THE INTERNET OF THINGS

Accelerating a Connected New Zealand

An Analysis of the Impact of the Internet of Things on the New Zealand Economy

Data, 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.

Please download a free copy of the e-book from the IoT Alliance website, **www.iotalliance.org.nz**

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About the New Zealand IoT Alliance

The New Zealand IoT Alliance sees a thriving future for New Zealand by connecting data, devices and people to seize opportunities for economic growth. The New Zealand IoT Alliance was established to empower industry to grow our nation's competitive advantage through the Internet of Things (IoT).

The New Zealand IoT Alliance's key purpose is to actively contribute to the prosperity of New Zealand through accelerating the uptake of IoT. It provides an independent platform for bringing together leaders in IoT technologies, government, academics and local IoT innovators. It aims to accelerate IoT innovation by promoting collaboration across industry and government and endeavours to identify strategic opportunities for economic growth.

The New Zealand IoT Alliance is an NZTech community. NZTech is the voice of the New Zealand technology sector representing over 400 organisations from across the New Zealand technology landscape from startups and local tech firms to multinationals, from ICT to high tech manufacturing. These organisations are redefining the world we live in. Our goal is to stimulate an environment where technology provides productivity gains and economic benefits for New Zealand.

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Introduction

IoT in New Zealand


05

Thank you to all our Project Supporters

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New Zealand IoT Alliance

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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INTRODUCTION

The New Zealand IoT Alliance

The Internet of Things ecosystem has rapidly moved beyond concept to commercial reality. It is evolving into a significant 'infrastructure' in its own right, providing the foundation for a hyper-connected world, one where the boundaries of physical and digital blur.

Graeme Muller
Chairperson
New Zealand IoT Alliance

Once widely deployed, IoT has the potential to be one of the most disruptive technologies in decades.

However, as with any rapid change, questions begin emerging. Just how much of an impact could IoT have on New Zealand? Are we ready for IoT? What are the opportunities? What risks are involved? What do we need to do to manage the risks?

While there is general agreement that IoT will be important for the New Zealand economy, until now there has been little research into its true potential.

As the entity established to enable industry, government and academia to work together to grow our nation's competitive advantage through IoT, the New Zealand IoT Alliance set about finding out just how important IoT will be for the nation.

The New Zealand IoT Alliance engaged specialist technology market research firm IDC to undertake an analysis of the New Zealand IoT ecosystem and comparisons with international markets. Economic consultancy Sapere was also engaged to undertake an economic analysis of the potential impact of increased deployment of IoT in key sectors across New Zealand.

This study has been designed to provide a stocktake of the current ecosystem of IoT in New Zealand, an economic analysis of the potential impact to the economy of the deployment of IoT in various applications and identification of opportunities and risk. The primary objective is to identify opportunities for economic growth through clever use of the Internet of Things.

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

FOREWORD

Ministry of Business, Innovation and Employment

We are living in a rapidly changing world and digital technologies are transforming the way Kiwis live, work, learn and play.

The Internet of Things is one of the most disruptive technologies to emerge in decades, and the possibilities for New Zealand are significant.

This research explores these possibilities, helping us to better understand and take advantage of the benefits that IoT promises across sectors as diverse as agriculture, utilities, manufacturing, logistics and smart city services.

The Ministry of Business, Innovation and Employment has welcomed the opportunity to work with industry to support this research and the recently formed New Zealand IoT Alliance.

Joining up across the public sector and with industry is critical if we are to seize the opportunities and address the challenges of disruptive technology and our changing digital world.

The New Zealand IoT Alliance was formed to promote and advance IoT for the economic and social benefit of New Zealand. It brings together a community of digital technology innovators, investors, researchers, educators, social entrepreneurs and government, all working towards a common goal.

Emerging technologies also bring new challenges. The Alliance will not only play a role in growing New Zealand's understanding and awareness of what IoT promises, but it will also look to raise and to help address potential issues.

David Smol
Chief Executive
Ministry of Business, Innovation and Employment

The establishment of the Alliance and this research is one of the new initiatives included in the Building a Digital Nation action plan, released in March 2017. This action plan sets out how government is partnering with New Zealand's digital sector, with other sectors of the economy and with the wider digital community, to enable New Zealand to become and to remain a leading Digital Nation.

The aim of the action plan is to ensure we're focusing on the right areas to enable New Zealand to become a leading digital nation – a nation with a thriving digital sector, where our businesses, people and government are all using digital technology to drive innovation, improve productivity and enhance the quality of life for all New Zealanders.

FOREWORD

Huawei New Zealand

The advanced technological age of the Internet of Things is here, bringing with it great opportunities across the industry and for New Zealand.

IoT extends digital connectivity to devices and sensors in homes, businesses, vehicles and potentially almost anywhere. This advance enables virtually any device to transmit its data, to which analytics can then be applied to facilitate monitoring and a range of operational functions.

IoT can deliver value in several ways. It can provide organizations with more complete data about their operations, which helps them improve efficiencies and so reduce costs. It also can deliver a competitive advantage by enabling them to reduce the elapsed time between an event occurring and operational responses, actions taken or decisions made in response to it.

The massive requirements and potential applications of IoT are becoming clear: the number of IoT connections will vastly exceed connections between people. IoT is destined to benefit the global economy with transformative technologies made available for wearables, smart home appliances, smart cities, logistics management, and much more.

100 billion

IoT connections worldwide by 2025

Jason Wu
CEO
Huawei New Zealand

We expect to see 100 billion connections worldwide by 2025 of which 55 per cent will be in the business domain and 45 per cent will be for consumers. The massive number of connections will enable significant productivity gains for companies and individuals.

ICT will emerge as a factor of production rather than remain a support system, and the integration of the physical and digital worlds will deepen.

IoT exists in a massive, sophisticated ecosystem that requires joint investment and collaboration between ICT solution providers, enterprises, research institutes, and governments. This in turn requires partnerships like the New Zealand IoT Alliance to ensure that this ecosystem thrives.

We believe that partnerships can build a strong IoT ecosystem; we believe that a strong ecosystem turns the key to innovation. Through the work the IoT Alliance is doing, we believe that New Zealand will be better prepared and aware of the opportunities created by this breakthrough technology.

The Internet of Things – what is it and why is it important?

The Internet of Things (IoT) is a collection of real life things that are connected to the internet. The same way a laptop or mobile phone connects to the internet, other things – devices, objects, machines, animals or people – can be connected and interact with each other. These connected things collect and exchange data. The data from a connected world benefits individuals, organisations and society by helping us make better decisions, problem solve and improve productivity. For example, farmers place sensors in their fields to understand the temperature and moisture content of the soil. This provides critical information for farming decisions like sowing seed and applying fertiliser.

Data can become Information and Insight

The true value of collecting and exchanging data is in using analytics to provide further information and insight. Instead of simply inspecting raw temperature and moisture readings, analytics can solve problems such as "which field needs irrigating?" or "when is the optimal time to apply nitrogen?".

Insight can become Action

The Internet of Things can use data to automate actions such as moving or controlling an object. For example, using IoT, sensors can instruct vents on shipping containers to open and close automatically to regulate the temperature. When transporting produce, this results in fresher produce. On the farm, an IoT system can automate the irrigation of crops. Or street level sensors in a city might be used to change traffic lights.

Action becomes Intelligent

Connecting together different things using the internet means people and organisations can obtain new insight. Our farmer can combine Metservice weather data with his soil temperature and moisture readings. Now his irrigation system won't waste precious water irrigating crops when rain is forecast.

Re-use of Data

Data collected via IoT can be used for more than one purpose. For example, New Zealand hi-tech exporter, EROAD, sells an in-vehicle tracker that helps companies track their fleets and automate road user charges. The anonymised EROAD data is then reused to provide insights on road use to the Government. The Government, in turn uses these insights to improve the road network in New Zealand.

> *The Internet of Things could soon be as commonplace as electricity in the everyday lives of people in OECD countries. As such, it will play a fundamental role in economic and social development in ways that would have been challenging to predict as recently as two or three decades ago."*
>
> *Organisation for Economic Co-operation and Development*

Why is IoT Important for New Zealand?

IoT delivers benefits to New Zealand in several ways:

1. *Increased productivity and efficiency for New Zealand – companies, government and citizens can streamline or automate processes, improve production and make better decisions.*

2. *Creation of new businesses – companies can discover new business opportunities through analysis of IoT data. Data itself can become a product or service to sell.*

3. *Creation of opportunities for organisations with adjacent expertise such as companies that provide artificial intelligence software.*

4. *IoT can improve customers' experience. For example, Air New Zealand provides smart bands to unaccompanied minors so that parents can track their safety. Provenance, tracking the origins of a product, improves consumer trust and can be used to charge a premium on a product, for example organic foods and wool based products.*

5. *Other economic and social benefits. For example, warmer, drier homes as a result of IoT sensors can reduce illnesses of residents. Less illness means more productive time at work and less burden on the health system.*

Executive Summary

The Internet of Things is a collection of real life things that are connected to the internet. These connected things collect and exchange data. Data from a connected world enables us to make better decisions, problem solve and improve productivity.

While IoT has been around for many years, it has been the subject of heightened interest in more recent years. Much of the current IoT hype is driven by consumer devices such as fitness trackers and smart fridges. However, the real value for IoT is in enterprise and government. Research by IDC, a specialist global technology research firm, found that there is much interest in IoT in New Zealand but very few deployments of substance. New Zealand was also found to be ranked highly as a nation in terms of IoT readiness yet a lack of understanding of the economic value appears to be holding back investment. The economic value that accelerated uptake of IoT could bring for the New Zealand economy appears significant. Economic analysis by Sapere, an economic consultancy, estimates a potential net benefit for the New Zealand economy over 10 years of $2.2 billion in present value terms across a mere nine common IoT applications. There are many ways to stimulate the uptake of IoT with most stemming from an increased awareness of the potential value that IoT can bring.

New Zealand has a Vibrant IoT Ecosystem

In New Zealand, the IoT ecosystem is fragmented, many vendors solve some pieces of the puzzle but few provide end-to-end solutions. However, there are a growing number of positive signs that interest and awareness of IoT is improving. Some of the more significant IoT projects underway include:

- A number of local councils are planning or deploying 'Smart City' initiatives.
- Many solutions are being developed for the Agribusiness sector, although few have reached scaled deployment status.
- Universities are undertaking IoT research within health and wellness, facility and building management, and early childhood education.
- Telecommunications companies are using their cellular connectivity to deliver IoT deployments.
- A race is underway to implement low powered wide area networks (LPWAN), designed specifically for IoT data. Thinxtra and Kotahinet are currently building LPWAN's across New Zealand and Vodafone Group have been trialling its version called NBIoT (Narrowband IoT) which is expected to be deployed in New Zealand in the future.
- Several startups or niche vendors developing IoT solutions, enabled by commercial models such as crowdfunding.
- Several international technology organisations are offering IoT services in New Zealand, for example, Huawei, NEC, Cisco and IBM. NEC has formed a partnership with Wellington City to use the city as its IoT laboratory, while the city receives the benefits of the solutions.

There are a number of drivers and enablers spurring awareness and interest for the Internet of Things in New Zealand. These can be placed in three categories:

- **Technology.** New Zealand has world class internet connectivity with the rollouts of the Government's Ultra-Fast Broadband and Rural Broadband initiatives, plus cellular networks and LPWAN.
- **Business/Economics.** New business models including innovation centres, business incubators and crowd funding models are enabling entrepreneurs and start-ups to quickly prototype new IoT concepts.
- **Culture.** New Zealanders have always been renowned for their pioneering and innovative ways. Our approach to solving problems and a highly-connected culture is driving experimentation with the Internet of Things.

Local IoT Uptake is Slow

While all of these projects indicates an active IoT supply in New Zealand, the demand uptake is slower. The research found that only 14% of New Zealand enterprises have deployed an IoT solution.

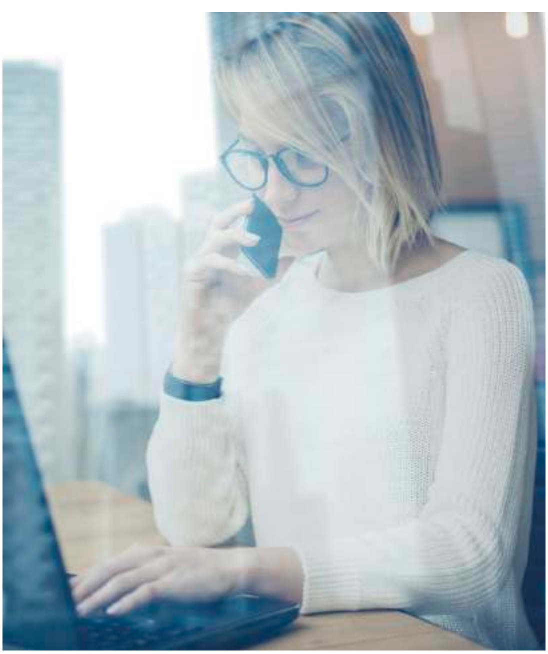
While many trials and proof of concepts are taking place across the country, scaled deployments are rare. Investment is currently inhibited by:

- Executives within organisations lack understanding of how IoT can benefit them.
- Buyers concerns over becoming tied to proprietary systems, the choice and longevity of connectivity solutions and standards.
- The fast moving pace of change in technology drives fear that by the time an organisation brings an IoT product or solution to the market, it could be redundant.
- A lack of clarity over how privacy and security of IoT data should work, including data ownership, accountability and sharing with third parties.

New Zealand is ready

The research found that 70% of organisations that have, or are planning to implement IoT, believe that IoT will be transformational or strategic to their business. This suggests that once organisations understand what IoT can do for them, it becomes increasingly important.

New Zealand, as a nation, is well prepared to take advantage of the opportunities IoT brings. According to the IDC G20 IoT Readiness Study, despite having a relatively small GDP and population compared with the G20 nations, New Zealand scored well on measures such as ease of doing business, government effectiveness, regulatory quality, innovation and education. New Zealand has the right ingredients to be ready for the growth of IoT. However, now it needs to put those ingredients together to create a winning formula. Central and local governments should work with each other and the industry to grow knowledge, design and implement sound policies that continue to cultivate innovation, maintain adequate technology infrastructure and sustain the environment necessary for the IoT's growth. The key role for government is as a catalyst for this growth.



70%

of New Zealand businesses believe IoT will be transformational or strategic for their business.

Key Opportunities

The key opportunities for using IoT to generate economic growth in New Zealand are:

- **Agribusiness.** As a significant contributor to the New Zealand economy, IoT can improve productivity and efficiency. For example, IoT could be used to 'reduce environmental impacts' and potentially help 'add value to volume'.
- **Across Cities.** IoT can reduce operational costs and make cities more desirable for citizens. Cities can also benefit from sharing data, leading to new business and revenue streams by third parties.
- **Utilities.** IoT metering reduces costs for both the supplier and the consumer. Opportunities include better network load management, early identification of leaks, automatic meter reading, and accurate billing.
- **Asset Tracking.** Tracking location and usage of equipment, cargo and vehicles drives efficiency and reduces maintenance.

The Potential is Significant

An analysis of the economic benefits of IoT across nine significant IoT applications estimated a potential net benefit for the economy over the next 10 years of $2.2 billion with a plausible range from $1.1 billion to $3.3 billion.

The economic analysts derived this number from the productivity and efficiency benefits of a mere nine applications of IoT across agribusiness, cities, utilities, asset management and manufacturing. The potential benefit to the total economy could be significantly greater.

To benefit however, the key change required is creating awareness, education and improving knowledge while managing challenges, such as security and privacy of IoT data. Vendors should seek to turn discussions from technology led to business led. Buyers need to better understand that data is the value of IoT, not the technology itself. Data should be considered a strategic asset. The industry needs to collaborate and build alliances to create the momentum to enable scaled deployments.

The Government can be a catalyst for growth by using Government tools to increase awareness, educate, create policy frameworks for IoT security and privacy, and make it easier for startups and innovators to negotiate commercialisation. A cohesive Government vision and strategy for IoT will help New Zealand to deploy unified city initiatives throughout the country. Government sponsorship of one or more flagship IoT initiatives would also accelerate New Zealand's transition into a Digital Nation.

Better use of IoT could create

$2.2 billion

in net economic benefit for New Zealand over the next 10 years.

> ***The pervasiveness of technology today in our lives is ever increasing, and the concept of connected devices (IoT) is only going to exacerbate this. As a country, we need to ensure that IoT delivers on its potential to be a positive impact on our ability to compete globally and improve our economic wellbeing."***
>
> *Craig Young, TUANZ*

tuanz

Key Highlights

100 billion IoT connections predicted by 2025

New Zealand is well positioned for IoT

NZ is connected

4 out of 5

New Zealanders own and regularly use a smartphone or tablet.

NZ has lots of data

600 TB

of data is captured by Auckland City Council alone, the equivalent of watching YouTube videos non-stop for 65 years.

NZ is ready for IoT

#4

New Zealand ranks among leading countries in the world for readiness for IoT deployment.

However uptake is low

70%

of New Zealand businesses believe IoT will be transformational or strategic for their business.

21%

of New Zealand businesses have concerns about the upfront cost of IoT.

Only 14%

of New Zealand businesses have deployed an IoT solution.

Yet the economic opportunity is enormous

$448m

economic benefit to New Zealand from better use of IoT in dairy farming.

$128m

economic benefit to New Zealand from the use of IoT for city infrastructure management.

$558m

economic benefit to New Zealand from better use of IoT across transport and logistics.

$72m

economic benefit to New Zealand from better use of IoT in horticulture.

$25m

economic benefit to New Zealand from better use of IoT in water metering.

$27m

economic benefit to New Zealand from the use of IoT for managing car-parking in cities.

Better use of IoT could create at least $2.2 billion in net economic benefit for New Zealand over the next 10 years.

Part One

The Current State of IoT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Part One The Current State of IoT

Connecting machines or devices together is not entirely new in New Zealand. Twenty-five years ago, Wairarapa based Harvest Electronics created the technology to monitor Coca-Cola vending machines remotely. However, the pace of change and levels of interest has increased in the last few years.

Why the Pace of Change is Increasing

Fast Paced Changes in Technology

The Government's Ultra-Fast Broadband (UFB) and Rural Broadband Initiative (RBI) enables IoT growth by delivering better broadband to more New Zealand properties. This means better access to online, cloud based applications that provide visualisations of IoT data. It also means that more properties have increased ability to take IoT sensor data from a property to the cloud. The second phase of RBI and the associated Mobile Blackspot programme currently underway will result in both extended coverage as well as significantly improved broadband and mobile performance in rural locations.

New Zealand has 2G, 3G and 4G networks which can all be used for IoT, with pros and cons for each mobile generation. It is anticipated that the mobile carriers will deploy the forthcoming 5G mobile network in the early 2020's. These 5G networks will bring high speed data and extremely low latency, making it suitable for critical IoT applications such as autonomous vehicles.

Alternative power sources are also enabling IoT growth. The use of solar power, kinetic power and long life batteries, means sensors can be placed in locations that traditional power sources cannot reach.

Connected Culture and Innovation

New Zealand has a connected culture. As at April 2016, IDC reports that four out of five (82%) of New Zealanders over the age of 18 own and regularly use smartphones or tablets. New Zealanders have a strong mobile mindset; we expect to be able to access the internet practically anywhere we are. We are passionate about digital devices and consumer electronics.

4 out of 5

New Zealanders own and regularly use a smartphone or tablet.

Consumer electronics such as Arduino or Raspberry Pi kits also provide those at home and school the opportunity to create IoT solutions. Our school leavers combine digital skills learning from social media like YouTube as well as formal education. As Millennials and soon the next cohort, Gen Z enter the work place they will bring with them collaboration skills and familiarity with using technology to achieve goals.

New Zealanders have long been known for our pioneering ways, and IoT offers a world of opportunity for our entrepreneurs, developers, mathematicians, thought leaders and creative minds. This new highly connected culture is a strong enabler for the Internet of Things in New Zealand. Alliances, meetups and collaboration are as much enablers for IoT as the advance of the technology itself.

New Ways of Doing Things

The advances of mobility, social media, cloud computing and analytics have formed the perfect storm to create the environment for IoT to flourish.

> ***The IoT opportunity will extend to all New Zealanders, as a nation of early adopters there is much to offer. People will be empowered to make choices that ease life and New Zealand based organisation will be equipped to compete on a global basis."***
>
> *Mike Davies, 2 Degrees*

61%

of IoT initiatives are business funded not IT funded.

Meanwhile, funding models are also shifting, with a trend moving away from Capex in favour of Opex. In New Zealand, 61% of IoT initiatives are business instead of IT funded. This has enabled Lines of Business to invest in IoT proof of concepts without governance or IT process delays.

