormous if we can enable our education system to evolve faster. There are a number of exciting developments occurring in schools throughout New Zealand as individual teachers and principals grasp the opportunity and engage with private or industry support to enable their own schools.



RECOMMENDATIONS

To enable a system wide acceleration we believe there are a number of areas where the government and the tech sector should work together:

- **Student Privacy and Data Security** – as learning moves more to online and digital environments, the duty of care that a school holds for their students extends to this online learning world. Protection of students' identity and data is a cornerstone element of delivering successful 21st Century learning and building a digital nation. The US government's Student Privacy Pledge, **www.studentprivacypledge.org**, is a good example of central leadership which we should consider emulating in New Zealand.
- **Addressing the Digital Learning Divide** – there is risk that many students of the priority learner group (particularly low decile, Maori and Pasifika students) have limited access to digital learning tools. This may exclude them from successfully participating in the move to 21st Century learning. In other countries this is being addressed through partnerships between the tech sector, the government and other private partners. This may be an approach worth exploring in New Zealand.
- **School Leadership for transformation** – we recognise the level of innovation shown by leading educators in New Zealand to incorporate technology into teaching, however we believe there is a challenge to scale this to deliver 21st Century teaching and learning across whole schools and across the wider schooling sector. The focus on Ministry-funded professional development initiatives should widen to now support school leadership teams to deliver the school-wide transformation that this move requires.
- **Building the talent supply chain for a digital nation** – New Zealand needs a skilled and innovative workforce in order to succeed in the global marketplace, for the tech sector to thrive and for all public and private sector organisations to perform. There are two areas that would benefit from additional focus in order to achieve this:
  - **The development of digital fluency and skills for the modern workforce** – research is showing that 21st century skills are rapidly increasing in demand. In a recent study[48] by the Foundation for Youth in Australia it was found that the demand for digital literacy skills has risen by 212% over the last 3 years. The education sector needs to have a greater focus on enabling all students to acquire digital skills that will help them succeed in the modern workplace.
  - **Opening pathways to digital technology careers** – addressing the supply side of the tech sector skills challenge begins in schools. Currently there are not enough students entering ICT study paths to supply the demand for skills by industry. We support the government's initiative with the review of the Digital Technology curriculum and believe there is a strong argument to bring Computational Thinking (including coding and computer science) into primary schooling. The governments of the UK and Estonia have shown leadership in this area, including active partnership with the tech sector to accelerate the success of these programmes.

Avondale College Innovation Programme

Like many schools in New Zealand, Avondale College could see that methods of teaching had to evolve.

They also identified an opportunity for their students to gain real world qualifications and project experience.

The Innovation Programme was designed increase the throughput of highly skilled, digitally savvy, industry certified and project experienced secondary school students into the system; remodel the end to end academic syllabus and practitioner development process; improve the connectedness of the educators with the industry; and to identify innovative opportunities to leverage different technologies in a manner that informs and redefines delivery and curriculum innovation.

With ICT and technology programmes underpinning a large scale change programme at Avondale, a philosophy of knowledge-creation and innovative practice as opposed to teacher-led 'textbook' lessons allows students to use sophisticated, industry-standard technology to create their own market-ready applications, as well as gain educational qualifications and industry-benchmarked certifications along the way.

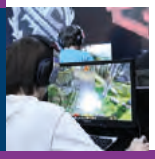
The development of strategic relationships with industry partners underpins the success of the programme, through which innovative practice is becoming embedded within the school, further helping students to gain real-world success across all curriculum areas.

The Innovation Programme operates as a real-world preparation environment, with students 'clocking in', ready to work, at 8.00am each day. Saturday clinics and school holiday workshops further bolster the boutique, positive and development focused environment. Inside the classroom students are immersed in interdisciplinary problems and empowered to create innovation. As a result, quality academic performance is achieved and innovation flourishes because students use higher order thinking to manage complex issues while solving ambiguous real-world business, community or social problems.

Underpinning the Programme, is a strategy to achieve anytime, anywhere and any means of transformative learning to cater for all learning styles and intelligence. Real-time teaching intelligence (or real-time assessment) tools have been developed which transform learning behaviours in students. The interaction with students is greatly enhanced and is based on the establishment of a mobile learning environment that creates opportunities to increase 1:1 learning and dialogue with students. With real-time intelligence to hand, this improves and heightens sophisticated higher order learning, as it happens and in context, for all students.