Economics are shifting as enterprises start to view data as a strategic asset. Some may go as far as recording data as a financial asset, having value and depreciation over time if it is not maintained.

Crowdfunding and angel investment is also enabling startups to progress their IoT ideas with momentum. Business incubators and colliders enable like-minded people to co-work.

In 2016, 72% of New Zealand organisations felt that their industry was either greatly or somewhat disrupted. Two thirds of enterprises have or are developing a digital transformation strategy. This desire to disrupt or adapt is a strong driver for IoT as one of the digital competencies to develop new models, products and services.

Recommended Actions

To realise the opportunities that IoT can provide for New Zealand, enablers requiring development are:

Partnerships in the ecosystem. Within the IoT ecosystem no one vendor can do everything well. Mechanisms to encourage the development of strong partnerships will help enable the growth of IoT.

Developer Community. New Zealand needs greater collaboration at the developer level, whether through professional groups or crowdsourcing type events, particularly aimed at young people to encourage skill development and connections.

Alliances at the business and strategic level. While vendors are likely to be reticent to collaborate at the technical level, strategic IoT alliances are a way to foster growth.

All of these actions can be supported by the development of a strong collaborative community or ecosystem. It is recommended that public and private investment continues to support the neutrally positioned IoT Alliance as a centre of gravity for the IoT ecosystem in New Zealand.

Perception of IoT in New Zealand

The general perception of technology decision makers in large businesses is that IoT will be important for their business. However, there are a number of concerns that serve as obstacles to investment in IoT solutions.

In 2016, IDC surveyed 256 New Zealand enterprise IT and business decision makers from large organisations* about their perceptions of IoT. The study found:

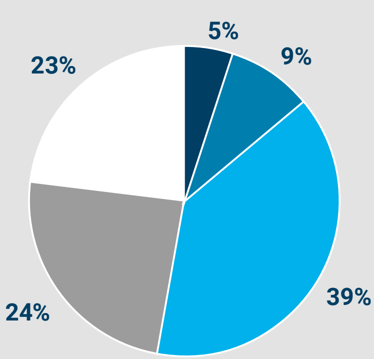
- Only 14% of organisations surveyed have deployed an IoT solution and 23% have no plans to use IoT solutions.
- An additional 63% think they will deploy IoT within the next couple of years, however while the can see the potential for IoT within their business many are struggling to budget as it is hard to clearly articulate value.
- 50% of respondents see IoT as strategic to their business as a means to compete more effectively.

***Note:** Firms surveyed had 250+ FTE's therefore some industries such as agriculture and farming are underrepresented in the research. This is because most farming companies would not meet the sizing criteria to be considered large enterprise.

Only 14%

of New Zealand businesses have deployed an IoT solution.

Figure 1 IoT Deployment Plans for New Zealand Enterprises



- Have already deployed an IoT solution, but have no additional plans currently.
- Have already deployed an IoT solution and planning to extend in the next 24 months.
- Think they will deploy an IoT solution in the next 12 months.
- Think they will deploy an IoT solution between 12-24 months from now.
- No plans for IoT.

Source: IDC, 2017. N=256 NZ firms with FTE 250+

The most common solutions deployed are security systems, such as video surveillance, employee tracking and asset management. New Zealand enterprises are looking to IoT to make things happen faster in their business, for less cost. They want to use IoT to improve their customers' experiences with them and automate processes.

The top three impediments to IoT deployments in New Zealand are:

1. concerns regarding upfront costs.
2. concerns regarding privacy.
3. concerns that existing infrastructure will limit possibilities.

Devices, connectivity and data management/software were most often rated as the most important part of an IoT solution by New Zealand enterprises. Only 6% of organisations rated analytics as the most important. The intrinsic value of data and analytics is not yet well understood.

Three in every four New Zealand enterprises say that a common set of data and connectivity standards is important for their IoT solution deployments. This indicates that many organisations may delay investment until their concerns around standardisation are addressed, or until the risk of being tied to proprietary systems is mitigated.

How IoT Ready is New Zealand?

For IoT to thrive in a country, the country must perform well in multiple capacities such as overall economic and political stature, technological preparedness and the quality of the business readiness environment. Countries that excel across these areas are more likely to generate major IoT opportunities and be more attractive to organisations within the IoT ecosystem compared with other countries.

A comparative study of IoT readiness was performed by IDC, comparing New Zealand with the G20 nations. (The study methodology is located in the appendix). Countries that score higher in the ranking are more likely to have the need for efficiencies that IoT solutions can create, will be more conducive for business and product innovation, be more likely to have the mindset for and availability of, technologies that align with IoT use cases.

> ***In New Zealand, we already see widespread adoption of smart meters, increasing connected devices in the home and an accelerating volume of connected cars. Over the next five years we expect to see this accelerate, with the adoption of IoT solutions to enable businesses to be more efficient, differentiate from their competition and create completely new services in almost every industry vertical."***
>
> *Ed Hyde, Spark Ventures*

Spark nz

New Zealand's IoT Readiness

When compared against the G20, New Zealand scores in the top tier among leading countries such as the United States, South Korea, and the United Kingdom. Despite having a relatively small GDP and population compared with most G20 countries, New Zealand scores exceptionally high on measures such as ease of doing business and startup procedures, government effectiveness, regulatory quality, and innovation and education, all of which point to New Zealand having the necessary ingredients for a business environment that is ready for the growth of the IoT.

New Zealand
ranks among leading countries for readiness for IoT deployment.

Countries that rank highly share a number of successful characteristics that place them in a position to accelerate the development of IoT opportunities. Each demonstrate a high proficiency across measures of stature, business readiness and technological preparedness, which combine to create a business and regulatory environment that promotes attractive investment opportunities for domestic and foreign businesses alike. To maintain their competitive edge, central and local governments should work with each other and with industry to design and implement sound policies that continue to cultivate innovation, maintain adequate technology infrastructure, and sustain an open business environment necessary for the growth of IoT.

How is IoT Evolving in Other Countries?

The rise of IoT is a cornerstone for the growth of digital economies, promising to transform the

Figure 2 IoT Readiness of New Zealand Relative to the G20 Nations

New Zealand

1	United States
2	South Korea
3	United Kingdom
4	**NEW ZEALAND**
5	Australia
6	Japan
7	Germany
8	Canada
9	China
10	France
11	Italy
12	South Africa
13	Russia
14	Mexico
15	Saudi Arabia
16	Indonesia
17	Turkey
18	Brazil
19	India
20	Argentina

Source: IDC, 2017

way people and societies interact. IoT provides significant opportunities for countries to gain competitive advantage in the global economy. Fundamental to the growth of IoT is the ability and willingness of governments around the world to play an active role in fostering an environment that enables IoT. This can be done by removing barriers to its adoption and helping coordinate industry stakeholders. Central governments play as important a role in this process as local government. This section highlights recent international IoT initiatives. It identifies some of the primary tools that central government policymakers can leverage to enable IoT and provides examples of best practice from several countries that are actively promoting the adoption and development of IoT.

Australia

While Australia does not yet have a national strategy for IoT the Federal Government is beginning to make progress in leveraging a variety of tools to harness IoT opportunities and realise its potential for competitive advantage. The Australian Government has:

- Joined the Communications Alliance think tank in an effort to promote collaboration and establish a regulatory framework to enable Australian businesses to harness the benefits created by the IoT. The think tank established the Australian IoT Alliance which published an industry report that provides a discussion on Australia's regulatory and policy enablers and inhibitors for IoT industry success. It proposes a number of collaborative work streams for industry, government, and other stakeholders to help drive IoT development. Key recommendations include encouraging a thriving startup community through alignment with Industry Growth Centres activities, reviewing the adequacy of Australian oversight and participation in the key IoT standards bodies, considering a simplification of governance in the development of Smart Cities in Australia, and developing a model for IoT data sharing.
- Invested $248 million in Industry Growth Centres Initiatives over four years. These not-for-profit entities are designed to identify opportunities to reduce regulatory burdens, increase collaboration and commercialisation, improve capabilities to engage with international markets, and enhance workforce skills in key sectors like advanced manufacturing, food and agribusiness, and medical technologies.
- Created the Standing Committee on Infrastructure, Transport, and Cities to inquire into and report on the role of smart technologies in the design and planning of infrastructure. Some proposed recommendations of the committee are efforts to harmonise data formats, encourage proactive use of smarter ICT in government planning and procurement, and enable better government collaboration.
- Established the Accelerating Commercialisation program, an online government resource that aims to assist small and medium-sized businesses, entrepreneurs, and researchers with commercialising novel products, processes, and services, including those related to the IoT. Its activities include commercialisation guidance, advisory services, the provision of grants and assistance, and portfolio services.
- Implemented an Open Data Program to serve as a mechanism for providing an easy way to find, access, and reuse public data.

Aspiring to be Australia's First Smart State

South Australia has signed a Memorandum of Understanding with IoT startup Thinxtra to create a Smart State. Thinxtra will deploy IoT specific connectivity across the state. This will make it easier and more cost effective for IoT initiatives to connect online, whether they be smart city initiatives or private industry deployments.

South Australia did not make a large financial investment to achieve state wide IoT connectivity. Thinxtra is making the investment to build a low power wide area SigFox network. The Government will provide access to rooftops for Thinxtra to place base stations, which would otherwise typically cost $2000 per year each on a 10 year contract. South Australia's financial investment is focused on developing the local ecosystem to enable startups and other suppliers to develop and commercialise solutions.

China

In recent years, the Chinese Government has implemented a number of policies and programs illustrating its focus on transforming China into a world leader in the IoT space. These activities include:

- In 2012, China's Ministry of Industry and Information Technology released its 12 year development plan aimed at growing the IoT market by billions of dollars. It includes using tax incentives for software and circuit manufacturers, demonstrating practical applications, setting communications standards and directing development at a provincial level.
- Created the IoT Special Fund, which aims to promote IoT research and development, distribute grants, and provide loan subsidies to enterprises involved in IoT.
- Established an interagency council in 2013, to assist with intergovernmental coordination. The council aims to provide thought leadership on the design of standards, enable technology research and development, provide industrial support, craft laws and regulations, provide for workforce development training, and establish proven business models.
- In 2015, the Chinese Government unveiled its "Made in China 2025" national plan focusing on developing intelligent manufacturing in several key sectors. The plan includes a focus on using IoT to connect enterprises more efficiently in global production chains, the creation of manufacturing innovation centres to provide support for research and innovation in IoT and smart manufacturing.

European Union

IoT programmes implemented by the European Commission include:

- Creation of the Alliance for Internet of Things Innovation in 2015. This alliance seeks to enable an ecosystem of industry players to assist the European Commission in the preparation of IoT research and standardisation policies and contribute toward shaping EU policy on IoT.
- Implementation of the Digital Single

Market initiative, which seeks to accelerate the growth of IoT. Its objectives include modifying copyright rules to reflect new technologies, simplifying consumer rules for online purchases, making it easier for innovators to start their own company, boosting digital skills and education.

- Launched its Digitising European Industry initiative in 2016, which aims to ensure Europe's readiness for digital products and services. The initiative is a subset of the Digital Single Market program and provides measures to implement standards to boost digital innovation, provide workforce development programs for digital and IoT related skills and jobs, and encourage the free flow of data between the EU member countries.
- Creation of the Future Internet Public-Private Partnership program. Through this program, the European Commission is partnering with industry players and IoT users to advance a shared vision for technology across the European Union and coordinate relevant policies and regulatory frameworks to support a digital economy.

United States of America

The United States has also made progress in recent years in leveraging the tools of government to enable the growth of the IoT.

- In 2014, the Federal Communications Commission Technology Advisory Council established an IoT working group to examine the impact of the IoT.
- In 2015, the Senate Commerce, Science, and Transportation Committee held the first congressional hearing on the IoT. Led by Senator Deb Fischer, the United States Senate also introduced a resolution lobbying for a national IoT strategy and for the federal government to incentivise IoT development in both private and public entities.

In 2016, the United States Department of Commerce called for public comments on potential policy issues related to IoT. The department aims to use the input it receives to help develop an approach that will encourage IoT innovation in the public and private sectors.

Human Condition Safety

In 2014 more than 20% of worker fatalities in the United States of America occurred in the construction industry. Construction industry insurer AIG invested in a startup called Human Condition Safety (HCS) in 2016. HCS have adapted wearable technology to reduce or eliminate human risks in industries such as construction, manufacturing, warehousing and distribution. For example, a worker enters a 'danger zone' such as a blind spot around a piece of heavy machinery. The system warns the worker to move away or it can automatically switch off the machine.

United Kingdom

The United Kingdom has recently introduced a number of policy recommendations, special Government funding investments and a series of reports promoting IoT.

- In 2014, the Prime Minister commissioned a report from the Government Chief Scientific Advisor to review ways in which the Government can leverage IoT for competitive advantage. Key recommendations included outlining a clear vision and national strategy for the United Kingdom's IoT aspirations as well as encouraging Government to focus on several target areas including IoT standards and interoperability guidelines, industry coordination and education, and skills and research.
- The recently launched IoTUK program looks to enable United Kingdom businesses and the public sector to collaborate and develop IoT technologies and services. The primary elements of the program include designating a city demonstrator to deploy and test IT technologies, creating a research hub to explore security issues, and providing a test bed for exploring the use of IoT technologies in healthcare.
- In 2016, the United Kingdom also announced providing a grant to invest in an IoT think tank as part of the government's IoTUK program. The think tank draws together several universities and private and public sector partners to look at a range of IoT considerations including privacy, security, and reliability concerns.

Recommended Actions

Central Government has many tools and methods through which it can promote the development of IoT. At minimum, Government should collaborate with academia and industry to raise awareness of the benefits that IoT provides to both businesses and consumers.

Investment. Local governments should begin investing in the necessary public infrastructure required for IoT use cases such as Smart Cities.

Strategic Customer. Government can be a strategic customer of IoT technologies and solutions. They should use their purchasing power to demonstrate the value IoT can offer in providing efficient and effective delivery of Government services.

Provide Insights and Information. Government should consider developing and sharing insights and information to help more market participants understand the developing landscape of standards.

What is Holding Back IoT Uptake?

Awareness, Education, Knowledge

In New Zealand, the key barrier to the uptake of IoT is a lack of knowledge of how it can improve business. The most commonly quoted barrier in New Zealand is 'upfront costs' (21% of firms share this concern). The underlying message is that organisations lack clarity around the return on investment they could receive, driven by a lack of knowledge. There is little understanding from Line-of-Business of the role real time data can play and the value of that data, which means there is currently little demand for it.

A key factor in the slower uptake of IoT in New Zealand is the perception that the industry continues to be supplier led. Vendors are seeking to create solutions that are standardised and repeatable to make IoT a sustainable line of business. New Zealand is a country of small scale and IoT solutions are fragmented by industry, making it a challenge to solve customer problems profitably.

Successful vendors are those who are accomplished at articulating the value proposition of their solution. A strong story around an IoT solution makes it a business proposition, instead of a technology solution. Having a business focus, a consultative sales process and credibility are key to selling IoT.

Vendors and end-users who were interviewed for this study agreed that in order for IoT to flourish in the mainstream, the focus needs to shift from technology to solving business problems.

21%

of NZ businesses have concerns about the upfront cost of IoT.

A key part of lifting awareness of IoT is shifting the perception it is all about technology. Tech vendors need to be better at articulating the value proposition. We need more business led conversations rather than technology led."

Michael Fitzgerald, Air New Zealand

AIR NEW ZEALAND

How Farm Credibility and a Customer Focus Led to an Award Winning IoT solution in New Zealand.

ReGen is a New Zealand business established in 2010, led by agricultural specialist Bridgit Hawkins, who grew up on a Bay of Plenty sheep and beef farm and holds an agricultural degree.

Together with Massey University, ReGen worked on a solution to solve a common dairy farming problem, how to avoid effluent runoff from the farm into waterways. Effluent is washed from the milking yards into holding ponds. Farmers irrigate fields with this water and natural fertiliser mix to encourage pasture growth, essential to a good milk yield. However, too much irrigation creates the risk of runoff into waterways. Non-compliance to council regulations can lead to ecological damage and hefty fines. ReGen's IoT solution is to send the farmer a daily text message, recommending the optimal amount of irrigation to fertilise pasture without runoff. Sensors collect information about soil moisture, weather and pond height. Meanwhile, analytics creates the recommendation.

ReGen have focused on the value proposition to farmers. The solution ensures compliance, optimises pasture fertilisation and frees up resource from daily manual field testing. A mapping system on the quad bike enables farm staff drop irrigators in the best place to ensure an even spread of nutrients. Farmers can build a picture over time of information specific to their farm which enables informed decisions and even predicts rates of pasture growth each season. By focusing on solving a problem, with the added benefit of improved profitability and stating a clear ROI, ReGen have created a compelling system for dairy farmers, supported by Hawkins' credibility in Agribusiness.

Fragmentation in the Ecosystem

It is clear that IoT use cases are not yet standardised and repeatable across industries and often not even within industries. For example, in agriculture, each farming ecosystem is unique. Taking a solution designed for a coastal dairy farmer and applying it to a highland sheep farmer is a challenge. There is currently a lack of skilled people able translate the technology into practical solutions. The same applies to other industry verticals creating fragmentation. There are few large- scale deployments aside from AMS's rollout of around 1.1 million smart power meters across New Zealand.

The current lack of large scale IoT deployments is a factor leading to fear of investment. It appears, most organisations do not want to be first to learn, preferring to wait until the lessons have been learnt elsewhere. Where are the IoT success stories in New Zealand? How could New Zealand learn from a major deployment?

Finding the Right Talent

For IoT to have a positive impact on New Zealand's economy, we need appropriately talented and skilled people. During the research interviews for this study the following key themes emerged:

- New Zealand has some great innovators; people who introduce and develop new ideas, methods and processes. However, what is often missing is the ability to articulate the value proposition to the customer.

- While New Zealanders are good at innovating, those same people lack the experience to commercialise their products. This results in lost opportunities.
- We need data scientists and mathematicians who can develop algorithms to create analytical applications to provide relevant and accurate insights.

IoT is already starting to create new kinds of employment and this will only continue to grow. Anticipated roles include:

- **Data Scientist:** Analyses and provides insight from complex digital data such as IoT data. Data scientists need to have strong mathematics, statistics and programming skills but also be able to see the bigger business picture.
- **Agricultural Technologist:** Designs and deploys IoT specifically to maximise food production from farming and livestock. Technologists may also analyse IoT data to make recommendations to maximise food production.
- **Data Security Experts:** To protect connected devices from attack and potentially manage disaster recovery and business continuity, should a breach occur.
- **IoT Business Analyst:** IoT needs to be more business led than technology led. A business analyst who understands the IoT ecosystem but can work from the customer's perspective to solve their issues and be the link between the customer and the technical people.
- **Grid Optimisation Engineers:** With IoT deployed into utility network grids (for example, electricity and water), the resulting information and insight enables network owners to modernise their grids for maximum productivity and efficiency. People who use the data and improve the network will be the Grid Optimisation Engineers.

Each of these roles requires confidence with technology, a broad understanding of IoT and deeper understanding of the relevant parts of the ecosystem to the role. Significant practical understanding of the industry in which the role is placed is also required.

Confusing Plethora of Standard Protocols

Consider this, a company would like to deploy IoT sensors on its factory robots. Should it choose LPWAN for IoT connectivity? If so, is Sigfox, LoRa WAN or NB-IoT the right choice? Or is cellular connectivity the way to go? 2G, 3G, 4G, 4.5G or wait for 5G? What if we could tap into existing Wi-Fi on the factory floor? Or perhaps Zigbee? Is Bluetooth an option? RFID? Thread? What about messaging protocols MQTT or CoAP? Maybe Node? There is certainly a confusing plethora of protocols but there is room for multiple standards in the IoT ecosystem depending on the use case. If an organisation is in the autonomous vehicles business, a carrier grade, high quality of service, cellular based connectivity for the sensing cameras on the vehicle will be sought. Conversely, if you want to intersperse vegetable fields on a farm, with two hundred sensors, a version of LPWAN might suit better, both technically and commercially.

Most local participants agree that the market will play itself out without the need for Government intervention, providing scope for multiple standards for different purposes. In the interim, the plethora of options, exacerbates customer concerns in making the best long term decision, especially regarding the longevity of standards.

Collectively, these concerns are inhibiting the uptake of IoT in New Zealand.

Recommended Actions

The key inhibitor for IoT uptake in New Zealand is a lack of understanding, knowledge and skill. This is not a technical issue, it is an education and awareness issue. To increase IoT uptake the following should be addressed:

Reduce Fragmentation. The industry, sector leaders, Government and academia should work together to reduce fragmentation, improve knowledge and experience sharing.

Digital Learning in Schools. The Government should continue to increase the focus on digital learning in primary and secondary schools to prepare the next generation with the skills they will need to exploit technologies such as IoT.

Evolve Tertiary Courses. Tertiary providers should evolve courses to enable their students to develop the skills required for future jobs, including emerging IoT roles.

Invest in IoT Research. The Government should ensure there are no unnecessary barriers deterring universities from undertaking research into IoT or preventing the IoT sector from accessing current R&D funding mechanisms.

Collaborate to Increase Awareness. The Government and industry should collaboratively create awareness and better understanding of the standard protocols to help reduce inhibition of business decision makers.

Challenges to Address

In addition to the key barrier regarding awareness and knowledge, there are further challenges in the IoT industry. These may be resolved in part by the market or may require government intervention.

Connectivity, Power and Standards

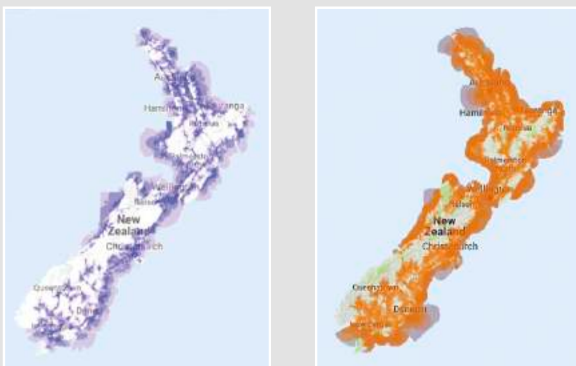
For a number of rural and commercial applications, connecting IoT devices in a field, mine, national park or other remote location is challenging due primarily to limited connectivity. As can be seen in the following coverage maps, cellular coverage still doesn't reach all of our rural and remote areas, however as mentioned earlier the second phase of RBI will extend and improve rural broadband and mobile performance beyond what is represented in these coverage maps.

Many of the high value use cases for New Zealand IoT such as agriculture, natural hazard monitoring and asset management are inhibited due to this lack of either fixed or mobile connectivity. Satellite remains a comparatively expensive alternative, meanwhile the three mobile network operators are well into upgrading their rural networks from 3G to 4G which provides significant improvements in both speed and latency performance.

Fixed line broadband coverage is as critical as device connectivity in remote areas. While IoT specific connectivity such as LPWAN addresses the challenge of device connectivity, without high performance internet, IoT applications cannot be easily accessed to provide value from the data. For example, a forestry worker is inspecting a forest after a weekend of heavy rain. They need to check that the area is safe for workers and that

Figure 3 National 2G + 3G Mobile Connectivity Showing Coverage Areas

Spark 3G *Vodafone 2G + 3G*



Source: Operator Websites, 2017.

The maps opposite are indicative only and show 3G coverage on the Spark (left) networks and 2G + 3G coverage on the Vodafone (right) networks, as at May 2017, highlighted in purple and orange respectively.

the waterlogged land will drain quickly to avoid a landslide that could destroy growing trees. The forest is laden with moisture and movement sensors which are only useful to the inspector if they can access that information, including safety warnings, in real time. If they have no internet coverage in the forest, they can't use the data. This entirely erodes the benefit of the IoT initiative. The same applies for a farmer in the field. If the farmer has no cellular coverage, they can only view their dashboard information from in or near their house, as far as Wi-Fi can reach. This makes IoT solutions of little use to them when decision support is required out in the field.

Residential smart power meters are conveniently located in meter boxes with mains power, however residential water meters tend to be located at the end roadside boundary. If a device is not located near a mains power source, then the most obvious choice is to power devices by battery.

The amount of battery power a device uses depends on how frequently it senses and transmits or receives data and on the type of data it is sending or receiving. A device that sends higher bandwidth video data once a day will likely use more power than a device that sends a low bandwidth temperature measurement several times a day. The more power used, the faster the battery depletes. The faster a battery depletes, the sooner the battery will need replacement. The more field trips to replace batteries during the expected lifetime of the device, the more the business case is degraded through ongoing costs.

Initial and Ongoing Costs

While the price of hardware is decreasing, if an IoT solution requires a large number of devices to collect useful data, device cost and connectivity cost can still be prohibitive. Unit price, when multiplied by a large number of items can inhibit investment.

However, new commercial models are emerging. For example, Kotahi.Net, a new local IoT network company, state their intention is to charge using a per sensor used per month model, potentially making the connectivity costs much lower.

Like connectivity standards, it is anticipated that the market will balance itself between supply and demand. To help increase IoT uptake, the Government could consider how to encourage organisations who are looking to disrupt traditional commercial and pricing arrangements. This could help stimulate the market.

Environmental Sustainability

Questions of sustainability are emerging about deploying devices, and batteries, throughout New Zealand.

What will the sustainability policy be around hundreds of thousands of small devices that are scattered around the country? Should regulation state that devices be biodegradable? How will used batteries be safely disposed of? Will councils require device owners be to be compliant to a sustainability policy? Who is accountable for damage to our environment caused by IoT devices or their batteries?

Government should consider what existing law and policy applies to devices and batteries, particularly where physical items are placed

Challenges for Environmental Monitoring Project

A New Zealand consultancy firm is currently working on an IoT based solution to a road construction business problem. The road builder creates ponds besides roads under construction that collects runoff from the construction areas. It checks the ponds for a range of measurable properties such as sediment, acidity or alkalinity and oxygen content. These measures form its key performance indicators (KPIs) for how well it is protecting the ecology in the area.

For a specific new road build through an area of 'significant natural beauty', 200 ponds will be required. The organisation's current testing plan involves testing two of the 200 ponds by taking measurements at the entry and the exit of the pond, twice per day. An employee must visit each pond, take and record measurements, rain or shine, every day. This currently results in just eight manual readings a day.

Using IoT, every pond could be measured at a rate of once per minute. The business benefit is not only automation of testing, but the ability to conduct 'what if' analysis. Subsequently, the road builder can better understand the impacts of construction activity correlated to different weather and temperature conditions. It can then use the analysis to improve processes to reduce risk of damage to the environment.

Purchasing 400 sensors (two for each pond) would cost $1.2 million. While the road builder can reuse the sensors, making the solution repeatable, the initial outlay from a unit cost perspective is prohibitive. The workaround is to purchase a few high-quality sensors and then correlate cheaper sensors, but this creates a larger margin of error.

A larger issue is that the consultancy firm discovered that there was no one vendor in New Zealand who could implement the system, each could only complete a finite part, with no one organisation having oversight of the outcomes required. This business challenge also provides an opportunity for smart New Zealand businesses.

in remote locations such as near streams or in trees. Understanding IoT use cases likely to apply in New Zealand will assist in creating the right policy to protect our environment.

Compliance Processes may be Stifling Innovation

To encourage IoT growth, innovators need to be able to move through commercial, legal and compliance requirements quickly. This is crucial in bringing new technologies to market. For example, smaller organisations such as startups, simply can't cope with being asked for a multimillion dollar indemnity insurance policy on its devices. New Zealand needs to ensure an appropriate balance is met between protecting consumers of IoT and creating an even playing field so smaller organisations also have market opportunity.

For example, gaining electrical and radio compliance for a new device in New Zealand costs around $11,000 and can take three months. Certifying an IoT device to be used in the gas sector as 'anti-explosive' can cost up to $70,000 and can take four to six months. This is an inhibitor for a small organisation trying to commercialise a device that may have a unit price of just $50. In most use cases that require thousands of devices, unit prices need to be low cost. Unfortunately, the costs of commercialisation may result in good ideas simply being shelved.

The Government can assist by making it easier for companies to innovate in a timely manner and by providing support for small organisations to get their products compliance certified.

Innovation is not a Predictable Process

Innovation involves developing new ideas by processes such as asking and observing customers or employees, analysing complaints, brainstorming sessions, contests and crowdsourcing opinions. While an innovator might start with a basic idea, "I want to develop a new service using city data that we can use to sell insights to city retailers", what that service is, or when the idea will materialise is notoriously hard to pinpoint.

For emerging technologies such as IoT, this makes it difficult to 'plan' new products or services. Subsequently, for an enterprise, investing in IoT innovation comes with risk. Where the government could assist is in considering if we have the right structures in place to foster innovation. Policymakers should consider how the process can be streamlined for innovators (especially startups) to navigate the quagmire of legal, commercial and compliance processes to bring an innovative product or service to the market?

Privacy and Security

Data Security and Privacy

Data security relates to the practices and processes in place to stop data being used by unauthorised people or entities. Data privacy pertains to the appropriate use of data by authorised users, ensuring data collected is not misused.

Security and Privacy in BioTech IoT

Digital medicine company Proteus Digital Health make a 'connected pill', made entirely of food based ingredients. The sensor enabled ingestible captures and transmits responses from the body as well as capturing the travels of the ingestible through the body. The data that the ingestible transmits is of a very personal nature. As yet, there are no rules in place to ensure this data is used appropriately.

Pacemakers also collect and transmit data about the human they are connected to. Internet connected pacemakers are the next evolution being discussed by the industry and health professionals. However, what if a pacemaker could be hacked and then controlled remotely?

Data Security Challenges in IoT

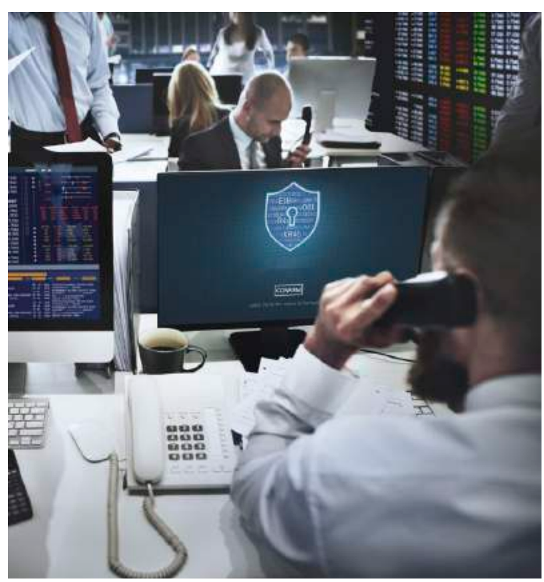
There are two layers to IoT security; security at the network server end, for example, how secure are the platforms used to manage devices or collect data, and secondly the endpoint security on the devices themselves. The widespread availability of devices that can be connected and the range of device types poses an inherent security risk for the Internet of Things.

As IoT devices are being installed in our world where we work and play, in our homes, on (or even in) our bodies, security is more important than ever. Enterprises cannot afford for their sensors to be breached and remotely controlled. IoT breach impacts could include:

- **Considerable inconvenience from disruption or breakdown of systems.** City traffic management could be hacked to cause serious traffic congestion resulting in a major loss of productivity and physical safety issues.
- **Unauthorised access to information and networks.** Retail customer proximity beacons linked to customer information to provide a personalised shopping experience could see personal information stolen.
- **Risk to health, life and property.** A driverless car or other autonomous machine could be hacked to either cause damage or to hijack the vehicle. Smart building sensor malfunctions could cause considerable disruption.

A current concern is the sheer volume of cheap insecure devices, particularly in the consumer market place. Many devices do not have a high enough level of security to stop unauthorised access. For example, Mirai, a piece

> ***The ubiquity of "smart" devices, combined with Internet connectivity, provides new opportunities for those with malicious or criminal intentions. We need to keep our eyes open to the risks. NCPO is looking at current policy settings to see what can be done to improve the security of IoT devices."***
>
> *Heather Ward,*
> *National Cyber Policy Office*



of malware, identifies and infects vulnerable devices. It primarily targets home devices such as surveillance cameras, baby monitors and broadband routers. It logs into vulnerable devices by using a table of dozens of common factory default logins and passwords. Once infected, the IoT device can be remotely controlled to launch a Distributed Denial of Service (DDoS) attack, where hundreds or thousands of controlled devices flood the target (which might be a network machine controlling a website, for example) to overload the system and prevent legitimate users from being able to access it. Last year DDoS attacks brought down several prominent websites including Amazon, Twitter and Spotify. The owner of the infected IoT device is unlikely to know it has been infected as it will continue to function normally, aside from a small increase in bandwidth use. These attacks have been the catalyst for new conversations about IoT vulnerabilities.

Generally, IoT devices are a combination of hardware and software. In many IoT devices, the accompanying software is written at low cost by those who are not necessarily experienced in security. What would have been a robust piece of hardware is now let down by the lack of security features in its built-in software.

There needs to be an onus on organisations in the IoT supply chain to ensure products they are designing, manufacturing, distributing or selling have a relevant and reasonable level of security. Resellers for example, should be encouraged to recognise that they are not just selling a device; they are also selling trust and security in that device.

In New Zealand, there has been strong progress in technology security in the last decade culminating recently in the launch of the New Zealand Computer Emergency Response Team (CERT) by the Government. The CERT's role is to formalise coordination, deal with problems and manage stakeholder communications when dealing with security threats. The CERT is also planning to respond to major incidents arising from IoT related breaches and plans to collate reports to provide insights and trends back to businesses so that they can improve their defence against relevant threats.

The New Zealand National Cyber Policy Office (NCPO) within the Department of the Prime Minister and Cabinet provides advice to the government on cyber security issues. It is working with other agencies, international partners and the private sector to explore possible ways to address the security vulnerabilities of IoT devices. This work will consider a range of issues, including:

- What more can the Government do to ensure consumers understand the security risks of IoT devices in the retail market and can take steps to protect themselves?
- Is there more that the Government can do to ensure that IOT devices are manufactured with built-in security features and there are means to update or improve the security during the lifespan of the device?
- Is the existing legal framework adequate to cover the unauthorised use of IoT devices and other risks arising from IoT devices? What international and extra-territorial jurisdiction issues arise from the proliferation of insecure IoT devices? What role can Internet Service Providers play?
- How does IoT security intersect with other emerging technologies such as Artificial Intelligence?

Challenges with Data
– Privacy, Ownership, Accountability, Value

Privacy isn't just about the type and nature of data that an organisation retains, it is also about how that data can be used by that organisation or reused by third parties. A citizen may feel comfortable with their doctor, local hospital and pharmacy sharing information about them so they can access the best care. However, that same citizen may feel uncomfortable with their health insurer accessing the data to enable better risk assessment, or a potential employer reviewing the data as part of an employment application.

Consider if it would be OK if a fitness tracker wearable device company sold user data to health or life insurers? What if an employer requires employees to don a wearable at work. The wearable enables the employer to undertake real time job scheduling, tracking and manage aspects of health and safety. Is it OK if the employer collects step and heart rate data to determine fitness and therefore productivity of individuals)? Is it OK to track employee's location and use the information as evidence in performance management meetings if wrong doing is suspected? These are just some of the issues pertaining to IoT specific privacy.

The potential for new revenue streams by creating new value out of existing data is undeniable. Aggregated fitness tracker data, including demographics (age, gender, location) could be highly sought after by organisations that sell health products, sleeping products, personal fitness services, exercise products,

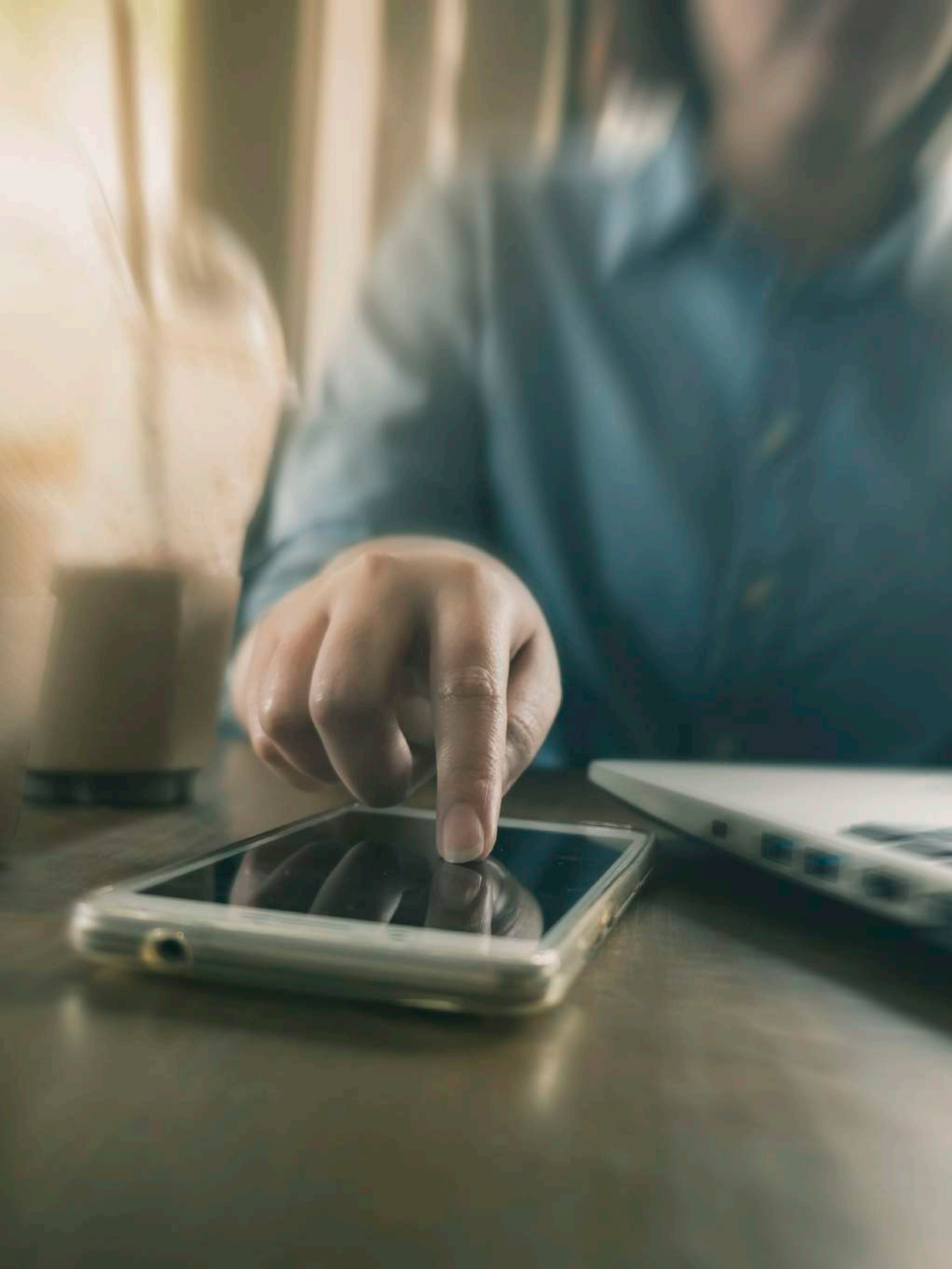
> ***The data generated by your home and personal devices about you should be yours, not the provider's. You should get to give and revoke consent over time – rather than just accepting certain terms and conditions when first signing up to a service or downloading an application. People should be free to choose whether they share their personal data in this new IoT enabled world."***
>
> *Jordan Carter, InternetNZ*

InternetNZ

Using Non-Identifying Individual Data in IoT

An airport wanted to reduce the time to process incoming passengers through arrivals. It needed to baseline the time it took passengers from gate to leaving the airport, without identifying individuals or needing to inform or seek consent to collect data about individuals.

BECA Advisory Services worked with the airport to create a solution that met their needs while maintaining data privacy. The airport placed Bluetooth antennas at the airport gate and at the exit of the airport. These antennas pinged the Bluetooth on passengers phones as they walked passed. The airport did not collect any private data but was still able to identify individual trip times by passengers from the gate to the airport exit.



or cardiac products. The bigger issue however is, what should the rules be regarding sharing and reselling user data? Is non-identifying data always OK? Is personal data ever OK? Does it depend on the intention of use?

The current Privacy Act focuses on the principle of data minimisation, where organisations are encouraged to keep the minimum set of personal data on its customers. However, in an IoT environment we are awash in a sea of data. Data minimisation is becoming fundamentally outdated, so how do we regulate and manage privacy in an IoT world?

Data Value – Use and Reuse

Data is the new currency and can be easily monetised. For example Wellington City Council intends to make its non-private IoT generated data open for third parties to find new value by reusing that data.

Open Data is data that is made freely available for anyone to use, without copyright restrictions, patents or other methods of control. There are still potential challenges with open data that will need to be addressed, including:

- Who owns the data once it has passed hands?
- Who is accountable to protect the data? How should it be protected and who sets that framework?
- What data is acceptable to be 'open' and who decides that?
- How do we monitor the provenance and origins of data to ascertain its authenticity when it has been reused?
- What rights do citizens have to know how open data is being used?