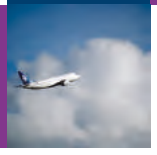
The results speak for themselves:

- In 2013, an Avondale College student topped the world in his Cambridge ICT exam – with two of his classmates just one and two percentage points behind.
- In 2014, Avondale students were 6 of the top 10 at the National Microsoft Champs, followed by a 3rd, 6th and 10th at the World Microsoft Championships against over 750,000 competitors.
- Then in 2015, having not studied a single text book, using only the core curriculum, three Avondale students again finished in the top ten at the World Microsoft Championships against a field of over 600,000 worldwide competitors.



CONCLUSION

Creating a Digital Nation



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As we have shown, the tech sector is a large part of the economy, generating considerable value, jobs and exports. The sector is also the foundation for New Zealand's transition to a digital nation. From the critical infrastructures that provide the underlying connectivity, to the innovations of our local and international tech firms.

The tech sector is also more than just simply a sector. As technology becomes more ubiquitous it has become an enabler across all parts of the economy and society. Better understanding of technology leads to better use and real economic benefits.

Additionally, due to the way that technology reaches across all parts of the economy, as the tech sector grows and becomes more productive, everyone benefits.

At a high level, this research has identified two significant opportunities to stimulate future economic growth for New Zealand.

1. The growth of the tech sector also in turn grows the economy. So, what is needed to help the sector accelerate its growth?
2. Better use of technology also delivers economic growth. So, what is needed to help businesses and citizens gain the most from internet connectivity and readily available technologies?

Growing the tech sector

Education

The number one catalyst for the success of the tech sector is a sustainable supply of skilled resources. While there is currently a global shortage of tech skills, immigration will only get us so far. New Zealand must enhance its own education system to develop a sustainable local talent base.

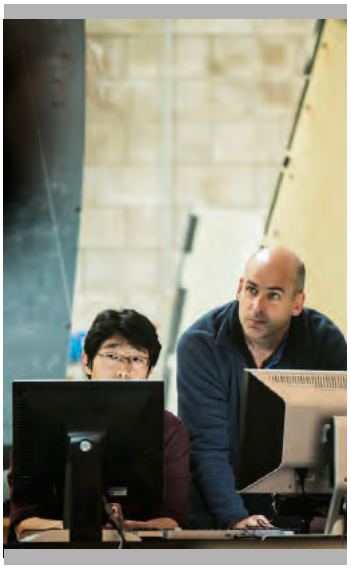
The first challenge is to inspire and excite more students, parents, teachers and principals about digital technology and the opportunities it creates for fulfilling careers. Scaling will require computational thinking and coding as a core subject, with educators supported to teach it. Industry and education need to do a better job of bridging the gap, from both higher education and secondary school, as not all tech sector workers require a degree.

Recommendations

- **Support school leaders and teachers** - increase investment in leadership programmes for school leaders so they can deliver the 21st Century transformation across their schools. Increase investment in digital technology

and collaborative learning training programmes for teachers so they teach based on an understanding of technology and how it enhances their students' learning across all subjects.

- **Prepare students** – make computational thinking, digital technology and cyber-security as integral as Maths and English from when students start school, rather than as electives taken by only a few senior students. Increase the focus on enabling all students to acquire digital skills required for the modern workforce. Underpinning the move to 21st Century learning, we believe attention should also be paid to protecting student identity and privacy, and addressing the equity of access issue to digital learning for all students.
- **Bridge the gap** – industry must work more cohesively with the government and connect deeper into the education system in order to support the development of work ready graduates.



Government

As the largest customer of the tech sector, the government has considerable influence on its future. That influence can be positive, by enabling and investing in innovation to support its own transformation. Conversely, it can be negative, through excessive costs of engagement.

While the government is looking for innovation and transformation, it has developed some policy to support it. Unfortunately, due to the risk adverse culture of government, the cost of engagement is still excessive which reduces the scope for innovation.

Recommendations

- **Incentivise innovation** – by providing a transformation fund from which to allocate investment to innovative transformation projects, the government may be able to stimulate more innovative and cost effective approaches for the use of technology.
- **Enable risk taking** – rethink the procurement process for software in a way that enables government agencies to contract for product design assistance and minimal viable product builds.