Data Ownership and Accountability

With the proliferation of data being created and stored and used from the Internet of Things, ownership and accountability of that data needs to be clear. For example, Whare Hauroa design temperature and moisture levels sensors for homes. Data can be used to deliver recommendations on changes to house environments to improve health. Whare Hauroa have recognised a number of data ownership and accountability challenges:

- Who owns the data collected from the sensors? Is it the house owner, the residents of the house, or Whare Hauroa? What happens to ownership of that data when those residents move out and another set of residents move in?
- Who else can use the data and how could it be ensured the data is not used for criminal purposes? For example, if the data shows an ambient increase in temperature it may suggest that heaters have been turned on in the evening in winter. The inference that date trends can suggest when the occupiers are home or not, providing time windows for burglary.
- If analysed data suggested, for example, that a crime had taken place in the house, who, if anyone, is responsible for alerting authorities?

If, for example, a third-party buys farming IoT data and discovers a farmer who is dumping effluent into streams, is that third-party responsible for bringing this to the appropriate authority's attention? Does having data make an organisation accountable, or culpable for the information from that data?

Without best practice privacy and security we could be exposing the data of some of our biggest industries, for example agribusiness, tourism and healthcare. However, approached correctly, it may create new value through collected data.

Recommended Actions

To ensure confident deployment of IoT solutions both the Government and industry should proactively address these challenges. While standard protocols will not require government intervention, issues of security and privacy should be immediately considered in collaboration with industry.

Develop Policy on IoT Privacy and Security. Government and industry should establish a working group within the New Zealand IoT Alliance to discuss and develop policy on IoT security and data privacy, including ownership and accountability of data and security breaches.

Capture and Share Security Issues. Vendors and buyers should ensure they are familiar with the objectives, processes and communications of CERT, learning from its cyber security threats analysis. They should also appropriately involve CERT in any IoT security breaches. Organisations with scaled IoT deployments should seek to be involved with the National Cyber Policy Office's exploration of the vulnerabilities of IoT.

Ensure Privacy Factored into Projects. Organisations planning to deploy IoT initiatives should front load those initiatives with privacy assessments to ensure privacy is appropriately catered for, particularly where data may be monetised or otherwise utilised by third parties.

Stimulate New Business Models. It is anticipated that the market itself, will find a balance between supply and demand. To stimulate the market, the Government should consider how it might encourage organisations who are looking to disrupt traditional commercial and pricing arrangements.

Support Innovation. The Government may be able to assist market growth by making it easier for companies to innovate in a timely manner and providing appropriate guidance to support small organisations to get their products compliance certified, while ensuring risks to consumers are minimised.

Consider Environmental Impacts. Government should consider which existing laws and policies apply to devices and batteries, particularly where those physical items are placed in remote locations such as near streams or in trees. Understanding IoT use cases will assist in creating the best policies to protect our environment. The Government could also consider ways to encourage use of long life batteries to reduce environmental impact by reducing frequency of battery depletion and change.

Part Two

The IoT Opportunity for New Zealand


43

Part Two
The IoT Opportunity for New Zealand

Identifying the Biggest Opportunity

There are literally thousands of ways to use IoT to develop economic and social benefits for a country. Yet, not every combination will drive significant value. Sapere, an economic consultancy, analysed a selection of IoT use cases and their potential implications for New Zealand to estimate the potential economic benefit from uptake of IoT. The nine applications of IoT selected for analysis are indicative uses of IoT across a range of sectors that the IDC research identified as most likely to see significant benefit from increased use of IoT.

The estimated net benefits of IoT are greatest in the commercial applications analysed. The estimated net benefits of IoT applications in cities, such as reductions in infrastructure maintenance costs or benefits from smart water meters are smaller, in part because the analysis focussed only on the three main cities (Auckland, Wellington, and Christchurch), but also because the scale of these activities is smaller than large commercial sectors of the economy.

More than $2.2b

worth of economic benefit in the next 10 years could come from greater use of IoT.

For each application, Sapere calculated estimates of economic benefits and costs over a 10-year period. These estimates are intended to illustrate the economic potential of each application but should not be interpreted as forecasts. The Sapere analysis relies on assumptions and has caveats that are detailed in the appendix.

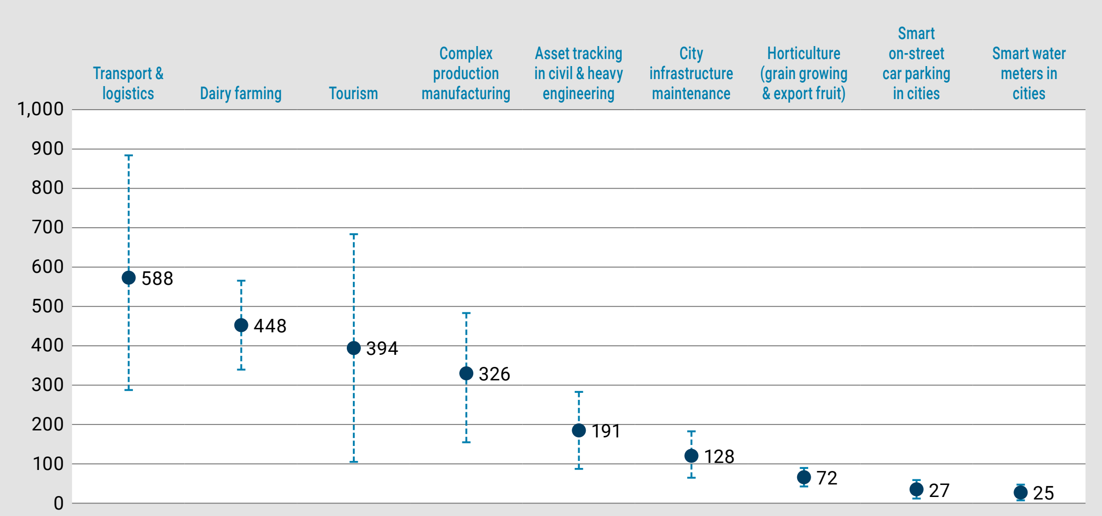
In total, across these applications, Sapere estimate potential net economic benefits for New Zealand over 10 years of $2.2 billion in present value terms, with a plausible range from $1.1 billion to $3.3 billion, assuming all nine applications are taken up concurrently.

Sapere have classified the uncertainty associated with the estimated net benefits of each application as high, medium, or low, and this is reflected in the ranges of the estimates shown in Figure 4.

In some cases (e.g. tourism), the range of plausible benefits of the baseline estimate is relatively large. This partly reflects the early stage of practical application of IoT in some sectors and the corresponding lack of quantitative evidence around benefits and costs. In contrast, in some other applications (e.g. dairy farming), IoT technology has been applied or tested in New Zealand and/or other countries and we can be more certain of its benefits and costs if it is adopted here.

> ***The whole physical world... so far has been largely untouched by the internet because the internet has been about digital industries. What the Internet of Things will change is that it will provide that same innovation and disruption that we've had in digital industries to now extend to physical industries".***
>
> *Vikram Kumar, Kotahi.Net*

Figure 4 Estimated Net Benefits of Selected Applications of IoT in New Zealand (10 year NPV $m)



In many applications, IoT technology may have additional benefits that have not been estimated. An example of such benefits are those arising from the combination and analysis of large sets of sensor data from different applications.

Further to the opportunities identified above, New Zealand can also consider the social and new business opportunities in other areas:

- **Insurance and Health** sectors could also both benefit from IoT. This is expected to be a longer term return on investment especially where issues around privacy of data and human safety must be overcome first. As a result, neither were analysed for this study.
- **Apps and Analytics.** Few New Zealand organisations are focused on providing true analytics and insights applications or services. This is an emerging opportunity as enterprises start to recognise the value of data and realise it is difficult to find the best talent to deliver this internally.

IoT and Agriculture

Agricultural is an important part of the New Zealand economy producing 40% of our merchandise exports so agricultural productivity is critical for the economic wellbeing of all New Zealanders. While New Zealand's agricultural productivity growth is still ahead of the world average of 1.7% a year, it has remained relatively low at 2.5% between 2008-2015 . Increasing use of technology is needed to lift productivity. Additionally, with increasing environmental and sustainability pressures, New Zealand's farmers are looking to technology to make their operations more compliant.

As at June 2016, New Zealand has 6.5 million dairy cattle, 3.5 million beef cattle, 27.6 million sheep and 850,000 deer. Additionally, 48,000 hectares of exotic forest was harvested in the year ending 31 March 2015 .

The total horticulture export value in 2015 was $4 billion which includes $1.2 billion of wine

> ***There is no dispute that using IoT systems to augment the intuition of the farmer will have a huge impact in terms of improving productivity on the farm and improving its environmental and sustainability performance. There is the ability to grow more while using less in a way that the community will find more acceptable"***
>
> *Ian Proudfoot, KPMG*

KPMG

exports. Horticulture New Zealand announced a goal in 2010 of becoming a $10 billion industry by 2020. IoT has the potential to play a part in reaching and sustaining this goal by supporting improvements in productivity and efficiency.

This research study has identified agri-business was one of the best opportunities to use IoT for economic advantage in New Zealand, mainly because of the contribution that agriculture already makes to our economy. Sapere estimate there is a potential $448 million net benefit to New Zealand from better use of IoT in dairy farming over the next ten years, and $72 million net benefit from IoT use in some types of horticulture.

While farmers are starting to use technology, including IoT, to increase productivity and reduce costs in the face of increased competition and compliance requirements, the uptake of IoT in agriculture is relatively low across the sector as a whole.

Examples of IoT use within New Zealand agriculture are developing, including:

- **Grow Bigger and Better Crops by Performing Tasks at the Optimal Time.** Farmers receive automated recommendations for the optimal time to apply nutrients or water to a field. Sensors measure soil moisture and temperature and local weather, recommendations are then calculated on when and how much water or nutrients should be applied. The same principle applies for calculating the optimal time to plant and harvest crops.
- **If Only They Could Talk.** Animal IoT tagging monitors individual weights, detect movement, know location and track production, feeding and medication. This builds a picture of an animal's overall health and productivity. The farmer can make real time decisions in the paddock to improve yield per head including which animals are ready to breed, which need special attention and which animals to cull.
- **Connected Cow sheds.** The faster milk is cooled the better its quality. Cooling milk uses about 30% of the total energy costs for running a dairy farm. IoT sensors and actuators can manage the temperatures at each stage of milk flow. Real time alerts are sent by text message or app notification if problems are identified. This enables the farmer to resolve the problem quickly to minimise milk loss. The IoT solution also automates compliance requirements to keep records of milk temperatures saving the farmer valuable time.
- **Getting Jobs Done Safely.** Wearable IoT devices can manage safety of employees, contractors and visitors. This is not just applicable for farms but also for construction and other potentially hazardous sites.

For example, a contractor could receive a notification that they must wear a hard hat in the area of the business they are in and visitors could receive a warning if they move away from a safe area.

New Zealand Pack House Uses IoT for Continuous Improvement

A. S. Wilcox and Sons was established in 1954 and has continued to grow and market potatoes, onions and carrots ever since, becoming an integral part of New Zealand's agricultural industry. Today Wilcox is a 4th generation, family owned and operated company, with a commitment to providing good, fresh, nutritious food from our fields to your table.

Wilcox are involved in the entire supply chain of fresh vegetables including growing, picking, processing, packing and transporting. Technology has become an integral part of their success.

The Wilcox pack house uses technology to integrate operations from the field to the customer and to ensure the best product is put in the best place. Its Continuous Improvement Coordinator, Hamish Gates, said at a 2016 Auckland TechWeek event that the key driver is the speed of business. Instead of human resources, he sends drones to check crops for quality and growth. Sensors on machinery report how much harvesters are gathering. This information enables him to reduce costs and maintain efficiency. Based on this product anticipation, he is also able to roster on the optimal number of staff and power the right machines at the right time.

- **Frosty Fruits.** Frost conditions can decimate acres of fruit blossom in a single cold night. To mitigate the risk of loss, IoT solutions can predict and manage frost conditions.

Beyond the farm, there are also a growing number of IoT uses within the agricultural supply chain including:

- Building trust in our exports by establishing provenance of goods.
- Improving quality of transported produce by automatically managing conditions such as refrigeration and humidity.
- Providing better security, such as IoT shipping container locks.

Farmers and growers are value purchasers. Cost is less of an issue if the value is obvious. For example, a farmer might struggle to see the value in a $20 a month phone upgrade, but have no qualms buying a $130,000 tractor.

Farmers seek decision support for farming and automation for compliance. As technology makes its way onto the fields in the future, more farm management will be done from a desk or device instead of in the field.

CREDIT: Kieren Scott, Pastural Growth

Low Cost Technology Reduces Unpredictability

Tony Walters, a Pukekohe based dairy farmer has partnered with Spark to enable technology to improve productivity. Walters said at the 2016 Auckland TechWeek that since deploying IoT solutions on the farm, productivity has lifted by 40%.

"We are looking at the data and making better decisions from it. We can have KPIs now because we have the data to measure it," he said.

On the farm, he uses sensors to collect data to recommend the amount of effluent irrigation to fertilise fields without risk of runoff into waterways. He also uses sensors to monitor and manage milk temperature at each stage of milk flow to meet required rules around temperature control. Text alerts are sent if there are any problems between the cow and the storage vat.

"We are focused on production yield, cost and avoiding risk. Every farm faces unpredictability on a daily basis and I'm keen to adopt any type of low-cost technology that can help me collect this type of vital data without having to manually collect it myself," he told IT Brief.

CREDIT: Kieren Scott, FirstLight

Embracing IoT technology may be a big cultural shift for some in the farming community. While many farmers are embracing technology, they have in the past trusted their own knowledge over the technology.

Industry needs to build its credibility within farming to encourage investment in technology. While a startup company may have a good IoT product, if they have no credibility with the farming community, it will struggle to sell. Meanwhile, the extended time frame to create credibility can simply be too long.

At present, IoT driven solution uptake is slow. However, the research indicates different rates of uptake across different agri-businesses. Uptake appears to be highest in horticultural farming mainly due to a tighter farming environment making it easier to embed sensors and stand up a business case. Uptake appears to be lowest in hill country broad acre farming such as wheat, oil seeds and beef, with slightly higher adoption in more intensive farming systems such as dairy, often located closer to towns with better broadband connectivity. Key drivers for the lack of uptake include:

- **The cultural change** required to embrace technology on the farm. In general, agricultural people tend to be less exposed to IT and may not immediately see the benefit that data provides to their business.
- **IoT connectivity challenges.** Most rural areas have a point to point connection such as rural broadband over a wireless connection, a standard copper or fibre connection or a satellite connection. Large farms need distributed connectivity such as mesh networks or LPWAN.
- **Remote Broadband Connectivity Challenges.** The value in IoT for farmers

is being able to make on-the-go decisions. Farmers need internet connectivity in the field to use applications on their mobile devices. LPWAN or mesh networks only carry IoT data. If the farm does not have strong mobile coverage out in the field, the farmer can't access their information apps to get the value out of their sensors.

- **Each farming ecosystem is unique.** It is not a simple task to turn data sets into actionable insight. The complexities of producing meaningful information and insights may be inhibiting growth.
- **Farmers are cautious about security and IP of their farm data.** Farm data is mostly confidential for competitive reasons. Some farmers compete to sell the same product to a wholesaler for the best possible price. However, John Deere sell sensor-enabled tractors which send data into the John Deere cloud. This can include the volume and type of seed planted at exact locations on specific dates. Farmers can then buy the processed data using John Deere's Farmsight™. Concerns have been raised over who owns the data and who has rights to use the data?

IoT and Cities

City based IoT initiatives, often called Smart Cities, are designed to save on the costs of running a city, making it more efficient and providing a better experience for the citizens who inhabit, visit or work there.

Some of the most common examples include:

- **Automated street lighting** to save energy costs and reduce pollution by intelligently

Recommended Actions

Given the scale of the estimated productivity gains across the agri-sector through better use of IoT, farmers, farm suppliers, the tech industry and Government should resolve to accelerate its uptake.

Continue to Expand High Speed Wireless Coverage. Better wireless internet data coverage is required for farmers to realise the full benefits of using IoT farming applications in the field. The Government is encouraged to continue supporting the deployment of high speed internet across rural New Zealand.

Consider Production Standards. The Government can assist the industry to build production standards that will require the use of technology to meet the standard, such as water standards. Farmers will measure their performance against the standards. Farmers can then articulate a powerful story about the safety and provenance of their products to building trust and loyalty with consumers.

Build AgriTech Talent. Encourage tech people to enter the agriculture industry. Anecdotal evidence suggests it is difficult to find tech trained people to work in the agri-sector, yet with these new emerging technology opportunities agritech pathways should be developed.

Enhance the Agri-Innovation Ecosystem. The Government should invest in the development of an industry led agri-innovation ecosystem tasked with encouraging more collaborative agritech development across New Zealand.

handling lighting. For example, Auckland Transport is currently installing around 40,000 smart LED streetlights.

- **Adaptive traffic lights** adjust to traffic flows in real-time to minimise congestion. This results in more productive workers, better experience for visitors and deferred investment in road solutions.
- **City infrastructure maintenance.** Tracking the structural health and use of highways, roads, tunnels, bridges and buildings reduces costs by optimising maintenance frequency. IoT can also reduce the time required to ascertain structural integrity of assets post-quake or other disaster event. For example, Wellington City Council are implementing a project to sense whether a building is safe to enter after a quake.

> *IoT connectivity models are opening up local ecosystems to dozens of new opportunities. New Zealand cities are already trialling productivity savers like bin sensors, car parking sensors, water metering and speed sign monitoring. IoT will help cities to become more efficient and data insights gained will help reduce cities running costs."*
>
> *Greg Howard, Thinxtra*

thinxtra
Empowering Internet of Things

$128m

economic benefit to New Zealand from the use of IoT for city infrastructure management.

- **Smart on-street car parking** reduces congestion in the city, improves usage and occupancy of car parks and improves revenue collection from parking fees.

Sapere estimate there is a potential $128 million net benefit to New Zealand, in present value terms, from the use of IoT in the management of city infrastructure over the next ten years, and an extra $27 million net benefit from IoT use in managing on-street parking, in the three main cities alone.

Reducing the Cost of Managing Public Assets with IoT

New Zealand has over $210 billion worth of physical assets in the public sector across central and local Government. Around a third of the assets are land and buildings, another third are transport related assets and the rest include storm water and wastewater assets, landfill, electricity, IT, cultural and defence assets. A 2013 Auditor General's office report showed that maintenance and renewal plans were being followed for only about 40% of assets. IoT data could determine the most efficient use of funds for preventative maintenance or planning for renewal, by using sensors to understand and track the condition of public assets over time. The data could also be used to measure and manage KPIs for adherence to plans.

Cost Savings not the Only Benefit to Cities

By managing traffic flows to reduce congestion, deterring crime using intelligent lighting and cognitive CCTV, enhancing public transport and using adaptive city lighting both for aesthetics and safety, IoT can make a city a more desirable place to be.

Monitoring School Speed Signs

Auckland Transport are utilizing an IoT network to improve school safety by connecting school zone road signs to the network,a proof of concept solution developed by Massey University in conjunction with Auckland based industrial design company Motiv.

Associate Professor Johan Potgieter says the live trial is in place at three schools and has demonstrated the impact that IoT will have on the everyday lives of New Zealanders by automatically monitoring the status of safety equipment (electronic school zone signs).

"Controlling the school signs used to rely on a manual operation, often by the school's receptionist, over a short range radio frequency (RF) link. There was no visibility on the status of the signs, which often relied on the public or school to report their condition. Now the signs are connected to an IoT network, real time information on their status and full control and monitoring is now available on a web application."

Data collected from IoT sensors can assist council to create evidence based policy. In Wellington, a Safe Cities Programme uses cognitive CCTV and overlays data from police, social welfare, DHB and organisations such as City Mission. The data is used operationally to help make the city safer and the council is also using it to inform its new policy on homelessness.

A city can also use IoT to start to understand the economic return on public events. Wellington City for example, are trialling stereoscopic cameras to count people at different choke points in the city. The system also uses Wi-Fi to understand the flow of pedestrians. This is enabling the council to better understand attendance at its free public events, from which an economic return on those events can be calculated.

Magnifying Benefits

The more data driven IoT initiatives a city delivers, the more the city can leverage the data assets

Adaptive Streetlights in Auckland

Auckland Transport is delivering a project that will see 40,000 individually addressable street lights deployed. The lights will be managed by an IoT central management system. Connectivity is currently via the cellular network but Auckland Transport are moving from SIM to fixed connectivity for more assured capacity, speed and security reasons. They will retain SIM connectivity for hot standby. The driver for the project was the anticipated cost savings from a reduction in electricity consumption and reduced maintenance costs.

to create new insights. For example, parking data, traffic congestion data and pedestrian foot traffic data in retail or commercial areas can be combined to understand the best place to build a new parking building. It can also help councils decide in which areas the price of parking should be increased or decreased to encourage shoppers to attend the city or encourage workers to use public transport.