Exports

Ultimately, to significantly improve New Zealand's prosperity we need to increase exports. Never before, has it been easier for us to connect to the world. The global economy is no longer far away and our natural resourcefulness is being applied successfully to global problems by leaders in the tech sector. To take full advantage of the available opportunities we need to become known for more than simply hobbits, sheep and beautiful scenery.

Recommendations

- **Market internationally** – industry and government should collaborate to create an international positioning for New Zealand as a world class digital nation to provide tech exporters the ability to cross leverage off each other's successes.
- **Continue to invest** – the investment in R&D support, accelerators and export support has helped many New Zealand tech firms successfully grow into international businesses. As the momentum begins to build, we would encourage continued investment.

Getting more from technology

The true economic opportunity will come from better use of technology across the whole New Zealand economy. Work should be undertaken to educate all business owners on the ways to use technology and connectivity to increase productivity. Incentives should also be deployed to accelerate the uptake and exploitation of technology.

Recommendations

- **Develop sector level tech strategies** - ensure growth strategies for all sectors include a strong element of tech enablement.
- **Stimulate uptake** - the focus should shift to the uptake and use of connectivity and technology. The government may be able to apply some incentives, but all sectors of the economy should be working to educate and support their constituents to enable more effective use of the technology.

Appendices

The Research team

NZTech is the voice of the New Zealand technology sector. Representing over 280 organisations across the technology landscape in New Zealand from startups & local tech firms to multinationals, and from ICT to high tech manufacturing.

Our goal is to stimulate an environment where technology provides important productivity and economic benefits for New Zealand.

NZTech designed, collated and edited the research.

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

NZIER designed the economic model and conducted the research.

Sapere Research Group is one of the largest expert services firms in Australasia. Sapere provides independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

Sapere peer reviewed, contributed and edited the research.

Defining the Tech Sector

Why we defined the Tech Sector

Defining the tech sector is not easy. The general opinion is that the standard industry code system used by governments to define industry sectors doesn't do a good job of capturing the tech sector. Technology is so pervasive that many more organisations could potentially be defined as tech companies even though they are officially in other sectors.

There is also the issue of how relevant is a tech sector. Is it worth grouping together organisations as diverse as telecommunication providers, game developers and high tech manufacturers? They seem so different, how could they have any similarities. In much the same way that there is value in considering the tourism sector, made up of diverse organisations including air transport, adventure tourism and accommodation – we believe there is value in understanding the features, challenges and opportunities of a tech sector.

How we defined the Tech Sector

In establishing an acceptable definition of the tech sector we looked for common features. Do firms exhibit similar levels of connectedness, demand similar inputs or have similar levels of R&D? Work undertaken by the European Commission to define high-technology manufacturing in 2010 identified high levels of R&D intensity as a common feature. NZTech has also noted that firms in both ICT and high-tech manufacturing are increasingly competing for similar labour such as computer engineering skills.

Following an analysis of ways to identify and measure a tech sector, it was identified that a group of companies with similar levels of R&D intensity, labour input demands and connectedness existed across what is commonly known as the ICT and high tech manufacturing sectors. Due to the similar features, and the fact that precedent had been set by sector reports published by the Ministry of Business, Innovation & Employment, it was decided that the most pragmatic definition for the New Zealand tech sector would be to use OECD definitions.

Definition of the Tech Sector

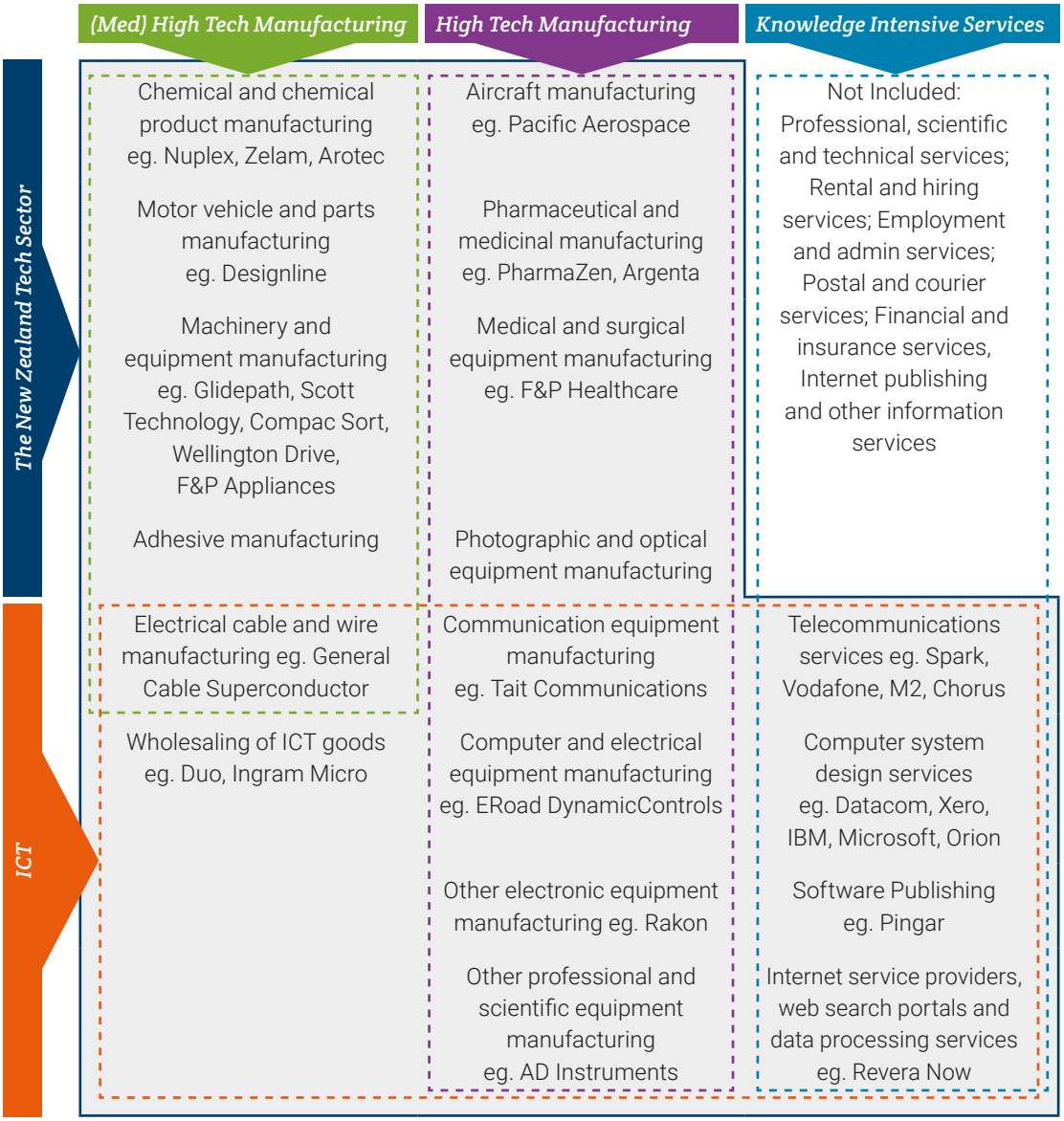
The New Zealand tech sector is defined to include both ICT and the high-tech manufacturing sectors.

This report uses OECD definitions for ICT and high tech manufacturing with data grouped into sectors using the Australian and New Zealand

Industrial Classification (ANZSIC) codes. A business or other type of organisation is classified to an ANZSIC code based on its predominant activity.

FIGURE 18: DEFINING THE TECH SECTOR

Using the OECD definition and showing the inter-relationship between high tech manufacturing and the cross cutting ICT sector.



Source: Adapted from OECD and MBIE sector reports

The OECD definitions for ICT makes it a cross-cutting sector that has some overlap with high-tech manufacturing as can be seen in Figure 18. The definition for ICT includes telecommunications goods and services, but excludes internet publishing and broadcasting. The ICT sector is defined as:

- goods and services which enable the function of information processing and communication by electronic means including transmission and display;
- goods which use electronic processing to detect, measure and/or record physical phenomena or control a physical process.