A Sea of Data

Local and central Government house large data sets, for example public data on assets, the housing market, education, health, police and defence. Auckland City Council alone has around 600 TB of data. This equates to the same amount of data you would consume watching YouTube videos non-stop for 65 years!

The Internet of Things is forcing people to consider their data and data structures to enable interrogation of large data sets. Standards for data and data structures mean that New Zealand cities could share data in a harmonised way. Central Government wrote a business case for data standards that suggests hundreds of millions of dollars' potential productivity gains across the public sector. Auckland Council is one of the public sector entities exploring the adoption of these standards. Another opportunity with Smart City data is to expose public data into the community so that citizens and organisations can add further value to the data and create new revenues.

Price Versus Value

IoT initiatives in smart cities don't have to be expensive. In Wellington, the National Institute of Water and Atmospheric Research (NIWA) have installed a $500,000 weather station at the city end of the Terrace Tunnel in Wellington. To complement this, Wellington City Council can buy relatively cheap sensors, calibrate them to the NIWA weather station and then place the sensors throughout the city to understand localised weather information and temperature patterns.

> ***Data is becoming the universal language, not English not Chinese... but the universal language of things."***
>
> *Jordan Duffy, World Economic Forum*

600TB

of data is captured by Auckland City Council, this is equivalent to watching YouTube videos non-stop for 65 years!

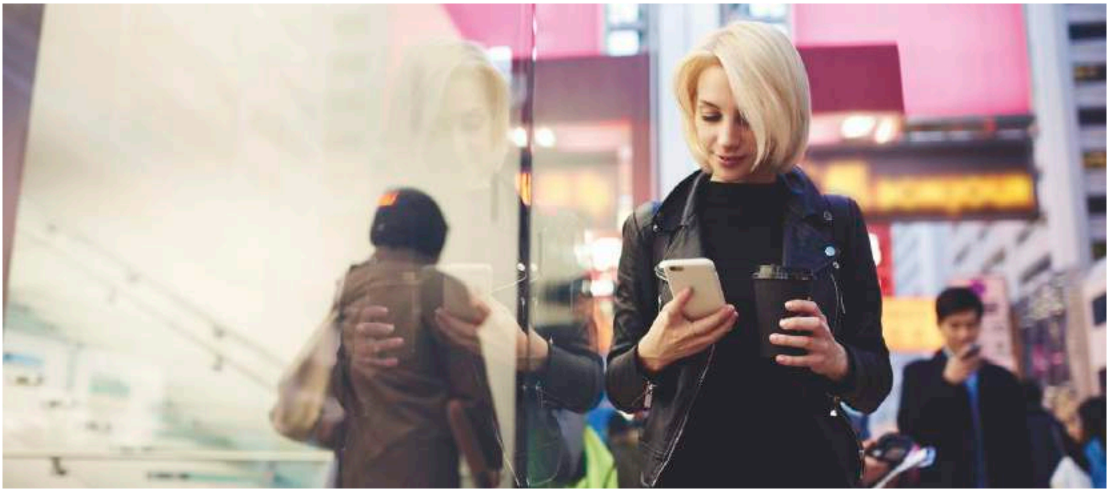
Getting Traction by Building Trust and Self-Governance

Engagement and trust at the C-level in local and central Government is critical for innovation and IoT initiatives. Wellington City Council's innovation team runs a self-governance group on all of its sensing projects. This removes the need for the initiatives to go through the usual committee process which, because of timeframes, would be likely to stall or even stop some innovation initiatives. This system works, primarily because the innovation team at Wellington City Council are trusted by its C-level team.

Challenges

Smart City initiatives are often not as simple as they may first seem. In this section, we highlight key challenges, barriers and inhibitors:

- **The business case is not as simple as you may first think** because the supply chain across a city can be complex. For example, a city wishes to install smart street lighting but is challenged by the number of organisations who have an interest in street light infrastructure. One entity owns the pole, another supplies the light fitting, a third supplies the lamp and a fourth entity maintains the street light. Breaking or varying multiple contracts at the same time may be difficult. Business models, policies and contracts need flexibility to enable a city to keep up with change.
- **We have yet to see a scaled deployment** of Smart Cities in New Zealand that could be used as a critical reference point. A reference point deployment would allow for learnings to be shared amongst local and central Government, in addition to creating awareness.
- **Lack of capability.** Anecdotal evidence suggests that a frustration for IoT vendors is their perception of the scarcity of appropriately skilled individuals in IoT, particularly to lead or manage initiatives within the Government sector.
- **Data is underutilised.** Local councils have a wealth of data, which will include sensor data from IoT deployments but the data is not standardised. It is used in silos, instead of being shared.
- **Processes in Government can be a constraint.** The pace of change outstrips the ability of Government to keep up, for example, procurement processes. Our interviewees felt that for a small country, New Zealand is less nimble and agile than it could be in this regard.
- **New Zealand's strategy for Smart Cities is not clear.** This may inhibit investment for buyers and make it harder for vendors to consider appropriate solutions.
- **Fragmented engagement.** Within local or central Government, there is no one place for a supplier to engage about Smart Cities. This leads to both duplicated effort and a fragmentation of engagement, knowledge sharing and buy in.



Recommended Actions

To use IoT and data to make New Zealand cities more efficient, safe and clean it is recommended that local and central government coordinate better on initiatives including:

Develop a Shared Vision. Central Government should develop a vision and strategy on how our cities could function as Smart Cities, then feed this into local Government decision processes to provide direction and a framework for initiatives and outcomes.

Standardisation of Data Actionable insight is a key value proposition for Smart Cities, to solve city problems and to reuse and add value to public data. To do this, agencies must be able to share data and this will require more focus on standardisation of data such as meta tags.

Create Living Laboratories. One approach for consideration is to make a city a live laboratory for a trusted ecosystem partner. This approach will limit a city's financial investment risk but enable the city to receive the benefits of initiatives delivered. Partnering with cities overseas can also enable shared learnings and benefits.

IoT and Utilities

Using IoT for metering, often called Smart Metering, delivers better network load management, early identification of leaks and losses, reduced costs for meter reading and a better customer experience through accurate billing. Where smart metering becomes insightful however, is by considering the wider stakeholders and treating the data as the strategic asset in the solution, instead of the technology. For example, leveraging the value from the 1.1 million smart power meters already installed in New Zealand by allowing the use of aggregated power data may provide new business or service opportunities.

Bottled gas is also used across many industries in New Zealand from hospitals to mines. Using IoT to automatically schedule gas canister replacement by sensing gas levels means buyers don't run out. Suppliers assure revenue and are more efficient through 'just-in-time' scheduled replacements.

$25m

economic benefit to New Zealand from better use of IoT in water metering.

Sapere estimate there is a potential $25 million net benefit to New Zealand, from the use of IoT connected water meters in the three main cities over the next ten years alone. These meters can be used to reduce water loss across the network and to provide more accurate and automatic billing for water consumers.

Electricity

In New Zealand, most homes have smart power meters. The smart meters collect usage data at regular intervals and send it back to the metering company. The metering company no longer needs to send out meter readers in person. Instead, customers are billed accurately every month and electricity retailers can offer customers products based on intraday readings. For example, online electricity retailer Electric Kiwi offers customers a free off-peak hour of power each day; a product which is facilitated by smart meters.

There is an opportunity to leverage smart meters to obtain further value. This can be done by considering the smart meters as an enabler, to create value, instead of the value itself. The solution should explore how IoT can provide data about electricity usage for the whole ecosystem, rather than it just solving the metering company's issue. While smart meters collect data and provide it near real time to the power retailer, they could be intelligently sharing this data with wider stakeholders. This includes customers' specific data for the householder or the homeowner, and aggregated data for the power generator, the local council, civil defence, the ministry for the environment, manufacturers of light bulbs and the Energy Efficiency and Conservation Authority (EECA).

Recommended Actions

The smart power meter deployment is one of the few truly scaled IoT deployments in the country and as such it should be leveraged to gain insight into the economic opportunity that IoT may be able to bring for New Zealand.

Incentivise Initiatives. The Government should consider how it might encourage research and experimentation with the national smart power meter ecosystem. Using incentives to stimulate a value chain from this deployment to showcase IoT outcomes and lessons learnt.

Water

In New Zealand, some local councils have installed water meters at residential properties. This allows councils to invoice residents for water based on actual usage instead of inclusion in a rates bill.

Smart water meters offer similar benefits to smart power meters; reduced resource to read meters, more accurate billing, a better customer experience, property owners or residents can better understand and change their water usage, allowing the network operator to optimise the water grid. Data from smart meters can also alert property owners or grid operators to leaks.

Smart meter data can be used to automate the process for commercial and industrial users to report compliance to council rules around water usage. Councils can remotely monitor their water fountain levels and park irrigation. Connecting data with weather information allows councils to reduce wastage by not watering council park areas on days where rain is due.

Watercare is currently trialling smart meters in Waiuku, south of Auckland. The existing water meter is fitted with a smart device. The device collects water usage data every hour and 24 hours' worth of data is transmitted to the cloud once a day. The device is connected to the 3G cellular network via a SIM card and the unit is battery powered. However, 3G data transmission is not optimised for long life battery. Sending data once a day means the battery will last longer, however, the network doesn't truly become smart because the data being supplied is now historical and not real time. An alternative solution is a long-life battery and connectivity via a low powered wide area network. By doing this, battery replacements may only be required once a decade, creating significant savings.

IoT and Asset Management

IoT sensors can be used to track, monitor and manage business assets including machinery, vehicles, cargo, raw materials, computers and laptops, or practically any physical object. Almost every industry relies on some form of transport or logistics process and cold benefit from managing and monitoring their assets in a smarter, more efficient and productive way. Across New Zealand, 32% of organisations who have deployed or are planning to deploy an IoT solution said they would deploy IoT for asset tracking. This includes fleet monitoring, freight monitoring and general asset management.

32%

of firms who have deployed or are planning to deploy an IoT solution said they would deploy IoT for asset tracking.

Organisations may want to track and monitor assets to understand;

- Current location, location history, speed and route taken.
- Whether a fixed asset that should remain still has moved, vibrated or shifted in position.
- Whether an asset is idle or in use.
- The current status or condition of the asset, such as the temperature of an engine, the fuel remaining, whether a container seal is intact or broken.

While asset management is the number one reason why organisations are considering IoT, it will also create the biggest potential

$558m

economic benefit to New Zealand from better use of IoT across transport and logistics.

economic benefit for New Zealand. Sapere estimate that within transport and logistics alone, the net present value of benefits that increased use of IoT could bring over ten years could be NZ$558 million.

One of the largest potential benefits for IoT based asset tracking is predictive maintenance. This involves using sensors to monitor measurements such as vibration, sound and motion. Data is then used to predict when maintenance should occur instead of undertaking scheduled maintenance that may be either too frequent, incurring wasted maintenance cost, or too infrequent, that can result in a breakdown.

Organisations with vehicle fleets such as milk tankers, buses and road maintenance vehicles can use IoT for fleet monitoring. The data not only provides insights for predictive maintenance but can also manage compliance and driver behaviour. Fleet management can also be used to track the health and safety of drivers, especially in adverse weather conditions, or to dispatch response jobs to the best located vehicle. 15% of New Zealand organisations who have deployed or are planning to deploy an IoT solution are looking to deliver IoT fleet management.

Construction and machinery hire companies can use IoT to better understand the location of their machinery and whether it is in use or idle. This improves visibility of which assets are free to be shifted to another job and which could be

Fleet Management Doubles as Emergency Response Tool

Porirua City Council's Works Depot unit has 31 response vehicles. Each vehicle is fitted with the EROAD fleet management system. This has proved invaluable to the council not only for Road User Charges (RUC) automation and for everyday vehicle and driver tracking, but as an emergency response tool. In May 2015, intense rain resulted in flooding, slips and road closures in Porirua. Having fleet tracking installed enabled the Council to track response vehicles, identify gaps, and choose the best vehicle to respond based on its location and status. It also meant the Council could further monitor safety of its teams working during an adverse weather event.

New Zealand Logistics Company Using Connected Solutions to Track Containers

One of New Zealand's largest logistics providers uses AT&T's Cargo View, a solution that allows enterprises to monitor and track global assets using near-real-time location and sensor information. The logistics company was experiencing missing shipping containers, which was a significant cost for its business. Using IoT, the logistics provider installed solar powered devices in each container to monitor location and the integrity of the goods held within, in some cases, dangerous chemicals.

moved most efficiently. Car rental companies could monitor their fleet's location in the same way to ensure the optimal use of the vehicles.

IoT cargo monitoring enables transport organisations to have a real time tracking view of items for its customers and introduces cargo provenance. It assists in understanding and mitigating risk and can pinpoint responsibility in the case of damage or loss. For example, it can identify that refrigerated produce was spoilt due to lack of power to the unit while it was waiting at the docks to be loaded onto a ship. Using IoT in this way also enables insurers to insure cargo in transit with a clearer understanding of risk to calculate more accurate premiums.

Recommended Actions

Given there is already great interest from transport and logistics firms in the use of IoT for asset management, an increased use of IoT in this sector will drive considerable economic returns for the economy. Initiatives to accelerate uptake should be considered.

Lead by Example. The Government should consider how it might lead by example across its own fleets and assets by deploying IoT solutions and demonstrating the benefit.

Demonstrate ROI. Technology vendors should be able to quickly demonstrate ROI across various different uses of IoT solutions for asset management in multiple sectors.

IoT and Manufacturing

The majority of New Zealand non-food manufacturers are small to medium enterprises, making products such as gearbox components for earth moving equipment or injection

60-70%

of what is manufactured in New Zealand is sold abroad.

systems for injection moulding machines. Complete products manufactured in our country include vegetable washing systems, fruit sorting equipment, baggage handling systems and weighing systems at airports.

The niche that New Zealand manufacturing has carved out for itself is high quality specialised short run manufacturing. There is very little mass production manufacturing left in New Zealand with a few exceptions such as Sistema who manufacture food storage containers. New Zealand manufacturers seek to differentiate based on specialisation, quality of product, agility and ability to develop new solutions. Due to the specialised nature of the products created the manufacturing sector is highly export dependent, with between 60% to 70% of what is made sold abroad.

In New Zealand, the driver for using IoT in manufacturing is to remain globally competitive. If organisations in other countries can manufacture specialised components or products faster, better and to a higher quality than in New Zealand then our industry will be at risk.

There are two key areas of opportunity for industrial manufacturing IoT:

- Inward-looking IoT: making better products faster.
- Outward-looking IoT: remaining electronically connected to products post-factory.

Inward-looking IoT

Industrial IoT will allow manufacturers to undertake mass customisation. It will enable short run manufacturing in factories that were traditionally equipped only for long run manufacturing. For example, an assembly line where components are produced in only one shape or colour. IoT can be used to enable the assembly line to work in a way where it can paint every item in a different colour and create multiple shapes of items at the same time.

IoT will also help reduce bottlenecks in factories. The electronic connection of all the elements of production, via the IoT, makes it easier to predict and identify early where those bottlenecks are likely to occur and then take measures to mitigate risk.

In Germany, some factories have fully automated the process for managing bottlenecks using IoT. In a fully robotic assembly line, a factory can place spare pieces of machinery that are part of the system. When the system detects a bottleneck it will automatically place an additional piece of machinery into the production line to keep the line going.

Outward looking IoT

Manufacturers who export pieces of machinery equipment around the world can monitor equipment wherever it is, by installing sensors as it is being manufactured. This enables the manufacturer to conduct remote performance management and preventative maintenance on the component.

Fisher and Paykel Production Machinery Ltd (FPPML) makes machinery and equipment that is used by its parent company who sell whiteware appliances. FPPML have developed inbuilt sensors in manufactured components and are using them in its services to its parent company.

Another local manufacturer who builds and exports starter motors for large electrical motors believes that if they monitor the performance of the starter motor then they learn more about the overall system. Currently, they are considering how it could create a sensor based service for its customers.

Challenges

There is an industry perception that IoT is only an advantage for very large manufacturers. Presently, some of the technologies being offered are price prohibitive for many New Zealand manufacturers. This includes both the cost of hardware but also the cost of changes to the manufacturing system. Our small and medium sized manufacturing companies need realistic IoT solutions rather than entire systems designed with large scale mass production in mind.

Locally, there is also a lack of capability in the understanding of IoT design. Many manufacturers, do not have in house capability to best utilise the data to improve productivity. Even if this realisation was made, and they were able to engage consultants, there are still few such resources available. While boundaries are blurring between information technology and manufacturing, the industry currently lacks the experience to leverage the overlaps.

Recommended Actions

In New Zealand, manufacturers must consider IoT in a way that makes sense in our market.

Take a LEAN Manufacturing Approach. LEAN manufacturing is a widely known methodology for reducing waste in a system. By using this approach, IoT becomes a way of system thinking instead of simply hardware and software.

Collaborate. Manufacturers should collaborate via groups like the New Zealand Manufacturers and Exporters Association. Such organisations are exploring ways to help members develop realistic plans to utilise the IoT and have established working groups and other related activity to begin the conversation about IoT.

Conclusion

Accelerating a Connected New Zealand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Conclusion
Accelerating a Connected New Zealand

What Does the Future Look Like?

As IoT matures in New Zealand, with appropriate support and guidance it will become mainstream in most enterprise's digital transformation journeys. Organisations will endeavour to use IoT for a competitive advantage, improve customer experience and gain deep insights into their business, alongside improvements to productivity and efficiency.

IoT deployments will become strategic and cohesive, rather than tactical and in silos as many deployments are now. In IoT today, the emphasis is on low cost, ubiquitous connectivity and placing a device into anything to make it 'smart' or remotely controllable. IoT will soon evolve to transforming static historic data to real time data and the benefits that enables.

IDC predicts that as adoption of IoT grows, 75% of adopters will turn to outside firms for help with strategy, planning development, implementation and management of these initiatives. While IoT has the potential to bring numerous benefits to enterprise, buyers will need help to truly exploit the business process innovation that IoT offers.

The complexity of data to be analysed from connected 'things' is often beyond the skill set of the IT and business teams collaborating on IoT engagements. Job roles will evolve and cultures will need to change as technology embeds itself even deeper into the everyday workings of our companies.

IDC predicts that by 2020, 100% of all effective IoT efforts will be supported by cognitive or artificial intelligence (AI) capabilities. For an IoT deployment to be effective, New Zealand organisations need applications such as machine learning and cognitive systems to obtain insight and action from data. Cognitive and AI applications will be particularly useful for understanding unstructured data, such as video, sound and images.

> *IoT's original technology opportunity was about connectivity. Data management is fast becoming the overarching theme"*
>
> *Vernon Turner, Global Head of IoT Research*
>
> IDC Analyze the Future

100%
of effective IoT initiatives will be supported by AI by 2020.

IDC also predicts that 20% of all IoT deployments worldwide will have basic levels of Blockchain services enabled. In IoT, Blockchain will enable devices to identify and authenticate each other without the need for central brokers on central servers which can become a bottleneck and a single point of failure. This decentralised approach will become increasingly important as the number of connected devices grows into huge IoT ecosystems.

By 2019, it is estimated that more than 75% of IoT device manufacturers will improve their security and privacy capabilities, making them more trustworthy partners for technology buyers. As security and privacy challenges are overcome, use cases involving human data will hit the spotlight in New Zealand. For example, connected cars, insurance telematics and personal wellness.

Creating the Catalysts

IoT is still in its infancy, much like the Internet was in the 1990's. Back then, the Internet was mostly static informational pages. Now the Internet is the enabler for over the top services like interactive social media, streaming content and e-commerce. Today, the Internet is primarily for content and multi-user collaboration, with the underlying connectivity a given. The Internet has become a place where people now go for outcomes, for example, to buy a book, sell a car, manage their mortgage, find a job, find a partner, communicate with friends, network with colleagues, watch TV or learn how to sew.

Today, the emphasis in IoT is on low cost, ubiquitous connectivity and devices. However, the real value of IoT is in what is done with the collected data. To gain true value from IoT in New Zealand, we need to remove barriers and improve enablers to create a catalyst environment. The emphasis should be on solving business problems with real time data for sustainable, profitable outcomes.

The Government as a Catalyst

The research suggests that greater awareness, education and knowledge is required to take full advantage of IoT. To deliver a programme that creates awareness and develops knowledge, New Zealand first requires an IoT vision and strategy.

The vision and strategy needs to consider:

- Is the right structure in place to create a sustainable and scalable IoT ecosystem in New Zealand?
- What overseas models could the New Zealand Government learn from?
- Should the Government partner with industry to look globally for the best start up technologies and bring that technology to New Zealand?
- What are the key IoT areas we aspire New Zealand to be world leaders in?
- How will we enable the ecosystem to deliver innovation?

Fundamentally, IoT is a discipline, no different than finance or planning and requires national leadership. A national role of Chief Technology Officer would help provide leadership in this burgeoning area.

Developing the right policy and regulatory frameworks for privacy and security will enable an explosion of new uses of IoT to be invested in as enterprises are no longer inhibited by uncertainty. The Privacy Act also needs to be reviewed to contemporise it for today's data rich world instead of the outdated principle of 'data minimisation'. Sellers of IoT devices need to be encouraged to stock devices that meet security standards, or to at least have systems that enable buyers to make informed choices about device security. Policy changes could also simplify the process to commercialise new products and services.

The Government can also create awareness of the benefits by becoming 'Government as a customer' or 'Government as a reference'. Delivering strong examples in New Zealand not only builds awareness, it also helps build the IoT environment, encouraging collaboration and discussion, providing New Zealanders the opportunity to learn important lessons about IoT. There are so many ways that IoT and connected devices could benefit New Zealand, the Government should keep an open mind for the possibilities.

Ultimately, our research participants agreed that the Government's role is not to provide infrastructure or set standards, but to act as a catalyst in raising awareness that will lead to investment.

In Summary

Greater awareness will create a change in perspective to enable the economic growth from the Internet of Things. New Zealand

IoT enabled autonomous drones and rural medical deliveries

Māori and rural communities experience higher rates of morbidity and mortality than urban communities, having poorer access to prescriptions and crisis support. Through its project, Medical Drones Aotearoa, Māori-owned tech company Paua Interface (Paua) is changing the face of rural access to medicines and emergency support using drone technologies. The company has been cleared by New Zealand's Civil Aviation Authority (CAA) to manage a new 874 square kilometre Restricted Airspace, dubbed 'Incredible Skies'. It will host drone trials using custom drones, safer autonomous and beyond visual line of sight flight, collision avoidance, medical supplies authentication, information systems and more. Paua's CEO Robyn Kamira says that it expects the trials to have international impacts.

> ***The Internet of Things is approaching a tipping point, and it's already starting to transform the way we live our lives and run our businesses. New capabilities let us securely connect a whole new world of equipment, devices and applications. We've got a crucial role to play in ensuring Kiwi businesses are ready to take advantage of what's coming."***
>
> *Scott Pollard, Vodafone*

vodafone

needs to look at IoT as a way to solve business problems, not as a technology solution.

The potential net benefit to New Zealand could be worth as much as $3.3 billion over ten years from just nine applications of IoT alone. As a society, we will be able to understand problems in our world and act upon them in real time, without human intervention. IoT will help our organisations run more productively. Utilising IoT, we can take better care of our people, through remote health monitoring. We can also find and assist people whose safety has been compromised. We can make our roads, our cities and our environments safer places to be by managing traffic to reduce congestion and pollution, enabling predictive maintenance on infrastructure and alerting authorities. We can make New Zealand more effective and efficient, by understanding and acting on water system issues, managing intelligent street lighting, and managing resources more intelligently.

To achieve this, New Zealand needs more collaboration between businesses to understand the wider opportunities that IoT data and the combination of data sources can provide. New business models for ideation and development, such as business incubators and crowd funding are a key enabler to grow the economic value of IoT in New Zealand. Startups can quickly gain momentum in a more collaborative space. There are numerous startups who are developing innovative IoT solutions for problems. These organisations are more likely to focus on business led solutions instead of technology led solutions and to use education, not market forces, to create change. The challenges for New Zealand startups is commercialising their innovations.

The Government should be the catalyst for change. While many of the IoT technology and standards uncertainties will play themselves out in the market, the government can drive investment with IoT strategy, framework and policy. A clear Government position on IoT will help New Zealand to deploy cohesive and unified smart city initiatives across the country. Government investment in flagship IoT initiatives will also accelerate New Zealand's transition into a Digital Nation and propel New Zealand's productivity.

APPENDIX

The Research Team

NZTech is the voice of the New Zealand technology sector. Representing over 400 organisations across the technology landscape in New Zealand from startups and 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.

The Telecommunications Users Association of New Zealand (TUANZ) is a not-for-profit membership association with over 27 years of positive telecommunications change in our history.

TUANZ comprises of over 200 members, predominantly large organisations with a strong dependency on telecommunications technology as well as small enterprises.

TUANZ collated case studies and provided quality review.

IDC is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide.

IDC conducted the local and international research.

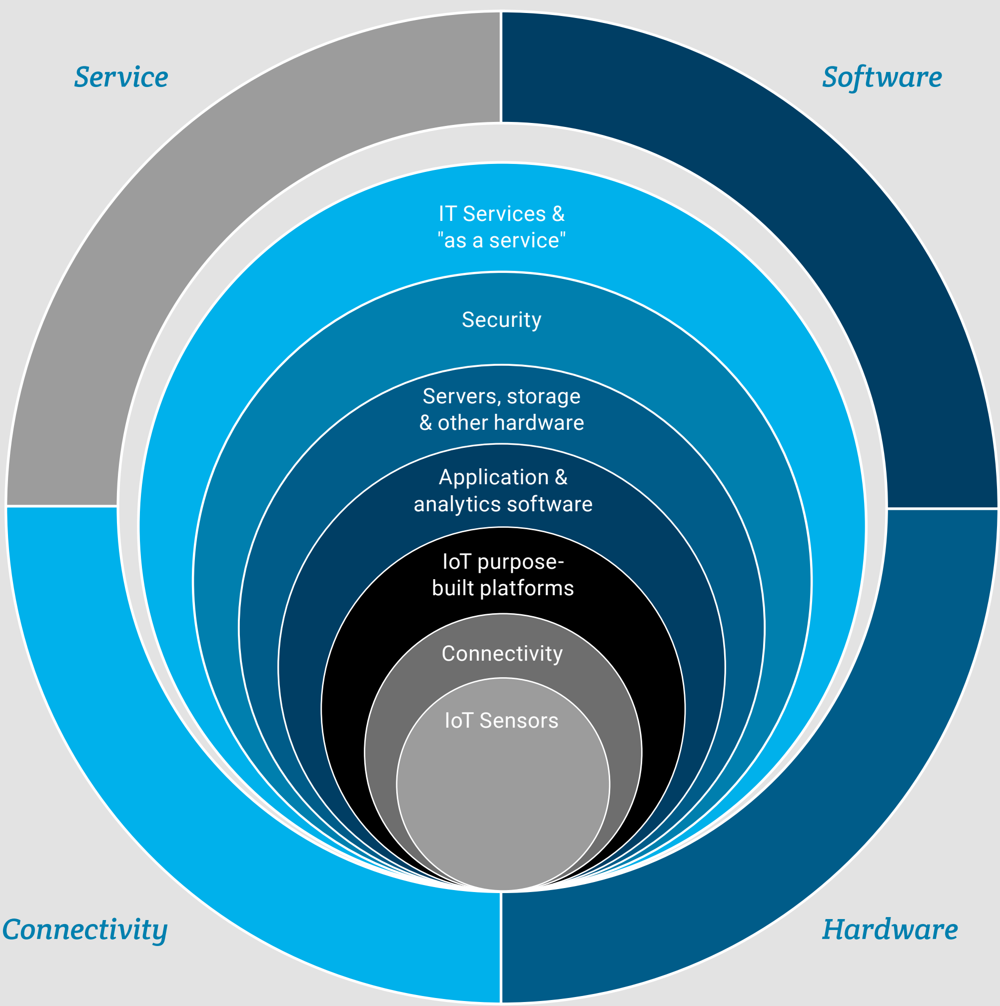
Sapere Research Group is one of the largest expert services firms in Australasia. Sapere provides independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

Sapere conducted the economic analysis research.

The New Zealand IoT Ecosystem

In New Zealand, the IoT ecosystem is fragmented. Many vendors solve some pieces of the puzzle but few provide end-to-end solutions.

Figure 5 The Internet of Things Stack of Technologies



Source: IDC, 2017

Devices / Hardware

IoT devices include sensors, RFID tags, or other such wired or wirelessly connected IoT devices. For example, video monitoring sensors, motion sensors, smoke detectors, electronic access points in a building, temperature and moisture devices, wearables such as fitness bands, thermostats, water or gas flow valves.

Sensors in a device could include:

- Chemical sensors which measure properties such as composition, concentration, reaction rate, acidity, and oxidation by looking for chemical information ranging from the concentration of a specific sample component to total composition analysis.
- Radiant sensors which measure properties such as phase, wavelength, polarisation, and transmittance. They are often used as a kind of thermostat.
- Mechanical sensors which measure properties such as length, volume, area, time, mass flow, torque, and force. One common type of mechanical sensor is an accelerometer.
- Electrical sensors which measure properties such as voltage, current, charge, resistance, capacitance, and induction. Many metal detectors employ electrical sensors.
- Thermal sensors which measure properties such as temperature and heat flow.

Magnetic sensors measure properties such as field intensity, flux density, and permeability.

In New Zealand, a number of vendors resell both consumer and enterprise IoT devices. Some of the organisations involved in developing IoT devices and hardware include:

- **iDefigo** – IoT cameras provide surveillance and visual monitoring of assets and properties.

Designing Device Chips for the Global Market in Hamilton

Virscient, is a local New Zealand company based in Hamilton. It helps its clients design, develop and integrate wireless connectivity into their clients IoT devices. It has worked with international names in mobile technology as well as consumer and industrial vehicle manufacturers.

Virscient has been successful in both creating a niche, in its expertise of wireless, radio frequency and chip security and creating scale, by focusing on exporting its services around the world.

- **Virscient** – design and develop wireless chips for IoT devices, mostly for global customers.
- **Teknique** – design and integrate camera modules into its customers' products.

Connectivity

IoT devices need to send and receive data. This is typically achieved using cellular, fixed broadband or even satellite connectivity. New networking technologies, specifically designed for the Internet of Things, are providing alternative choices. IoT startup Kotahi.Net is building an LPWA network in New Zealand. It charges $1 per month per device connected (subject to some conditions), regardless of the amount of data sent and received. This makes connectivity commercially viable for large scale deployments.

There are several ways devices may connect to the internet:

- **Connecting IoT devices on your person.** Devices such as smart bands and smart watches usually connect to a smartphone via Bluetooth. From there, the connection to the internet is via a smartphone's Wi-Fi or mobile data connection.

- **Connecting IoT Devices in Your Home or Office.** Home or office based IoT deployments such as smart thermostats, smart air conditioning, or smart lightbulbs, are usually connected to the internet by an existing broadband connection to the premise, with no additional costs for the IoT devices to connect.
- **Connecting IoT Devices Everywhere Else.** Some IoT deployments are in remote locations, where WiFi or fixed broadband do not reach. For example, smart power meters or smart water meters, a construction company wanting to install IoT sensors into its vehicles and machinery, or frost sensors at a vineyard.

Longer range IoT connectivity options include:

- **Cellular Connectivity is useful for mobile IoT such as fleet tracking.** It is a choice for fixed IoT deployments where it is impractical to connect a device via fixed connectivity. Most of the 1.1 million smart power meters in residential homes in New Zealand are connected by Vodafone's 2G cellular connectivity. The disadvantage being that not all New Zealand has mobile coverage and the cost of sending and receiving data may be relatively high. An upside to cellular is that it is carrier grade technology. This means the mobile provider can guarantee levels of service.
- **Satellite connectivity is available almost everywhere in New Zealand**. This makes it an option for remote areas with no cellular coverage. However, satellite connectivity is expensive, and devices need more power to transmit and receive data from a satellite than

Are Low Power Wide Area Networks the Future for IoT Connectivity?

LPWAN stands for Low Power, Wide Area Network. It is suitable for connecting devices that send and receive small amounts of data over a long range. The transmissions use a small amount of power, making LPWAN ideal where devices need a long battery life. Long battery life opens up use cases that previously were not feasible because of the difficulty of powering remote devices. Consider domestic smart water meters. While energy companies place smart power meters next to a source of power (the mains to your house), water meters tend to be placed outside, away from the house, usually near the street by your letterbox. A long life battery solves the problem when used in conjunction with a low power wide area network.

Currently in New Zealand there are two deployments of LPWAN occurring: Startups Thinxtra and Kotahi.Net are both deploying their own networks.

Use cases suitable for low power wide area network connectivity include: mini local weather stations, water metering, power or other utility metering, environmental monitoring, many smart city use cases, logistics and cold chain, and waste management.

from a cell tower. The device may require mains power in a remote location, or someone must replace the battery often. Neither option may be cost effective or even feasible.

- **Power line communication (PLC).** Data can be sent and received using power lines including electric fences on the farm. The downside is interference on the lines could cause problems with data transmissions.
- **Mesh Networks.** A mesh network can use each of its sensors to relay information until it reaches the right place. By way of explanation, imagine two people at either end of a playing field who are too far apart to throw a tennis ball to each other. If ten more people space themselves out in the field, they can move the ball from one end of the field to the other by throwing it to the nearest person in the correct direction.
- **LPWAN. Low Power Wide Area Networks are suitable for small bursts of data.** It is not suitable for high bandwidth applications such as video. LPWAN works in unlicensed radio spectrum, where multiple users may cause some interference. This makes it unsuitable for critical IoT applications as providers cannot guarantee quality of service but a good option for non-critical uses.

The challenge with being a connectivity provider for IoT, is that connectivity itself is simply an enabler with little value to the final output. Telcos need to find ways to add value in the ecosystem. One IoT organisation seeking to align itself to telecommunications providers is iDefigo. The company provides a platform for IoT surveillance and visual monitoring of assets. While many IoT use cases only involve transmitting small amounts of data, camera surveillance is high bandwidth and high data rate transmission. iDefigo provides the IoT platform to enable channel partners and telecommunications companies to monetise camera devices via mobile connectivity.

Management Platforms

IoT platforms are like the middleman that helps manage IoT solutions. The platforms can take care of administrative tasks like registering a device on the network and updating software on a device.

Imagine a City Council has IoT sensors deployed for local weather, structural integrity of buildings, traffic management, smart parking and smart street lighting. The Council needs an IoT platform to manage all these end points. The platform will manage which devices are doing what, the location of the device, updating firmware and security, tracking and fixing device faults, battery refreshes and device refreshes.

Many IoT platforms are offered as cloud software, while others can be deployed on-premises in a data centre or at the edge. For example, Spark Digital use Cisco's Jasper to manage its client's IoT device. Vodafone uses its own Vodafone Global M2M (Machine to Machine) Platform. 2degrees has also built its own management platform.

Analytics and Applications

Analytics software uses the data collected by connected devices to turn it into actionable insights that consumers, end users or organisations can use. Analytics makes raw data meaningful.

Applications provide a display of data, such as graphs on a dashboard. Apps can let a person control and manage the IoT solution, such as changing what time of day is suitable for irrigation to be automatically turned on. Applications can also be built to consume data for a purpose, such as modelling a forecast.

For example, a farmer wants to reduce their overall water usage. They have soil moisture, temperature and humidity sensors in her fields. Their analytics software takes all the measurement readings from the sensors and turns it into information about the state of the soil in each paddock. Their applications software uses this data and information about soil conditions to model scenarios and make irrigation recommendations.

Some New Zealand organisations who are building specific local applications and analytics for IoT are:

- **IoT Stream.** This Auckland based company work proactively project to project to build analytics to customise IoT platforms.
- **Innovators.** Also based in Auckland, Innovators design analytics and applications as a part of their overall technology incubation, design and manufacture work streams.
- **Crystalnix.** With offices in Auckland and Wellington, Crystalnix focuses on creating mobile apps.

In New Zealand, specifically in Agribusiness and Smart Cities there are significant opportunities for vendors to design and develop applications and analytics software that are vertical specific. While there are global providers, there is scope for local companies to work with local people.

Security

Security in IoT is critical, especially in mission critical applications such as autonomous cars or use cases that impact the human body. Who would agree to a connected pace maker if it could be hacked? What if someone took control of your self-driving car? As we deploy more IoT and rely on it for more critical processes, if security isn't improved then breaches will become considerably more serious.

G20 IoT Readiness Index – Methodology

IDC has created a composite index to provide a single point of guidance to vendors assessing the IoT opportunity across the G20 nations. The index is made up of 13 criteria that IDC views as critical elements necessary for the continued development of the IoT and collectively reflect the quality of a nation's stature, technological preparedness, and business readiness (see Table 1). Data used in the study was from 2015 and obtained from a variety of sources, including IDC's Black Book , IDC's Worldwide Semiannual Internet of Things Spending Guide , IDC's Worldwide Semiannual Public Cloud Services Tracker , Cornell University in conjunction with INSEAD and the World Intellectual Property Organisation . To produce a final rank ordered index, raw data for each variable was first assigned a score according to the distribution of the data and then summed for each country and weighted by order of importance hypothesised to impact the development of the IoT.

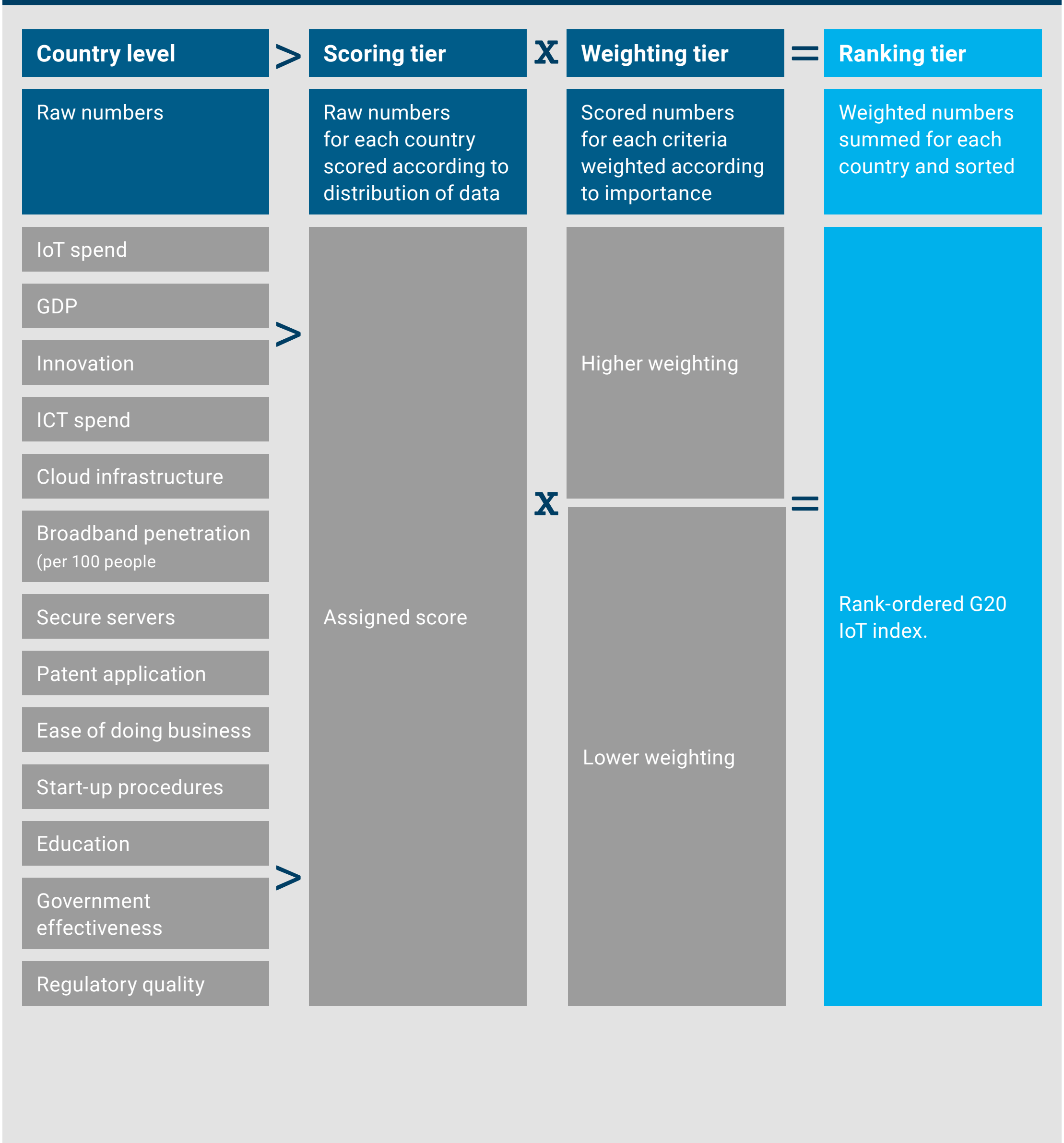
Table 1 G20 IoT Readiness Index Criteria