ICT Services consist of:

- **J580** Telecommunications services
- **M700** Computer system design
- **J542** Software publishing
- **J591** Internet service providers and web search portals
- **J592** Data processing services
- **F349** Wholesaling of ICT goods

IT services is a sub-category of ICT services and includes:

- **M700** Computer system design
- **J542** Software publishing
- **J592** Data processing services

ICT goods includes the ICT manufacturing elements of the ICT sector:

- **C2421** Computer & electronic equipment manufacturing
- **C2422** Communication equipment manufacturing
- **C2429** Other electronic equipment manufacturing
- **C241** Professional and scientific equipment manufacturing

The OECD defines high technology manufacturing as the sub-set of manufacturing industries in which expenditure on research and development is greater than 8% of revenues (high-tech) or between 2-8% (medium-high tech) when measured across multiple developed countries combined.

The assumption made is that there is a strong link between technology and innovation. Firms that spend more on R&D are the firms that innovate more, win new markets, are more productive and pay employees more.

A feature of the tech sector is that there are overlaps between ICT and the high-tech manufacturing sectors. Figure 19 shows the broad product and service categories included in the tech sector, their ANZSIC codes, overlaps between certain manufactured goods that are also part of the ICT sector and examples of businesses in each group.

FIGURE 19: THE TECH SECTOR & SUB-SECTORS

Showing the ICT overlaps with tech manufacturing.

Tech Sub-Sectors	ANZSIC Code	Categories	Examples
ICT	J580	Telecommunications services	Spark, Vodafone, 2Degrees, M2, Chorus
	M700	Computer systems design	Datacom, Xero, IBM, Microsoft, Orion Health, Fronde, GeoOp, Wynyard, PartsTrader, Serko
	J542	Software publishing	Pingar
	J591	Internet service providers & web search portals	Now, Inspire.net
	J592	Data processing services	Revera, Gentrack
	F349	Wholesaling of ICT goods	Ingram Micro, Duo
High-tech Manufacturing	C242	Computer & electronic equipment manufacturing	ERoad, Novel Ways, Smartrak, Dynamic Controls
	C2422	Communication equipment manufacturing	Tait Communications
	C2429	Other electronic equipment manufacturing	Rakon
	C241	Professional & scientific equipment manufacturing	AuCom, F&P Healthcare, AD Instruments, Atrak
	C243	Electrical equipment manufacturing	Wellington Drive
	C239	Aircraft manufacturing & repair	Pacific Aerospace
	C184	Pharmaceutical & medicinal product manufacturing	PharmaZen, Argenta
	C244	Domestic appliance manufacturing	F&P Appliances
	C181	Basic chemical & chemical product manufacturing	Nuplex, Zelam, Arotec Diagnostics, Skinfood
	C245 C246 C249	Specialised machinery & equipment manufacturing	Glidepath, Scott Technology, Compac Sort, Skope
	C231 C239	Motor vehicle & other transport manufacturing	Designline, Hamilton Jet

Source: adapted from MBIE Sector Reports

Tech Sector by Region

This appendix contains a detailed breakdown of information on the tech sector at the regional level (estimates produced by NZIER from Statistics New Zealand data).

TABLE 2: REGIONAL TECH SECTOR GDP

NZIER 2015, except figures for regional GDP and regional population (from MBIE, 2015)

Region	Region GDP %	Region population %	Region high-tech manufacturing sector GDP $m	Region ICT sector GDP $m	Regional combined tech sector GDP	
					$m	% of region's GDP
Northland	2.5	3.7	67	124	191	3.3
Auckland	**35.3**	**33.9**	**1,622**	**6,168**	**7,791**	**11.6**
Waikato	9.0	9.6	327	722	1050	5.9
Bay of Plenty	5.2	6.3	203	342	545	4.7
Gisborne	0.7	1.0	12	30	43	2.3
Hawke's Bay	2.8	3.5	73	175	248	3.5
Taranaki	4.0	2.5	97	187	284	4.5
Manawatu-Wanganui	4.0	5.2	129	279	409	4.4
Wellington	**13.2**	**10.9**	**225**	**2,188**	**2,413**	**9.8**
Tasman/Nelson	1.8	2.2	44	123	167	3.8
Marlborough	1.0	1.0	35	49	84	3.2
West Coast	0.7	0.7	10	34	44	3.0
Canterbury	**13.1**	**12.7**	**710**	**1,717**	**2,428**	**9.1**
Otago	4.3	4.7	82	248	330	3.5
Southland	2.4	2.1	39	95	134	2.6
New Zealand	**100**	**100**	**3,677**	**12,482**	**16,159**	**8.0**