CRITERIA	IDC'S RATIONALE FOR INCLUSION	IDC'S ASSESSMENT
GDP		
GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data is in current U.S. dollars. (Source: The World Bank)	**Reflection of a country's stature**	**Higher GDP = higher IoT score**
Education		
Graduates from tertiary education (total, both sexes) include the total number of students successfully completing tertiary education programs in public and private tertiary education institutions during the reference academic year. (Source: The World Bank)	**Reflection of a country's stature**	**Higher number of graduates = higher IoT score**
Government effectiveness		
Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. (Source: The World Bank)	**Reflection of a country's stature**	**Higher government effectiveness numerical rank = higher IoT score**

CRITERIA	IDC'S RATIONALE FOR INCLUSION	IDC'S ASSESSMENT
Regulatory quality		
Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. (Source: The World Bank)	**Reflection of a country's stature**	**Higher regulatory quality numerical rank = higher IoT score**
Innovation		
The Global Innovation Index (GII) aims to capture the multidimensional facets of innovation and provide the tools that can assist in tailoring policies to promote long-term output growth, improved productivity, and job growth. The GII helps to create an environment in which innovation factors are continually evaluated. It provides a key tool and a rich database of detailed metrics for economies. (Source: Cornell University, INSEAD, and the World Intellectual Property Organisation)	**Reflection of business readiness**	**Higher innovation numerical rank = higher IoT score**
Patent applications		
Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention — a product or process that provides a new way of doing something or offers a new technical solution to a problem. (Source: The World Bank)	**Reflection of business readiness**	**Higher number of patent applications = higher IoT score**
Ease of doing business		
Ease of doing business ranks economies from 1 to 189, with first place being the best. A high ranking (a low numerical rank) means that the regulatory environment is conducive to business operation. The index averages the country's percentile rankings on 10 topics covered in the World Bank's Doing Business. The ranking on each topic is the simple average of the percentile rankings on its component indicators. (Source: The World Bank)	**Reflection of business readiness**	**Lower ease of doing business numerical rank = higher IoT score**
Startup procedures		
Startup procedures are those required to start a business, including interactions to obtain necessary permits and licenses and to complete all inscriptions, verifications, and notifications to start operations. (Source: The World Bank)	**Reflection of business readiness**	**Lower number of startup procedures = higher IoT score**

CRITERIA	IDC'S RATIONALE FOR INCLUSION	IDC'S ASSESSMENT
IoT spend		
IoT spend across 20 primary vertical markets (mutually exclusive and collectively exhaustive) and 12 IoT-specific technology capabilities (including connectivity, module/sensor, security hardware, servers, storage, other hardware, ongoing service or content as a service, IT and installation services, analytics software, application software, IoT purpose-built platforms, and security software). (Source: IDC's Worldwide Semiannual Internet of Things Spending Guide)	**Reflection of technological preparedness**	**Higher IoT spend = higher IoT score**
ICT spend		
Information and communications technology spend on hardware (servers, storage, printers/MFPs, PCs, monitors, smartphones, and tablets/eReaders), packaged software (applications, application development and deployment tools, and system infrastructure), IT services (planning, implementation, support services, operations, and training and education), telecom equipment (mobile phones (smartphones/feature phones), and telecom services (fixed line and wireless). (Source: IDC's Black Book, 2015)	**Reflection of technological preparedness**	**Higher ICT spend = higher IoT score**
Cloud infrastructure		
Total market size and vendor share of public cloud services measured in revenue. (Source: IDC's Worldwide Semiannual Public Cloud Services Tracker, 2015)	**Reflection of technological preparedness**	**Higher cloud revenue = higher IoT score**
Broadband subscriptions (per 100 people)		
Fixed broadband internet subscribers are the number of broadband subscribers with a digital subscriber line, cable modem, or other high-speed technology. (Source: International Telecommunications Union)	**Reflection of technological preparedness**	**Higher number of broadband subscriptions per 100 people = higher IoT score**
Secure servers		
Secure servers are servers using encryption technology in internet transactions. (Source: The World Bank)	**Reflection of technological preparedness**	**Higher number of secure servers per 1 million people = higher IoT score**

Figure 6 G20 IoT Readiness Index Weightings



Source: IDC, 2017

Estimated Net Economic Benefits of IoT – Methodology

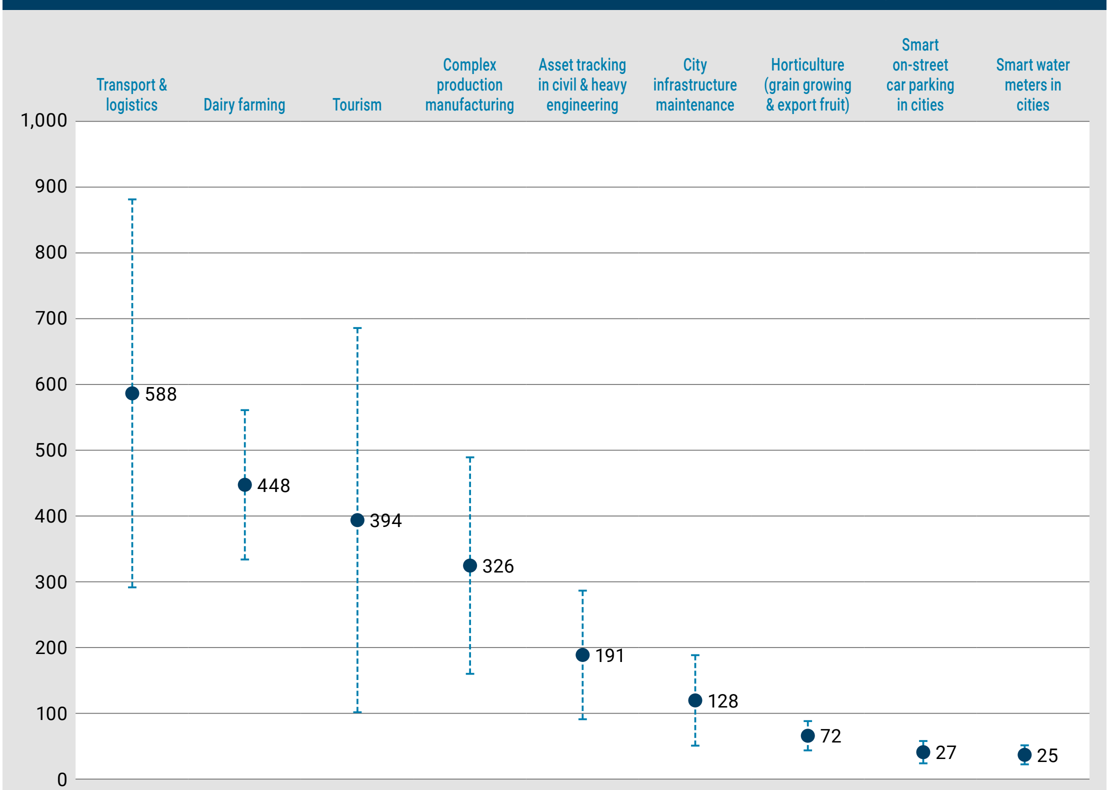
Sapere Research Group, an economic consultancy, undertook an analysis of nine selected applications of Internet of Things technology in New Zealand to calculate estimates of net economic benefits. The nine applications of IoT selected are indicative uses of IoT across a range of sectors that the IDC research identified as most likely to benefit from increased use of IoT.

For each application, Sapere calculated estimates of economic benefits and costs over a 10 year period. These estimates are intended to illustrate the economic potential of each application but should not be interpreted as forecasts.

The Sapere analysis relies on assumptions and has caveats that are outlined below.

The estimates of the net benefits of the nine IoT applications analysed are shown in Figure 7, including a plausible range of net benefits based on the assessment of the level of uncertainty associated with the baseline estimate in each case. In total, across these applications, Sapere estimate potential net benefits over 10 years of $2.2 billion in present value terms, with a plausible range from $1.1 billion to $3.3 billion, assuming all nine applications are taken up concurrently.

Figure 7 Estimated Net Benefits of Selected Applications of IoT in New Zealand (10 year NPV $m)



Definitions

To undertake this analysis, Sapere have defined IoT broadly to include applications where distributed Internet connected sensors collect data that is aggregated and analysed, and the results of data analysis are used for decision-making and/or to provide improved products and services.

This definition of IoT encompasses some existing specialised telemetry and machine-to-machine (M2M) communications applications in commercial and infrastructure sectors, as well as newer applications involving general purpose sensors and cloud-based data infrastructure. This is because the boundaries of IoT are blurry, and many of the factors that affect the success or uptake of new applications are also likely to affect existing applications that are similar. As a practical matter, it is impossible to apply a precise definition of what is and is not IoT to high level estimates of economic benefits and costs because such estimates do not explicitly model the different ways that different end users may apply the technology.

Information sources

Sapere have estimated the benefits and costs of IoT applications by relying first on documented reports of real world outcomes, where these exist. They also sought to corroborate and fill gaps in such evidence by discussing the impacts of IoT applications with relevant experts in New Zealand. A list of the people that were interviewed is provided in this appendix. The assumptions used for each application are explained in more detail below. The model developed is readily able to test alternative assumptions about benefit and cost parameters.

Applications

This analysis focused on business and government applications of IoT technology. Consumer oriented applications, such as 'smart home' devices and services, were specifically excluded as consumer uptake and benefits from such applications are currently more difficult to quantify given the very early stage of consumer IoT technology.

The list is by no means a complete list of the current and potential applications of IoT technology in business and government in New Zealand.

The applications analysed were:

1. Dairy farming: use of data captured by sensors in fields, in milking sheds, on farm equipment, and on cows, to make better decisions about farm management and improve productivity.
2. Horticulture: use of data captured by sensors in fields to improve farm management, reduce water use, and respond to frost conditions optimally. The analysis was confined to grain growing and exported fruit.
3. Smart water meters: installation of residential smart water meters leading to reduced manual meter reading costs and reduced water losses from leakage in the reticulated water networks in Auckland, Wellington, and Christchurch.
4. Smart on-street car parking: deployment of intelligent on-street parking systems in Auckland, Wellington, and Christchurch to better manage demand for parking and reduce the amount of time drivers spend searching for a place to park.
5. City infrastructure maintenance: use of data about the condition of infrastructure such as roads, wastewater networks, and community facilities such as parks,

libraries and swimming pools, to optimise maintenance schedules and reduce costs.

6. Asset tracking in civil and heavy engineering: use of position and performance sensors to optimise placement and use of mobile assets in large construction projects.
7. Transport and logistics: tracking of vehicles and goods, and using data analysis to improve freight routing and efficiency.
8. Tourism: tracking positions and movements of tourists, and moveable assets of tourism businesses (including employees) to manage demand and optimise service delivery.
9. Complex product manufacturing: use of sensors in factories and in finished products to monitor after-sales performance, to improve production efficiency, guide product improvements over time, and provide better customer service.

Sapere also considered the use of smart traffic management technologies in cities and the potential for these to reduce congestion on roads. However, experts feedback indicated that traffic management systems in New Zealand's main cities are already relatively 'smart' compared to many other countries, and the opportunities to further reduce traffic congestion using these types of systems appear to be relatively limited. Accordingly, Sapere did not attempt to estimate the net benefits of such systems.

Assumptions

To develop net benefit estimates, some simplifying assumptions were made that apply to all applications:

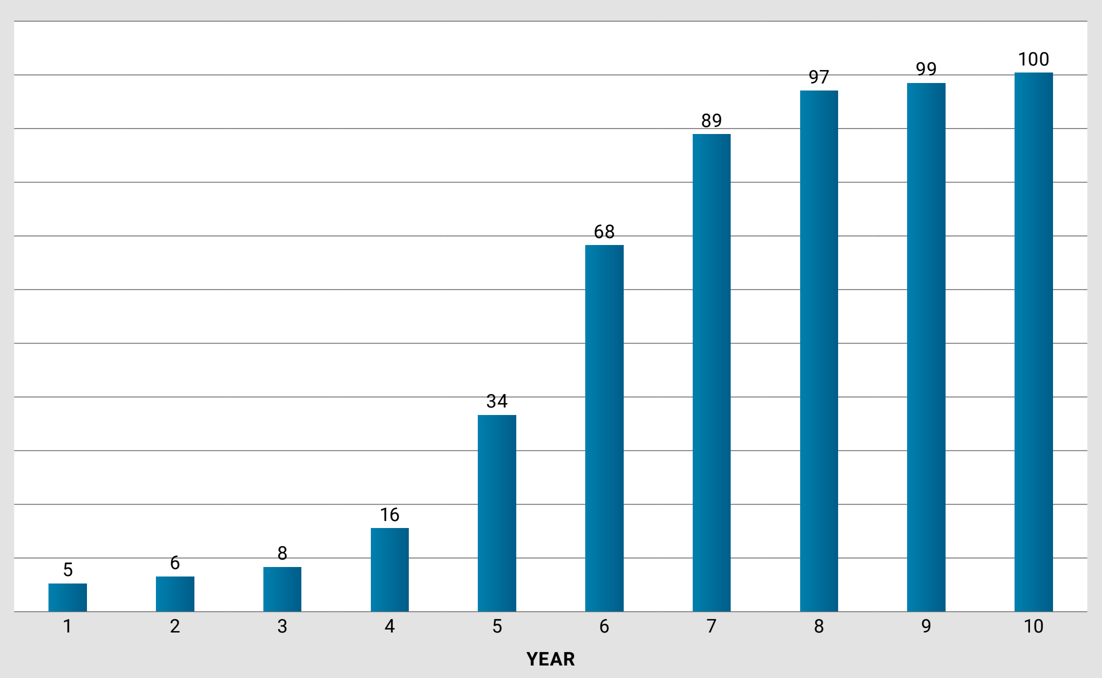
1. There is no attempt to predict the timing of uptake of each application in New Zealand. Given the early stage nature of these technologies, it is not possible to accurately predict how business and government organisations will adopt these technologies over time. To simplify, it is assumed that uptake of each application follows an 'S' curve over 10 years, with 5% of potential uptake occurring in the first year and the fastest growth rate occurring between years five and six (Figure 8). Such curves are often used to describe the adoption of new technologies.
2. The 'S' curve is used to determine the proportion of potential benefits and costs occurring in each year. An assumption is also made about the maximum potential uptake achievable in year 10 for each application. For example, it is assumed that half of New Zealand dairy farms will have adopted IoT after ten years.
3. Sapere calculated the present value of benefits and costs over 10 years using the Treasury's discount rate for telecommunications, media, and technology investments (7%). No attempt is made to estimate an individual discount rate for each application based on its risk characteristics. Instead, uncertainty about the benefits and costs of each application is handled in a simplified way (described below).
4. The above assumptions also mean that calculating net benefits across applications in any given year or in total over 10 years requires an additional assumption that net benefits from all applications are realised at the same time. In practice, this is unlikely to occur as different applications will have different timing of implementation. The aggregate net benefit estimates should therefore be interpreted as a guide to the overall potential of IoT in New Zealand, rather than a total projected benefit that can be realised. That

said, the estimates can also be used to see the relative value of different IoT applications.

5. To keep the analysis tractable, it is assumed that the drivers of the benefits and costs of each application remain constant over time, e.g. we assume constant prices for implementation, and constant annual potential benefits (in real terms). The only driver of benefits and costs in each year of the analysis period is the uptake S-curve.
6. In addition to monetary costs, interviewees indicated that some IoT applications face practical barriers to implementation caused by legal, regulatory, or commercial restrictions. The analysis implicitly assumes that such barriers have been overcome, and focuses on the benefits and costs of large scale deployment in each case. For some applications below, potential barriers to adoption that were discovered during the research are listed.
7. The duration of the analysis is arbitrary. A longer or shorter period than 10 years would produce larger or smaller net benefits. Sapere have chosen 10 years as some IoT applications require up front investments that will take some time to pay off, but beyond 10 years it is difficult to have any confidence about changes in technology.

Additional specific assumptions that were used to estimate benefits and costs of each application are outlined below.

Figure 8 Assumed 10 year adoption curve for each IoT application (Take-up rate – percent of potential)



Uncertainty

All the applications studied are in their infancy in New Zealand and, in some cases, in the world. This means that the estimates of benefits and costs are subject to a relatively high degree of uncertainty compared to more mature technologies. This uncertainty has been captured as follows:

- It is not possible to be very precise about the level of uncertainty for each application. Instead, the level of uncertainty in the benefits and costs of each application has been subjectively classified as being low, medium, or high. Then scaling factors (Table 2) have been applied to the net benefits estimated in the baseline case, to generate the alternative low and high net benefit estimates and to define the plausible range around the baseline.
- The low and high net benefits are not specific outcomes that have been modelled, but rather represent the plausible range of net benefits around the baseline net benefits. In other words, all outcomes between the low and high estimate are equally plausible.
- This assessment considered the quality of available information about benefits and costs for each application, and the extent to which the benefit and cost assumptions could be based on data rather than judgement.

Table 2 Net Benefit Uncertainty Scaling Factors

Uncertainty level for an application	Low	Medium	High
Plausible range of net benefits relative to baseline estimate	+/- 25%	+/- 50%	+/- 75%

Estimated Net Economic Benefits of IoT - Estimates & Assumptions

Dairy Farming

The estimates in dairy farming relate to using data from on farm sensors (in fields and on animals) to optimise farm operations and increase milk yield. Based on international experience, it is assumed that better informed management of dairy farms could increase yields of milk solids by 4.6% on average, which translates to $189 million per year in value at current prices for milk solids, if this improvement is achieved by half of the dairy farms in New Zealand. Sapere assess the uncertainty associated with this estimate as low, as the technology is relatively well known and has been trialled in New Zealand and elsewhere.

Current barriers to uptake of IoT on dairy farms factored into this estimate include:

- The costs and difficulties of establishing data network coverage on farms (beyond the farmhouse and cow shed). However, it is understood that new technologies are emerging to overcome these barriers.
- Resistance to change among some farmers and a lack of experience with data driven decision making.

Table 3 Net Economic Benefit Estimates – Dairy Farming

Uncertainty level: LOW

Net Benefit Scenario

Low (NPV) **$298m**

Baseline (NPV) **$448m**

High (NPV) **$599m**

Table 4 Net Economic Benefit Assumptions – Dairy Farming

Assumption	Source
Benefits assumptions	
Milk solids output increased from average of 366 kg/cow/year to 383 kg/cow/year (4.6%).	Based on figures cited in Vodafone's IoT in Agriculture Insight Guide for Irish dairy farms applying on farm sensor networks: an additional 1.74 kg/cow/day of liquid milk. Only 50% of this gain is realised by NZ dairy farms as they are relatively efficient already.
$4.50/kg market price of milk solids	NZ Dairy Statistics 2015-16
Costs assumptions	
$25,000 deployment cost per dairy farm	Estimate based on interviews
$2,500 annual operational cost per farm	Estimate based on interviews
Uptake assumptions after 10 years	
50% of dairy farms and 50% of dairy cows	Estimate based on interviews
12,150 dairy farms in NZ	Statistics New Zealand (2012 data)
5.01 million dairy cows in NZ	Statistics New Zealand (2015 data)

Horticulture (grain growing and exported fruit)

The estimates in the horticulture sector relate to on-farm applications in grain (wheat, barley, and maize) growing, and exported fruit. Data from environment and soil sensors on farms is expected to generate an incremental improvement in crop yields due to better management decisions and improved responses to adverse events such as droughts and frosts. It is also expected that growers will be able to reduce their energy usage, mainly due to optimised watering. The gross benefits if these technologies were adopted by all grain and fruit farms are estimated to be about $40 million per year.

The uncertainty associated with these estimates were assessed as low, for the same reasons as dairy farming. As with dairy, the barriers to uptake include communication issues on farms (although these are apparently somewhat less severe than on remote dairy farms) and resistance to change among farmers.

Table 5 Net Economic Benefit Estimates – Horticulture

Uncertainty level: LOW

Net Benefit Scenario

Low (NPV) ***$35m***

Baseline (NPV) ***$72m***

High (NPV) ***$108m***

Table 6 Net Economic Benefit Assumptions – Horticulture

Assumption	Source
Benefits assumptions	
1.75% increased market value of grain and exported fruit production	Based on http://www.businessinsider.com/internet-of-things-smart-agriculture-2016-10/?r=AU&IR=T
$35 reduction in energy cost per hectare per year	
Costs assumptions	
$15,000 deployment cost per farm	Estimates based on interviews; accounting for smaller size of horticulture farms compared to dairy
$1,000 annual operational cost per farm	
Uptake assumptions after 10 years	
100% of grain and fruit farms and output	Estimates based on interviews
3,867 horticulture and fruit farms	Statistics New Zealand (2012 data)

Smart residential water meters in large cities

The benefits of installing smart water meters in residential properties have been estimated for Auckland, Wellington, and Christchurch cities only. It is estimated that full residential deployment of smart water meters in the three cities could lead to reduced manual meter reading costs in Auckland of $15 million per year, and help water utilities and their customers to reduce water losses from leakage valued at $17 million per year. A medium level of uncertainty has been assessed for these estimates, primarily due to uncertainty around the costs of smart water meters.

The main barrier to large scale deployment of smart residential water meters appears to be the cost of replacing existing meters on each property. However, these costs are expected to fall as technology improves. The estimates assume that it costs $200 to replace a water meter in a dwelling (including labour costs).

Table 7 Net Economic Benefit Estimates – Water Meters

Uncertainty level: MEDIUM

Net Benefit Scenario

Low (NPV) ***$12m***

Baseline (NPV) ***$25m***

High (NPV) ***$37m***

Table 8 Net Economic Benefit Assumptions – Water Meters

Assumption	Source
Benefits assumptions	
Reduced water losses from the reticulated network of 5% of annual water volumes	Estimate based on judgment
Reticulated water valued at $1.44/m3	Based on Watercare's volumetric charge (set on a cost-recovery basis)
Manual meter reading cost savings of $30/dwelling/year ($5 x 6 readings)	Estimate based on interviews
Costs assumptions	
$200 smart meter device and installation cost per dwelling	Estimate based on interviews
$12/year smart meter operating and service cost per dwelling	Estimate based on interviews
Uptake assumptions after 10 years	
Smart meters installed on 734,000 residential dwellings in Auckland, Wellington, and Christchurch	Statistics New Zealand (2016 data)

More efficient local government infrastructure maintenance in main cities

It is expected that local government agencies can reduce infrastructure maintenance costs through the analysis of better data about the condition of various infrastructure that they are responsible for maintaining. This will enable maintenance to be based on actual condition, rather than pre-defined schedules as is largely the case at present. While some infrastructure will need maintenance earlier than expected, in aggregate it is expected that there will be cost savings as fixed maintenance schedules are usually conservative in the sense that maintenance is usually planned earlier than required.

It is estimated that 10% of infrastructure maintenance costs could be saved, generating annual gross benefits of $78 million if such technology is deployed in Auckland, Wellington, and Christchurch. A medium level of uncertainty has been assessed for these estimates, as without detailed analysis of existing maintenance patterns the potential for maintenance cost savings is not well understood.

Table 9 Net Economic Benefit Estimates – City Infrastructure

Uncertainty level:
MEDIUM

Net Benefit Scenario

Low (NPV) *$64m*

Baseline (NPV) *$128m*

High (NPV) *$192m*

Table 10 Net Economic Benefit Assumptions – City Infrastructure

Assumption	Source
Benefits assumptions	
$15.7 billion of infrastructure assets owned by Auckland Council (incl. Auckland Transport), Christchurch City Council, and Wellington City Council	Statistics New Zealand (2015 data)
Annual infrastructure maintenance costs of 5% of asset value	Estimate based on interviews
10% infrastructure maintenance cost savings with IoT	Estimate based on interviews
Costs assumptions	
Total deployment costs $120 million for Auckland, Wellington, Christchurch cities	Estimate based on interviews
Annual operational costs 10% of deployment cost	Estimate based on judgement
Uptake assumptions after 10 years	
Deployment in Auckland, Wellington, and Christchurch cities only	Assumption based on judgement

Smart on-street car parking in cities

Smart on-street car parking systems, such as the SFPark system in San Francisco, aim to improve utilisation of on-street parking and reduce the time that drivers spend searching for a place to park their vehicle. This can be achieved via a combination of providing better information to drivers about where available parking spaces are located, and dynamic pricing to better manage demand.

The analysis focuses on the value of on-street car park search time saved by drivers, estimated to be $71 million per year if all metered parking in Auckland, Wellington, and Christchurch converted to smart systems. Other benefits (not measured) include the ability to relocate some parking spaces to lower-cost locations if drivers are better informed about parking availability and increased economic activity if parking availability is optimised. A high level of uncertainty was assessed with these estimates, given lack of detailed local information about how much time drivers spend searching for on-street parking currently.

Table 11 Net Economic Benefit Estimates – Smart Parking

Uncertainty level: HIGH

Net Benefit Scenario

Low (NPV)	*$7m*
Baseline (NPV)	*$27m*
High (NPV)	*$47m*

There are some regulatory barriers to fully adopting these systems at present. Implementing dynamic pricing appears to require some existing on-street parking regulations to be changed or removed.

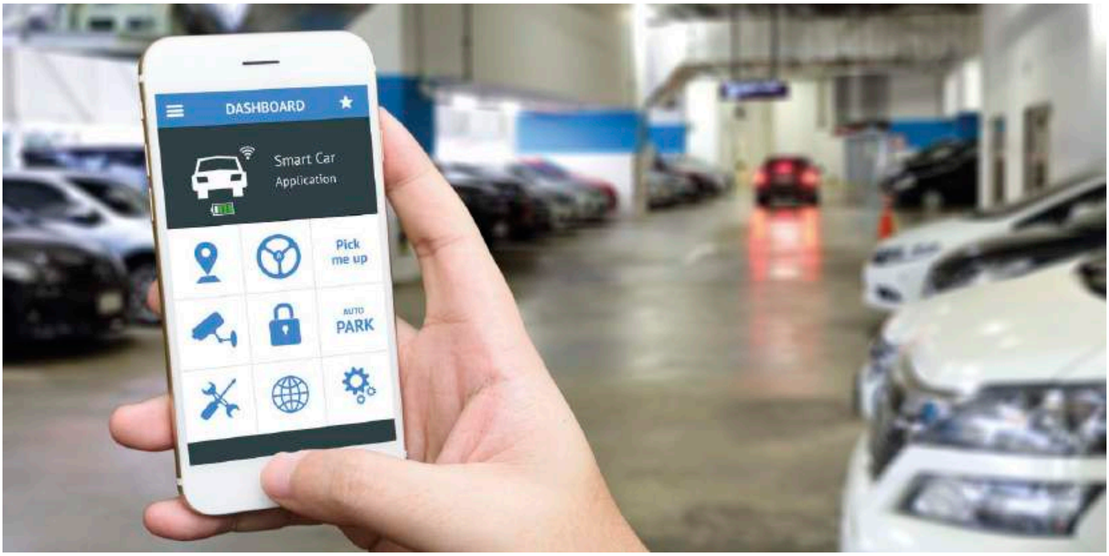


Table 12 Net Economic Benefit Assumptions – Smart Parking

Assumption	Source
Benefits assumptions	
729 million hours of car driving time per year (drivers and passengers)	Ministry of Transport travel survey
1% of all driving time spent searching for metered parking	Scaled down estimate based on http://www.uctc.net/access/38/access38_free_parking_markets.shtml
Travel time valued at $10.66/hour for drivers and $8.01/hour for passengers	NZTA Economic Evaluation Manual
15% reduction in parking search time with smart parking systems	Scaled down estimate based on http://sfpark.org/wp-content/uploads/2014/06/SFpark_Eval_Summary_2014.pdf
Costs assumptions	
$5,000 capital cost per parking meter	http://www.stuff.co.nz/motoring/news/74848235/wellingtons-new-sensor-car-parks-will-tip-parking-wardens-off-when-your-time-is-up
1,400 metered parking spaces in cities	810 in Auckland (https://www.gets.govt.nz/AT/ExternalTenderDetails.htm?id=18261099), 300 in Wellington (http://www.stuff.co.nz/motoring/news/74848235/wellingtons-new-sensor-car-parks-will-tip-parking-wardens-off-when-your-time-is-up), Remained (290) assumed for other cities
Annual operational costs 10% of deployment cost	Estimate based on judgement
Uptake assumptions	
Rolled out to all metered car parks in cities.	Assumption

Asset tracking in heavy and civil engineering

It is estimated that firms involved in heavy and civil engineering where large, mobile machines are used on construction sites can increase productivity and reduce costs through better information about the locations and performance of these assets, and by optimising their placement and use. Assuming such technologies are adopted by all heavy and civil engineering firms with 50 or more employees, gross benefits of $71 million per year were estimated. A medium level of uncertainty was assessed for these estimates, due to lack of case studies of this type of application, and lack of clarity around deployment costs.

Table 13 Net Economic Benefit Estimates – Asset Tracking

Uncertainty level:
MEDIUM

Net Benefit Scenario

Low (NPV) $96m

Baseline (NPV) $191m

High (NPV) $287m

Table 14 Net Economic Benefit Assumptions – Asset Tracking

Assumption	Source
Benefits assumptions	
$1,412m of fixed assets in the heavy & civil engineering sector	Statistics New Zealand (2014 data)
$6.47 revenue per dollar of fixed assets	Calculated from Statistics New Zealand 2014 data
1% improvement in revenue per dollar of fixed assets with better tracking and placement of assets	Estimate based on interviews and judgment
Costs assumptions	
$500,000 sensors and systems deployment cost per business	Estimate based on interviews and judgment
Annual operating cost 10% of capital cost	Estimate based on judgment
Uptake assumptions after 10 years	
Technology adopted by all firms with 50+ employees (69 firms)	Estimate based on interviews and judgment; Statistics New Zealand 2015 data
Benefits calculated on proportion of sector revenue estimated to be generated by firms with 50+ employees (78% of sector employment)	Estimate based on interviews and judgment; Statistics New Zealand 2015 data

Transport and logistics

It is estimated that larger firms (those with 50+ employees) in the transport and logistics sector could realise gross benefits of $227 million per year through improved tracking and routing. These benefits are calculated from an assumed 2% operating cost saving by such firms, for an up-front expenditure of $500,000 per firm. A medium level of uncertainty was assessed for these estimates, due to the large size of the transport and logistics sector and the difficulty of knowing how IoT technology could be used by different firms within that sector.

Table 15 Net Economic Benefit Estimates – Transport & Logistics

Uncertainty level: MEDIUM

Net Benefit Scenario

Low (NPV) $294m

Baseline (NPV) $588m

High (NPV) $882m

Table 16 Net Economic Benefit Assumptions – Transport & Logistics

Assumption	Source
Benefits assumptions	
$16.7b total annual direct operating costs of the transport and logistics sector	Statistics New Zealand (2014 data)
2% cost savings with improved tracking and routing	Estimate based on interviews and judgment
Costs assumptions	
$500,000 sensors and systems deployment cost per business	Estimate based on interviews and judgment
Annual operating cost 10% of capital cost	Estimate based on judgment
Uptake assumptions after 10 years	
Technology adopted by all firms with 50+ employees (261 firms)	Estimate based on interviews and judgment; Statistics New Zealand 2015 data
Benefits calculated on proportion of sector costs estimated to be generated by firms with 50+ employees (68% of sector employment)	Estimate based on interviews and judgment; Statistics New Zealand 2015 data

Tourism

The tourism sector generates around $63,000 in direct value added per worker, according to Statistics New Zealand's 2016 Tourism Satellite Account. It is estimated that this could increase by 5% for medium and large firms (those with 50+ employees) by using better information about tourist movements derived from sensor data (e.g. mobile phone and Bluetooth tracking) and through more efficient management of tourism service operations. If fully adopted by medium large tourism businesses, this could generate gross benefits of $168 million per year. A high level of uncertainty was assessed with these estimates, due to the fragmentation of the tourism sector and the lack of experience with such applications.

Table 17 Net Economic Benefit Estimates – Tourism

Uncertainty level: HIGH

Net Benefit Scenario

Low (NPV) ***$98m***

Baseline (NPV) ***$493m***

High (NPV) ***$689m***

Table 18 Net Economic Benefit Assumptions – Tourism

Assumption	Source
Benefits assumptions	
Total direct employment in tourism: 180,000 FTE	Statistics New Zealand (2016 data)
Direct value added per tourism worker: $63,000	Statistics New Zealand (2016 data)
Improvement in value per worker with IoT: 5%	Estimate based on judgment
Costs assumptions	
$200,000 deployment cost per firm with 50+ employees	Estimate based on interviews and judgment
Annual operating cost 50% of capital cost	Estimate based on judgment
Uptake assumptions after 10 years	
Technology adopted by all firms with 50+ employees (309 firms; used accommodation & food services as a proxy for tourism)	Estimate based on interviews and judgment; Statistics New Zealand 2015 data
Benefits calculated on proportion of sector value-added estimated to be generated by firms with 50+ employees (30% of sector employment; used accommodation and food services as a proxy)	Estimate based on interviews and judgment; Statistics New Zealand 2015 data

Complex Product Manufacturing

It is estimated that firms involved in the manufacturing of 'complex' products such as consumer electronics, medical devices and transport equipment could experience a 7% increase in productivity by optimising their manufacturing operations through analysis of sensor data from production processes and by analysing data collected from sensors embedded in products delivered to their customers.

While it is estimated that only around 20% of the GDP generated by New Zealand's manufacturing sector is associated with complex products, the relatively high value of these products means that the estimated productivity gain translates to a gross benefit of $329 million per year if fully adopted by relevant firms. A medium level of uncertainty was assessed with these estimates, due to lack of clarity about deployment costs for IoT technology, and uncertainty about the number of firms in New Zealand that manufacture complex products.

Table 19 Net Economic Benefit Estimates – Manufacturing

Uncertainty level: MEDIUM

Net Benefit Scenario

Low (NPV)	*$163m*
Baseline (NPV)	*$326m*
High (NPV)	*$489m*

Table 20 Net Economic Benefit Assumptions – Manufacturing

Assumption	Source
Benefits assumptions	
7% improvement in labour productivity	Estimate based on interviews and Cisco case study of Black & Decker use of IoT
$106,500 weighted average GDP per worker estimated for 'complex product' manufacturing sub-sectors	Estimate calculated from Statistics New Zealand 2016 data
Costs assumptions	
$100,000 deployment cost per firm	Estimate based on interviews and judgment
Annual operating cost 10% of capital cost	Estimate based on interviews and judgment
Uptake assumptions after 10 years	
Adopted by all firms estimated to be involved in 'complex product' manufacturing (7,200 firms)	Estimate based on interviews; Statistics New Zealand 2015 data

Glossary

Term	Definition
AI	Artificial Intelligence.
AT	Auckland Transport.
CCTV	Closed Circuit Television.
CEO	Chief Executive Officer.
CERT	Computer Emergency Response Team.
CoAP	Constrained Application Protocol. A communication protocol for networks with devices that have limited processing, storage or memory.
COPD	Chronic Obstructive Pulmonary Disease.
DHB	District Health Board.
EECA	Energy Efficiency and Conservation Authority.
EEZ	Exclusive Economic Zone.
EU	European Union.
EULA	End User Licence Agreement.
FPPML	Fisher & Paykel Production Machinery Ltd.
GDP	Gross Domestic Product.
HVAC	Heating, Ventilation, Air Conditioning.
ICT	Information and Communications Technology.
IDC	International Data Corporation.
IoE	Expands the concept of the IoT to bringing together people, process, data and things.
IoT	A network of uniquely identifiable end points (or things) that communicate bi-directionally without human interaction using IP connectivity.
IP	Internet Protocol. The set of rules that governs the format of data and method by which data is sent from one computer to another over the internet.
IP	Intellectual Property.
IT	Information Technology
LED	Light Emitting Diode. More efficient form of lighting than incandescent bulbs.
LPWAN	Low Power Wide Area Network. A network that connects Internet of Things devices to the internet.
M2M	A network facilitating communications between devices.
MAC	Media Access Control.
MQTT	Message Queue Telemetry Transfer. A data transfer protocol.
NB-IoT	Narrow Band IoT is a low power IoT connectivity standard.
NCPO	National Cyber Policy Office.
NIWA	National Institute of Water and Atmospheric Research.
NZTA	New Zealand Transport Agency.
OECD	Organisation for Economic Co-operation and Development.
PLC	Power Line Communication.
POS	Point of Sale.
QoS	Quality of Service.
RBI	Rural Broadband Initiative. New Zealand Government funded initiative to provide internet or better internet to New Zealanders in rural areas.
RFID	Radio Frequency Identification. A micro chipped tag can be read when it passes by an electromagnetic reader. Used for tracking objects.
RFP	Request for Proposal.
ROI	Return on Investment.
RUC	Road User Charges.
SIM	Subscriber Identification Module. Removable smart card in a mobile phone.
SME	Small to Medium Enterprise.
UFB	Ultra Fast Broadband. New Zealand Government funded initiative to provide fibre based internet to the majority of New Zealand premises in most cities and towns.
USB	Universal Serial Bus. A type of port on a device to transmit power or data. Commonly found on personal computing devices for connecting keyboards, mice, and flash drives.
WAN	Wide Area Network. A network of devices in a geographically disparate area.

References

1 Partially sourced from: "10 New Jobs Created By The Internet Of Things" HowStuffWorks.com

2 Apatov, E. et al, "Agricultural Productivity in New Zealand", 2015.

3 Statistics New Zealand, 2017. Productivity Statistics: 1978–2016

4 Statistics New Zealand, 2016. Agricultural Production Statistics: June 2016 (provisional)

5 Statistics New Zealand, 2015. Agricultural Production Statistics: June 2015

6 IDC G20 Nations and the IoT: A Comparative Assessment. Nov 2016.

7 IDC Worldwide Black Book, Version 3.2, 2016. Dec 2016.

8 IDC Worldwide Internet of Things 2016–2019 Forecast: Market Opportunity by Region and Narrowing the Lens On Use Cases. Mar 2016.

9 IDC Worldwide and Regional Public IT Cloud Services Forecast, 2016-2020. Dec 2016.

10 Cornell University & INSEAD Global Innovation Index 2016 - Winning with Global Innovation. Dec 2016

11 LexInnova. Internet of Things Patent Landscape Analysis. 2016

12 New Zealand Treasury Website. Current Discount Rates: October 2016

13 Most residential properties in Wellington and Christchurch currently have un-metered water supplies, and therefore do not incur manual meter reading costs. If this situation changes, the benefits of smart water meters will be greater than estimated.

14 See http://sfpark.org.

The following research was also referred to during the analysis:

15 Heydon, Geof and Frank Zeichner. Enabling The Internet of Things for Australia. Communications Alliance Ltd, 2015. Print.

16 McKinsey Global Institute, The Internet of Things: Mapping The Value Beyond the Hype. McKinsey Global Institute, 2016. Web. 9 Nov. 2016.

17 The Internet of Things in New Zealand: A Discussion Starter. 1st ed. Wellington: InternetNZ, 2016. Web. 21 Nov. 2016.

18 The Value of Big Data and The Internet of Things to The UK Economy. 1st ed. SAS, 2016. Web. 19 Dec. 2016.

19 The Internet of Things: Seizing The Benefits and Addressing the Challenges. 1st ed. Organisation for Economic Co-operation and Development, 2016. Web. 19 Dec. 2016.

20 Centre for Sustainability, University of Otago, Smart Homes. What New Zealanders Think, And Want. Dunedin: University of Otago, 2016. Web. 15 Jan. 2017.

21 MacGillivray, Carrie. "IDC FutureScape: Worldwide Internet of Things 2017 Predictions". 2016. Presentation.

22 IDC Energy Insights: Gas Smart Metering in Italy: Rollout Update and Emerging Communications Technologies for Utility-Grade IoT. Oct 2016.

23 IDC Worldwide Internet of Things 2016–2020 Forecast: Regional Market Opportunity by Use Cases. Sep 2016.

24 IDC IoT Standards Bodies, Consortia, And Alliances: Defined. Mar 2016.

25 IDC International Initiatives in IoT. Aug 2016

26 IDC Worldwide Consumer Internet of Things Taxonomy. Dec 2015.

27 IDC Market Analysis Perspective: Worldwide IoT Ecosystem and Trends. Sep 2016

28 IDC Enterprise Mobility: Managing Stakeholders in an IoT Ecosystem. May 2015

29 IDC Market Analysis Perspective: Asia/Pacific (Excluding Japan) Internet of Things Ecosystem and Trends. Jan 2017

30 IDC FutureScape: Worldwide Internet of Things 2017 Predictions. Nov 2016

31 Kafle V.P. et al. Internet of things standardization in ITU and prospective networking technologies. IEEE Communications Magazine 54(9):43-49. Sep 2016

32 Naito K. A Survey on the Internet-of-Things: Standards, Challenges and Future Prospects. Journal of Information Processing 25:23-31. Jan 2017.

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