Source: NZIER, MBIE (Regional Economic Activity Report, 2015)

TABLE 3: REGIONAL TECH SECTOR LABOUR INCOMES

NZIER estimates for 2015

Region	Regional high-tech manufacturing sector incomes		Regional ICT sector incomes		Regional combined tech sector incomes	
	$m	% of total incomes	$m	% of total incomes	$m	% of total incomes
Northland	44	1.6	64	2.4	108	4.0
Auckland	**1,022**	**3.0**	**2,955**	**8.6**	**3,977**	**11.6**
Waikato	210	2.5	368	4.4	578	6.9
Bay of Plenty	130	2.3	184	3.2	314	5.5
Gisborne	7	0.8	16	1.7	23	2.5
Hawke's Bay	47	1.4	92	2.7	139	4.0
Taranaki	61	2.3	94	3.6	156	5.9
Manawatu-Wanganui	83	1.7	144	2.9	227	4.7
Wellington	**138**	**1.1**	**1,004**	**7.7**	**1,142**	**8.8**
Tasman/Nelson	29	1.3	68	3.0	97	4.3
Marlborough	24	2.0	22	1.8	46	3.8
West Coast	7	0.9	19	2.6	26	3.5
Canterbury	**465**	**3.5**	**848**	**6.4**	**1,313**	**10.0**
Otago	55	1.2	121	2.6	176	3.8
Southland	26	1.1	54	2.3	81	3.5
New Zealand	**2,350**	**2.3**	**6,053**	**6.0**	**8,403**	**8.4**

Source: NZIER

TABLE 4: REGIONAL TECH SECTOR EXPORTS

NZIER estimates for 2015

Region	Regional high-tech manufacturing sector exports		Regional ICT sector exports		Regional combined tech sector exports	
	$m	% of total exports	$m	% of total exports	$m	% of total exports
Northland	79	4.2	16	0.9	96	5.0
Auckland	**1,879**	**9.3**	**959**	**4.8**	**2,838**	**14.1**
Waikato	378	6.0	106	1.7	484	7.6
Bay of Plenty	239	5.8	49	1.2	288	6.9
Gisborne	18	2.2	5	0.6	23	2.8
Hawke's Bay	107	3.1	26	0.7	133	3.8
Taranaki	122	4.2	26	0.9	148	5.0
Manawatu-Wanganui	161	5.6	43	1.5	204	7.0
Wellington	**305**	**5.7**	**385**	**7.2**	**690**	**12.8**
Tasman/Nelson	57	3.0	20	1.0	76	4.0
Marlborough	33	2.9	6	0.5	39	3.4
West Coast	19	2.0	5	0.5	24	2.5
Canterbury	**802**	**8.6**	**255**	**2.8**	**1,058**	**11.4**
Otago	117	3.7	37	1.2	154	4.8
Southland	59	2.0	14	0.5	73	2.5
New Zealand	**4,375**	**6.5**	**1,951**	**2.9**	**6,326**	**9.3**

Source: NZIER

TABLE 5: REGIONAL TECH SECTOR EMPLOYMENT

NZIER estimates for 2015

Region	Regional high-tech manufacturing sector employment		Regional ICT sector employment		Regional combined tech sector employment	
	Counts of people employed	% of total counts of employed	Counts of people employed	% of total counts of employed	Counts of people employed	% of total counts of employed
Northland	781	1.4	504	0.9	1,285	2.3
Auckland	**19,312**	**2.8**	**28,370**	**4.1**	**47,682**	**6.9**
Waikato	4,038	2.3	2,571	1.5	6,609	3.8
Bay of Plenty	2,567	2.2	1,356	1.2	3,923	3.4
Gisborne	151	0.7	201	1.0	356	1.7
Hawke's Bay	889	1.2	677	0.9	1,566	2.1
Taranaki	1,329	2.6	568	1.1	1,897	3.7
Manawatu-Wanganui	1,532	1.6	759	0.8	2,291	2.4
Wellington	**2,151**	**0.9**	**11,282**	**4.7**	**13,433**	**5.6**
Tasman/Nelson	540	1.2	495	1.1	1,035	2.3
Marlborough	483	2.2	343	1.5	826	3.7
West Coast	181	1.2	49	0.3	230	1.5
Canterbury	**8,604**	**3.0**	**6,233**	**2.2**	**14,837**	**5.2**
Otago	994	1.0	910	0.9	1,904	1.9
Southland	610	1.2	433	0.9	1,043	2.1
New Zealand	**44,161**	**2.2**	**54,750**	**2.7**	**98,911**	**4.9**

Source: NZIER

The NZIER TERM-NZ CGE Model

Computable General Equilibrium (CGE) models provide an economy-wide perspective. They capture complex inter-relationships among sectors and industries, consumption, imports and exports.

Their main advantage over other approaches, like stylised two-sector models or partial analyses of particular markets, is that they can use rich datasets to explore how changes in one part of an economy impact on other parts. After a simulated change in economic conditions (called a "shock"), market forces return the economy to equilibrium through changes in prices, wages, production and consumption. Growth in one part of the economy draws resources from other areas, and CGE modelling can trace out possible consequences.

These models are abstractions that are intended to be complex enough to capture the essential features of an economic setting, yet simple enough to be tractable: the idea is that they enable the major adjustments that happen throughout the economy in response to a change in some economic factor to be taken account of in a consistent manner.

A CGE model works by using data to describe the economy in a benchmark year, and then specifying hundreds of mathematical equations to represent the relationships between data values. By varying one or more elements, users of the model can trace throughout the economy the changes in the values of the data items. The model is 'calibrated' when a solution to the mathematical system replicates the benchmark data. After a shock, the model finds a new set of prices that clears all markets so that supply equals demand.

NZIER's TERM-NZ ("The Enormous Regional Model") provides considerable detail, covering fifteen regional economies in New Zealand (Nelson and Tasman are combined into one region), 106 industries and 205 commodities. It is based on Statistics New Zealand 2007 input-output tables, which have been updated and modified to include 2014 data.

The fundamental approach of the model is quite simple: as in the real world, consumers in the model purchase goods from producers, and supply the factors of production. Selling labour and 'renting out' capital (including land) are major sources of household income. Consumers/households also pay taxes to the government. Households demand goods and services in a way that maximises their wellbeing subject to a budget constraint: they decide which

goods and services to buy and how much to spend on local and imported goods. Similarly, firms produce goods using primary factors (land, labour and capital) and intermediate inputs (which can be purchased locally or imported). Output is sold locally or exported.

In the model, each region has its own economy, and all regions are linked via inter-regional trade in commodities and movements in labour and capital. In response to simulated changes, the model traces impacts on firms, households, local and central government, and the national and global economy.

NZIER's TERM-NZ has been built in consultation with CGE experts at Centre of Policy Studies which now based at Victoria University, Melbourne who are well-regarded internationally and recognised as world leaders in CGE modelling for more than a decade. Using 2014 data is helpful (many previous New Zealand CGE simulations have reduced credibility because they have been generated from outdated input-output tables).

Additionally, the broad range of CGE analyses NZIER have undertaken in recent years means they have experience of how shocks in other sectors play out in the model. This experience will help inform judgments about how to best close the model making it as close to real world as possible.

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This index is not ideal but is the best estimate NZIER could construct within the limits of publicly available data.

[29] NZIER comparisons here are with the national level indices that are not adjusted for labour force composition as the NZIER index is a simple weighted average and they cannot control for differences in labour composition which are specific to the tech sector.

[30] For ease of reading, the results reported in the text are generally rounded to 1 decimal place when shown as percentages. This 1% impact is actually estimated to be 0.97%, rounded to 1%.

[31] These values reflect the dollar impacts on the economy based on the size of the economy today. However, if tech sector productivity growth occurs it will occur in the future and on top of underlying growth. This means the dollar impacts would be larger than shown here. NZIER do not take this into account because to do so would conflate the effects of assumptions about baseline growth and the effect of the productivity increase. Taking account of baseline growth matters if we are considering a policy analysis but in these circumstances, of testing a growth shock, it is not necessary and would reduce the transparency of the analysis.

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